Montlake Triangle and Lower Rainier Vista

UNIVERSITY OF WASHINGTON

Project No. 203593
Date of Specifications: March 20, 2012

PROJECT MANUAL
Volume II
Divisions 2 - 34

CIVIL AND STRUCTURAL
KPFF Consulting Engineers
1601 Fifth Avenue, Suite 1600
Seattle, WA 98101
(206) 622-5822

LANDSCAPE AND DESIGN
Gustafson Guthrie Nichol
1101 Alaskan Way, Floor 3
Seattle, WA 98101
(206) 903-6802

ELECTRICAL AND LIGHTING
Affiliated Engineers | Pivotal Lighting
1601 Fifth Avenue, Suite 1400
Seattle, WA 98101
(206) 256-0800

BUILDING ENVELOPE
Wetherholt and Associates
13104 N5 85th Street
Kirkland, WA 98083
(425) 822-8397

ELECTRIC TROLLEY BUS SYSTEM
LTK Engineering Services
505 Fifth Avenue South, Suite 640
Seattle, WA 98104
(206) 288-1780

GEOTECHNICAL
Shannon & Wilson
400 N. 34th Street, Suite 100
Seattle, WA 98103
(206) 695-6823
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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. References and standards listed herein are to be the latest edition available, unless specifically stated otherwise.

1.2 SUMMARY

A. Section Includes:
   1. The work includes removing and disposing of or salvaging materials as indicated on the plans or directed by the Engineer. The work also includes the backfilling of trenches, holes or pits that result from such removals.

B. Related Sections:
   1. Division 01 Section "Submittals Procedures"
   2. 01 56 39 Temporary Tree and Plant Protection
   3. 01 57 13 Temporary Erosion and Sediment Control
   4. 31 00 00 Earthwork
   5. 31 11 00 Clearing and Grubbing

C. All work to be performed and materials to be used shall be in accordance with the 2011 Standard Specifications and Standard Plans for Road, Bridge and Municipal Construction, as published by the City of Seattle (COS), unless otherwise indicated herein.

D. The Contractor shall have one copy of the Standard Specifications and Standard Plans at the job site.

E. The Standard Specifications apply only to performance and materials and how they are to be incorporated into the work. The legal/contractual relationship sections and the measurement and payment sections do not apply to this document.

1.3 SUBMITTALS

A. General: Make submittals in accordance with Division 1 Section "Submittal Procedures."

B. Approved, legal disposal site locations.

C. Provide delivery/tip tickets with weights, material type, receiving location/facility listed, and monthly reports.

D. Provide lists of salvaged material with weights, material type and receiving location/facility.

E. Provide lists of items to be re-used with weights and material type identified for Owner’s purposes.
F. Protection of King County Trunk Sewer Manhole: Removal of manhole sections above operating combined sewer systems will be required. Contractor shall prepare and submit separate manhole protection plans for King County (KC) Manhole N16-2 in Northeast Pacific Street. Manhole protection plans shall address protection from falling debris and loading from construction equipment. The manhole protection plan shall address protection from falling debris and loading from construction equipment. Manhole protection plans shall be submitted for approval to King County. Submit approved manhole protection plans to the Engineer “For Information Only”.

1.4 QUALITY ASSURANCE

A. All Work shall conform with the City of Seattle Standard Specifications for Road, Bridge and Municipal Construction and City of Seattle Standard Plans, 2011 edition, as modified herein, and with the Street and Sidewalk Pavement Opening and Restoration Director’s Rule, 5-2009.

B. The Contractor shall have one copy of the Standard Specifications and Standard Plans at the job site.

C. The Standard Specifications apply only to performance and materials and how they are to be incorporated into the work. The legal/contractual relationship sections, and the measurement and payment sections do not apply to this document.

PART 2 - PRODUCTS

Not applicable.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. See Section 01 56 39 Temporary Tree and Plant Protection. Only remove trees indicated for removal on the plans. All other trees must be protected.

B. The Contractor shall perform utility locates in areas of demolition prior to initiation of demolition activities.

C. The Contractor shall raze, remove and dispose of all utilities and foundations, structures, fences and other obstructions as indicated on the plans. The exceptions are utility-owned equipment, items indicated to remain on the plans, and any other items the Owner may direct the Contractor to leave intact. The Contractor shall:

1. Remove foundations and slabs completely.
2. Fill the cavities left by the removal of structures. The fill shall match the level of the surrounding ground. Any such fill shall be compacted to meet the requirements of Section 31 00 00 Earthwork.
3. Make a vertical saw cut between any existing improvements to remain and the portion to be removed.
4. Install bypass pumping as required prior to removing utilities.
5. Replace at no expense to the Owner any existing improvements to remain that are damaged during the removal of other improvements.
D. The Owner will provide a list of items to be salvaged and returned to the owner. Any material not named as the Owner's property will belong to the Contractor. The Contractor shall store or dispose of such material off-site in a safe and legal manner at no expense to the Owner.

E. Contractor shall prioritize diversion of waste from landfill and proper source separation.

END OF SECTION 02 41 13
PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. The Contractor shall perform all planning, notifications, administration and execution necessary to safely remove, dispose and/or handle the regulated materials listed within this Section in accordance with local, state and federal regulations.

1.2 RELATED WORK

A. Work performed under this specification section is governed by related specification sections, plans or drawings not limited to the following:

1. Division 00 – Conditions of the Contract
2. Division 01 – General Requirements

1.3 WORK INCLUDED

A. The Contractor shall supply all labor, equipment, notifications, services, insurance, special permits and equipment necessary for the following regulated materials:

1. Asbestos:

   a. Asbestos abatement is not included in this Project.

   b. Contractor shall refer to the Hazardous Materials Survey Report (attached) and prepared by PBS Engineering + Environmental). This document lists suspect-ACMs sampled and analyzed for asbestos content, or presumed to exist (e.g. buried asbestos piping), in the areas included in the Work. The Contractor shall ensure that copies of this information are made available to and retained on the project site by all subcontractors.

   c. Contractor is cautioned that suspect-ACMs may exist in inaccessible areas included in the Work. Should suspect materials be uncovered during demolition and construction promptly inform the Owner for materials testing and seal-off the area immediately from impact or disturbance.

   d. Contractor is advised that, should additional ACMs not included in the Hazardous Materials Survey Report be encountered, the Owner may elect to include the abatement of such materials in the work at a mutually agreed upon price. Work impacting such materials is not to occur prior to the Contractor receiving explicit written authorization from the Owner, and any Work performed without such approval is performed at the Contractor’s own risk and expense.

   e. The disturbance or impact of ACMs may cause asbestos fibers to be released into the building’s atmosphere, thereby creating a potential health hazard to building occupants. Contractor is to apprise all workers, supervisory personnel, subcontractors and consultants who will be at the jobsite of the seriousness of
this potential hazard and of proper Work procedures that must be followed, should it occur.

f. Where in the performance of the Work, workers, supervisory personnel, subcontractors, or consultants encounter, disturb, or otherwise function in the immediate vicinity of any identified ACMs, Contractor shall take appropriate continuous measures, as necessary, to protect its employees and subcontractors from the potential hazard of exposure to airborne asbestos. Such measures shall include the procedures and methods described herein, and compliance with applicable local, state and federal regulations.

g. Damage of Asbestos by the Contractor: Damage to asbestos-containing materials to remain caused by the Contractor shall be repaired to the satisfaction of the Owner by the Contractor using certified asbestos workers according to these specifications, and at the sole expense of the Contractor.

2. Lead:

a. Lead-containing items and related handling requirements are in the scope of work.

b. The Owner’s consultant has conducted a survey of representative areas in the Building to be impacted by the Work for the presence of lead-containing components. Findings and related analytical data are included in the attached in the Hazardous Materials Survey Report. Based on the report, lead-containing paint was identified on coatings (green, yellow and gray paint) associated with steel railings, light poles and traffic barrier post.

c. Contractor shall comply with all applicable regulations, laws and ordinances concerning the impact, removal, handling, storage, disposal, monitoring and protection against exposure or environmental pollution related to building components containing lead coatings or lead products. Impacts to lead that may be required by the Work include, but are not limited to: product installation, manual demolition, mechanical demolition, cutting, sawing, drilling, sanding, scraping, welding or torch-cutting. Confirm required impacts with other applicable specification sections and drawing sheets. In addition, provide all infection controls and engineering controls per contract requirements.

d. Work impacting lead-containing painted coatings and lead-containing items and products within this contract is the responsibility of the Contractor, and all affected Sub-Contractors, and shall be performed in accordance with all applicable local, state and federal regulations and the requirements outlined specification Section 02 83 00, Lead-Related Activities.

i. Based on paint chip testing data, historical waste characterization data and the Environmental Consultant’s calculations of lead concentrations in the anticipated waste stream, it is anticipated that disposal of the waste stream generated by the Work will not require waste characterization or disposal according to WAC 173-303, Dangerous Waste Regulations.

ii. The Contractor is to submit a description of actual waste stream constituents, including approximate volumes, to be generated by the Work for review by
the Environmental Consultant. Include approximate volumes and types of waste stream constituents to be disposed of as solid waste, accounting for any waste minimization or recycling. Lead-containing items must be handled and be disposed of as general construction debris (landfill) at a UW approved landfill and cannot be recycled even if TCLP lead results are below 5 parts per million. Recycling is permitted for metal or steel components.

iii. Provide submittal information outlined in Section 02 83 00, Lead-Related Activities, for all trades impacting lead-containing painted surfaces and substrates.

iv. Contractor is responsible for the handling of all dust, debris, disposable protective equipment, cleaning rags, wash water, and any other materials contaminated with residues from activities impacting lead-containing painted coatings or lead components, such as surface preparation, sanding, scraping, etc. Owner will disposed-off all dangerous waste (construction solid debris that failed waste profiling for lead and other regulated metals). Dangerous waste will be drummed or properly packaged and containerized by contractor for Owner disposal.

3. Polychlorinated biphenyls (PCBs):
   a. PCB-containing light ballast was not identified at the project site.

4. Mercury
   a. Fluorescent Lighting Tubes:
      i. Fluorescent lighting tubes and compact fluorescent lights must not be disposed-off as general construction debris as they contain mercury. Intact fluorescent and undamaged light tubes are much cheaper to dispose of than broken light tubes, contractor to ensure these items remain intact during handling, removal, storage, and transport.

      ii. Whole fluorescent light tubes and light ballast from the project on the Seattle campus are recycled through UW recycling program through the UW EH&S Environmental Programs Office (EPO). Coordinate with the Owner’s representative for the recycling program. To initiate this process, the Owner will contact UW Recycling by calling the Recycle Information Line at 206.616.0595 at a minimum one week prior to the scheduled removal of lamps.

      iii. The UW’s fluorescent tube-recycling vender will drop off and subsequently pick up the appropriate number of fiber drums at the project location on specified dates. The project will be billed directly for tube recycling. Fluorescent tubes must be managed under the state Universal Waste rules and all fluorescent tube drums must be labeled as Universal Waste (usually the recycling contractor does this, but it is the ultimate responsibility of the Construction Manager to label them). The drums must also be under the generator’s control at all times and must be stored at a covered or indoor site.

      iv. Broken bulbs are disposed of as hazardous waste through UW EPO as well. Contractor to provide to Owner for review their work plan to address
removal of light tubes and light ballast including all appropriate worker protection and environmental controls.

v. UW EPO will provide containers for removed light ballast to be deposited which will then be recycled through the UW Recycling program.

5. Refrigerants – Not Used – Not in the Scope


8. Contaminated Ductwork - Not Used – Not in the Scope

9. Biological Hazards - Not Used – Not in the Scope

10. Silica and Fugitive Dust

   a. Silica-containing building materials such as concrete slab and walls are present in the areas of work to be impacted. Contractor is responsible for handling, removal, storage, and proper recycling of silica-containing materials according to all applicable regulations and employee protection.

   b. Construction activities including but not limited to chipping, drilling, sawing and jack hammering and other general construction or demolition require control of potentially airborne silica dust from contaminating the environment. Impact of these building materials with detectable concentrations of silica shall be performed according to Washington Labor and Industries regulations for Silica in Construction (WAC 296-841).

   c. All employers of personnel performing work related to the above are to submit the following information related to all tasks to be performed by their personnel: Work Safety Plan to address Silica: Provide a detailed description of the work impacting Silica in building materials to be performed, including: personal protective equipment and engineering controls to be implemented during the work, decontamination procedures, access restriction procedures and controlled/restricted areas, enclosures, debris clean-up procedures, exposure assessments and any related air monitoring.

   d. Recycling Information of Waste: Prior to commencing work, provide the name, address and phone number of the proposed end-point facility to receive Silica in building materials removed from the project site. Submit to the Owner all waste manifests and recycling receipts during removal operations on a weekly basis.

11. Contaminated Soil Remediation – Not Used – Not in the Scope


1.4 WORK NOT INCLUDED

A. Not Used

PART 2 - PRODUCTS
2.1 MATERIALS
A. Not Used

2.2 EQUIPMENT
A. Not Used

PART 3 - EXECUTION

3.01 WORK PERFORMED BY ENVIRONMENTAL CONSULTANT
A. All necessary sampling and analysis for determination of ambient air levels, regulated materials, regulated metals (Lead) or dangerous waste streams and waste profiling will be performed for the Owner by the Environmental Consultant.

END OF SECTION 02 80 00
PART 1 - GENERAL

1.1 SUMMARY OF WORK

A. General work items include, but are not limited to:

1. Compliance: Activities requiring compliance with this Section include the impact and installation of painted coatings or building components containing lead as defined in these Specifications. Impacts may include, but are not limited to: installation of building products and tie-ins, manual demolition, mechanical demolition, cutting, sawing, scraping, surface preparation, drilling, sanding, welding or torch-cutting. See section 02 80 00, for information regarding lead-containing items and products in areas of the Work. Recycling of metal or steel components and building materials is permitted.

2. Handling: Conduct activities involving lead-containing coatings on concrete wall assemblies under Work of this Contract in accordance with this Section and current applicable state and federal regulations including WAC 296-62-07521: "Lead"; WAC 296-155-176: "Occupational Health and Environmental Control"; and 29 CFR 1926.62: "Lead Exposure in Construction - Interim Final Rule".

3. Initial waste stream characterization of the site indicates demolition debris will not require hazardous waste handling and disposal related to lead, and may be disposed-off as general solid waste (construction demolition and land clearing debris) using Owner approved facilities and landfill.

4. Upon waste profiling, lead-containing items and lead painted building materials must be segregated and handled as regulated waste without regard to waste stream characterization and must be disposed of as general construction debris (for landfill) and cannot be recycled.

5. Monitoring: Monitoring of airborne concentrations of lead in accordance with WAC 296-155-176 and this Section (contractor’s responsibility). The intent of this Section is to reduce and maintain employee exposure to lead and surrounding environmental airborne concentrations at or below the permissible exposure limit.

1.2 RELATED SECTIONS

A. Work performed under this specification section is governed by related specification sections, plans or drawings not limited to the following:

1. Division 00 – Conditions of the Contract

2. Division 01 – General Requirements

1.3 SUBMITTALS

A. Submit four bound sets the following "Pre-Work Submittals" prior to start of work. The Work may not proceed until complete Pre-Work Submittal package has been reviewed and approved by the Environmental Consultant. Allow ten days for Owner review.

1. Lead Compliance Program: Submit a site-specific lead compliance program in accordance with WAC Chapter 296-155 and EPA lead renovation requirements. The plan shall be developed and implemented to provide engineering, work practice and administrative controls to reduce and maintain employee exposure to lead at or below the permissible exposure limit. The plan will include at a minimum task-specific descriptions of activities; controls; personnel;
procedures; method of compliance; technology used to meet compliance; air monitoring plan; detailed schedule; work practice program; administrative controls and other relevant information. Implementation of work practices not described in the Lead Compliance Plan will not be permitted until an amendment to the submittal is reviewed by the Environmental Consultant and Owner.

2. Medical Program: Submit written proof medical exam program complies with OSHA Lead Regulations 29 CFR 1910.2 and 1926.62, and WAC Chapter 296-155. Initial medical surveillance consisting of biological monitoring in the form of blood sampling and analysis for lead and zinc protoporphyrin levels shall be submitted for each employee occupationally exposed to lead at or above the action level.

3. Worker Training Program: Submit written proof indicating that all employees impacting lead-containing materials have received training per 29 CFR 1926.62 and WAC Chapter 296-155. Proof shall include a signature from the Contractor's Principal indicating that all employees performing lead related activities have completed such a program.


5. Waste Stream Calculations: Submit a detailed breakdown of waste stream constituents and associated volumetric calculations for review by the Environmental Consultant to determine the need for additional waste stream calculation or further waste characterization.

B. Final Submittals:

1. Project Record Documents: Provide record of lead control activities including disposition of each type of lead-containing item and products removed from the site.

2. Air Monitoring: Submit copies of all air monitoring data (including sample data sheets), chain-of-custody documentation and calibration records related to the initial exposure assessment for workers impacting lead-containing materials.

3. Disposal: Submit completed disposal manifests and bills-of-lading for any waste disposed of as "dangerous" per WAC 173-303, or any items recycled as lead.

1.4 AIR MONITORING

A. Testing Laboratory: An Independent Testing Laboratory shall be retained by the Contractor for all lead air analysis. All exposure monitoring analysis shall be performed in accordance with 29 CFR Part 1926.62 and WAC Chapter 296-155. The laboratory must participate in the ELPAT Program and be a member of AIHA. Air sample collection may be performed by an Industrial Hygienist or the Contractor's trained supervisor at the Contractor's option.

B. Sample Documentation: Documentation shall be kept for each filter sample procured as to worker sampled, social security number, activity, work area location, date and time taken, volume of air drawn through filter, pump identification number and calibration. Documentation shall indicate in what areas tests were taken and shall clearly indicate the specified maximum allowable levels for each area tested. Report all data. Complete laboratory chain-of-custody records.

C. Analysis Procedures: The samples shall be collected on 37 mm filters and analyzed within 24 hours using NIOSH Analytical Method No. 7105 or 7082. The containers shall be clearly labeled with project name and Sample Number and shall become property of the Owner at work completion at the Owner's request.
D. Contractor's Sampling During Lead Related Activities:

1. Initial exposure: Exposure monitoring shall be performed by the Contractor during impact of representative lead-painted building components per WAC 296-155.

2. Most Contaminated Worker: The Contractor shall determine which worker(s) in each work area is probably experiencing the most severe exposure. This is the "Most Contaminated Worker(s)". An 8-hour TWA samples shall be collected on this worker(s). Worker shall wear a personal sampling pump and the sample shall be drawn from the breathing zone of this worker.

3. Number of samples: The number of air samples collected shall be as defined in the approved Lead Compliance Program. Historical measurements per WAC 296-155 may be used to satisfy continuing exposure assessment requirements.

E. Work Area Monitoring

1. Monitoring: The Owner reserves the right to monitor Contractor's performance via air, dust wipe and TCLP samples during lead related activities, in addition to the Contractor's exposure monitoring and testing. Sampling by the Owner will not be available for use as the Contractor's Initial Exposure Assessment.

2. Quality Control

   a. Maximum allowable airborne concentrations: Contractor shall ensure that at all times airborne concentrations of lead outside lead work areas are maintained at or below the OSHA Action Level of 30 μg/m³.

   b. Immediately upon being notified of concentrations exceeding the specified maximum allowable levels, the Contractor shall perform the following steps in the order presented, at no additional cost to the Owner: Stop lead related activities work, identify source of high lead concentrations, develop plan with Environmental Consultant and Owner to complete lead related activities in a manner to prevent visible emissions and elevated lead levels.

1.5 SUBCONTRACTORS

A. Subcontractors employed by the Contractor shall be bound to all the work and safety standards specified. Subcontractor's personnel shall meet requirements as specified, and shall be supervised by the Contractor during performance of this work.

1.6 LIABILITY

A. The Contractor is an independent contractor and not an employee of the Owner, Architect or Environmental Consultant. The Owner and the Environmental Consultant shall have no liability to the Contractor or any third persons for Contractor's failure to faithfully perform and follow the provisions of these Specifications and the requirements of the governing agencies. Notwithstanding the failure of the Owner or the Environmental Consultant to discover a violation by the Contractor of any of the provisions of these Specifications, or to require the Contractor to fully perform and follow any of them, such failure shall not constitute a waiver of any of the requirements of these Specifications which shall remain fully binding upon the Contractor.

PART 2 - PRODUCTS

2.1 PROTECTIVE CLOTHING AND EQUIPMENT
A. Personnel Protective Equipment and materials for Lead-related activities shall be provided per WAC 296-155.

PART 3 - EXECUTION

3.1 WORK PRACTICES

A. Restrictions: The use of mechanical methods including, but not limited to power sanding, grinding, sand-blasting, etc. shall be performed within a negative pressure enclosure (NPE) pending approval of negative exposure assessment by the Owner.

B. Negative Exposure Assessment: The Contractor may waive the requirement of a negative pressure enclosure when using mechanical methods upon approval by the Environmental Consultant of data indicating a negative exposure assessment has been completed per WAC 296-155 and paragraph 1.4, Air Monitoring. The Contractor shall allow 48-hours for review of such data.

C. Housekeeping: Maintain all surfaces as free as practicable of accumulations of lead and perform clean-up of work areas as necessary according to WAC 296-155-17617.

D. Work Practices:

1. Set-up Activities: Prior to impact of lead-containing painted components, Contractor shall cover the ground below the work area with 6-mil plastic sheeting or equivalent. The drop-sheeting shall extend outward a minimum of 6 feet from the location of item(s) being removed. Any tears that occur in the drop-sheeting shall be immediately repaired with duct tape or other acceptable seal. Debris shall be collected with a wet/dry vacuum to avoid escape from the drop-sheeting. Wash water shall be retained on the drop-sheeting and removed by mops or wet/dry vacuums. The residue/debris and water shall be placed in storage drums for testing prior to disposal. See paragraph 3.1-E for testing requirements.

2. Perform work impacting lead-containing items and painted components in accordance with approved lead work plan. Use procedures and equipment required to limit occupational and environmental exposure to lead when lead-containing paint is impacted. The procedures employed by the Contractor shall not create the potential for contaminating surrounding areas or materials with lead-containing dust. Dust generation shall be minimized at all times.

3. At completion of the above operations, HEPA vacuum drop-sheeting to remove any paint particles or debris. Wet-wipe or mop plastic sheeting to remove all dust.

E. Water and Debris Testing

1. Water collected with wet/dry vacuums be filtered to remove paint and debris chips and then stored in drums for testing. The paint and debris chips shall be placed in a separate drum for disposal at the Contractors expense. No rinse water shall be discharged without testing by the Environmental Consultant.

2. Debris Testing: A representative sample from debris shall be collected for TCLP testing by the Environmental Consultant. The method/location of disposal will be established by test results. See paragraph 3.1-F for disposal requirements.

F. Disposal Procedures:

1. Waste characterization and sampling of the anticipated general waste stream will be
performed by the Owner as necessary. Results of such characterization will be provided to the Contractor as appropriate. The Owner anticipates that disposal of demolition debris can be performed as general construction waste.

2. Leaded or Lead-Containing Building Materials Disposal: Any waste failing TCLP and categorized as hazardous and regulated waste will be separated and segregated from the general construction/demolition debris, packaged and disposed through UW's Environmental Programs Office. Contractor shall coordinate with Owner for arrangement of the disposal of properly packaged leaded building materials.

3. Construction Debris containing lead paint: Construction and demolition debris such as concrete generated from the project site will be treated as construction/demolition and land clearing debris (CDL) waste for landfill even if TCLP test for lead leachate is below 5 parts per million. CDL solid waste will be disposed-off at an Owner approved landfill listed below:

   a. Rabanco Regional Disposal Facility in Roosevelt, Washington
   b. Eastmont Transfer Station in Seattle, Washington
   c. Cedar Hills Landfill in Maple Valley, Washington
   d. CWM Landfill in Arlington, Oregon
   e. WCI Finley Butte Landfill, in Boardman, Oregon
   f. CWM Landfill in Kettleman Hills, California

END OF SECTION 02 83 00
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. References and standards listed herein are to be the latest edition available, unless specifically stated otherwise.

1.2 SUMMARY

A. This Section specifies cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:

1. Footings.
2. Interior Slabs-on-grade.
3. Suspended slabs.
4. Building walls.
5. Concrete retaining walls.

B. Related Sections include the following:

2. Division 03 Section “Architectural Concrete” for general building applications of specially finished formed concrete at exposed bridge and wall surfaces.
3. Division 03 Section “Precast Architectural Concrete” for precast benches and wall caps.
4. Division 09 Section “Painting” for finish coat requirements at Approach Ramp. Coordinate with surface preparation specified in this section.
5. Division 09 Section “Graffiti-resistant Coatings” for finish coat requirements at site walls and bridge structure. Coordinate with surface preparation specified in this section.
6. Division 12 Section “Site Furnishings” for skate deterrents and miscellaneous foundations.
7. Division 31 Section "Earthwork" for drainage fill under slabs-on-grade.
8. Division 32 Section "Rigid Paving" for exterior concrete pavement, walks, and topping slabs.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.

1.4 SUBMITTALS

A. Submit in accordance with Division 01 Section "Submittal Procedures."
B. Product Data: For each type of product indicated.

C. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1. Submit proposed mix designs at least 15 days in advance of placing operations for each type of concrete. The submitted mix designs shall include the following:
   a. The Concrete Mix Design Submittal Form is included in this specification. Either the "Field Experience Method Form" or the "Trial Batch Method Form" may be used. Fill out the forms in their entirety.
   b. Supporting test data not more than 12 months old. At the Engineer's request, reports from the independent testing agencies may be required to document the test data.
   c. Statistical analysis in compliance with ACI 301.
   d. Gradation of fine and coarse aggregates not more than 90 days old (ASTM C 33). No substitution of aggregate type or size from those submitted will be permitted.
   e. Proportions of all ingredients, including all admixtures added either at time of batching or at job site. Aggregate weights shall be based upon saturated surface dry conditions.
   f. Water/cement ratio.
   g. Slump (ASTM C 143): When high range water-reducing admixtures are used, slump before and after addition of admixture are required.
   h. Air content of freshly mixed concrete (ASTM C 231).
   i. Strength is measured at 7 and 28 days. For mixes with a 56-day acceptance strength, strength shall be measured at 7, 28, and 56 days. Strengths shall be as tested using 4" x 8" cylinders in accordance with ASTM C 31 and ASTM C 39.
   j. Certification that all ingredients in each mix design are compatible.
   k. Locations or intended use of each mix design.
   l. Source of all materials.

2. Indicate amounts of mixing water to be withheld for later addition at Project site.

D. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement. Provide placement details for all specific reinforcing intersection and clearance conditions not shown by the typical details on the structural drawings. Prepare drawings in sufficient detail to resolve all reinforcement intersections.

E. Formwork Shop Drawings: Design, engineering, and shop drawings for formwork are the Contractor's responsibility and are to be prepared by or under the supervision of a qualified professional engineer detailing fabrication, assembly, and support of formwork.

1. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and installing and removing reshoring.
F. Concrete Forming Drawings: Drawings indicating the in-place cast shape, size, and location of formed concrete surfaces including, but not limited to, the following:
   1. Top of concrete elevations.
   2. Concrete soffit locations at slabs, beams, and other horizontal members.
   3. Penetrations, sleeves, or openings in concrete slabs, walls, beams, or other members.
   4. Details of unique forming conditions.
   5. Beam or slab cambers.

G. Embedded Item Placement Drawings: Drawings indicating the location and type of plates, anchorages, or other items to be embedded in the finished concrete surfaces. Include wall elevations, slab plans, and details required to locate and install embeds.

H. Qualification Data: For Installer.

I. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:
   1. Aggregates.

J. Material Certificates: For each of the following, signed by manufacturers:
   2. Admixtures.
   3. Form materials and form-release agents.
   4. Steel reinforcement and accessories.
   5. Waterstops.
   6. Dampproofing
   7. Curing compounds.
   8. Floor and slab treatments.
   10. Vapor retarders.
   11. Semirigid joint filler.

K. Written curing procedure.

L. Construction Joints: Indicate proposed location for all construction joints not shown on the drawings.

M. Saw Cut Joints: Indicate proposed locations for all saw cut joints not shown on the drawings.

N. Floor surface flatness and levelness measurements to determine compliance with specified tolerances.
O.  Field quality-control test and inspection reports.

P.  Minutes of preinstallation conference.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.

B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

C. Testing and Inspection: Testing and inspection shall be in conformance with Section 01 45 23. Specific concrete inspection requirements are outlined in Section 03 30 00, Part 3, Article “Quality Control.”

D. Special Inspector Qualifications: An independent agency, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.

E. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from one source, and obtain admixtures through one source from a single manufacturer.

F. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 301, “Specification for Structural Concrete.”
3. ACI 318, “Building Code Requirements for Reinforced Concrete.”

G. CRSI Publications: Comply with the following, unless more stringent provisions are indicated:

2. Documents 63 and 65.

H. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

I. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, semirigid joint fillers, forms and form removal limitations, shoring and reshoring procedures, vapor-retarder installation, steel reinforcement installation, floor and slab flatness and levelness measurement, concrete repair procedures, and concrete protection.
J. Batch Tickets: Provide batch tickets for review by inspector for each truckload of concrete used in the work, indicating project identification name and number, date, mix type, mix time, quantity, and amount of cement and water introduced.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store materials in accordance with ACI 301. Admixtures which have been in storage at the project site for longer than six months or which have been subjected to freezing shall not be used, unless retested and proven to meet the specified requirements.

B. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Avoid damaging coatings on steel reinforcement.

C. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

D. Store formwork above ground on framework or blocking in a ventilated or protected area to prevent deterioration from water and damage.

1.7 COORDINATION AND SEQUENCING

A. Coordinate schedule with other trades where embendments, attachments, or interferences occur.

B. Schedule and sequence concrete work to coordinate with fabrication and delivery schedules for items to be embedded in concrete work.

1.8 FIELD MEASUREMENTS

A. Verify that field measurements and conditions are as shown on drawings, shop drawings, or as instructed by Product Manufacturer.

1.9 REDESIGN

A. Obtain written acceptance from the Structural Engineer for Contractor-initiated redesign or departures from that indicated by the contract documents.

B. Bear costs for Contractor-initiated or construction error caused changes to type, form, system, or details of construction from those indicated by the contract documents.

C. Pay the engineering fees required by the Structural Engineer to check the adequacy of such changes.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
2. Products: Subject to compliance with requirements, provide one of the products specified.
3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
4. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

1. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
   a. High-density overlay, Class 1 or better.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

C. Void Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads. Where supports for reinforcing steel are placed directly on void forms, protective cover sheets as recommended by the manufacturer must be placed over void forms to distribute working loads, bridge small gaps, and protect void material from puncture and other damage during concrete placement. Void forms that are exposed after concrete formwork is removed must be shielded with a high density polyethylene plastic backfill retainer to prevent the migration of backfill material into voided area.

D. Chamfer Strips: Wood, metal, PVC, or rubber strips, sized as shown on the drawings.

E. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.

F. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.


G. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
1. Furnish units that will leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.

2. Furnish ties that, when removed, will leave holes no larger than 1 inch in diameter in concrete surface.

3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

2.3 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

B. Epoxy-Coated Reinforcing Bars: ASTM A 706/A 706M, deformed bars, ASTM A 775/A 775M, epoxy coated, with less than 2 percent damaged coating in each 12-inch bar length.

C. Plain-Steel Welded Wire Reinforcement: ASTM A 185, plain, fabricated from as-drawn steel wire into flat sheets.

2.4 REINFORCEMENT ACCESSORIES

A. Tie Wire: Minimum 16 gage, ASTM A 82, or acceptable patented system.

B. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain-steel bars, cut bars true to length with ends square and free of burrs.

C. Epoxy-Coated Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain-steel bars, ASTM A 775/A 775M epoxy coated.

D. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A 775/A 775M.

E. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

1. For concrete surfaces exposed to view or weather where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports or plastic bar supports.

2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports or plastic bar supports.

2.5 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:

1. Portland Cement: ASTM C 150, Type I/II. Supplement with the following:

   a. Fly Ash: ASTM C 618, Class F.

B. Silica Fume: ASTM C 1240, amorphous silica.
C. Normal-Weight Aggregates: ASTM C 33, Class 3S coarse aggregate or better, graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials.

1. Unless maximum aggregate size is listed specifically under "Project Mix Requirements," the maximum aggregate size shall not exceed:
   a. Three-fourths of the minimum clear spacing between reinforcing bars.
   b. One-fifth of the narrowest dimension between the sides of the forms.
   c. One-third of the thickness of the slabs or toppings.

2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.


1. Do not use undocumented nonpotable water for concrete mixes.
2. Recycled water may be used in conformance with ASTM C 94, including optional chemical limits and the City of Seattle DPD Director's Rule 24-87.

2.6 ADMIXTURES

A. General

1. Admixtures certified by manufacturer to contain not more than 0.05 percent water-soluble chloride ions by mass of cementitious material. Do not use admixtures containing calcium chloride or thiocyanate.

2. Where more than one admixture is used in the mix, furnish manufacturer's certification to the Engineer that the admixtures to be used are compatible in combination with the cement and aggregates.

3. Accelerating admixtures shall not be used.


1. Micro-Air; Master Builders.
2. Davavair 1000; W.R. Grace.
3. Air Mix; Euclid Chemical Company.

C. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
   a. Low-Range Water-Reducing Admixture
      1) Pozzolith 200-N; Master Builders.
      2) WRDA G4; W.R. Grace.
      3) Eucon WR; Euclid Chemical Company.

2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
a. Rheobuild 1000; Master Builders.
b. ADVA 100; W.R. Grace.
c. Eucon 37; Euclid Chemical Company.

5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.

6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.7 WATERSTOPS

A. Flexible PVC Waterstops: CE CRD-C 572, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.

1. Available Manufacturers:
   a. Bometals, Inc.
   b. Greenstreak.
   c. Meadows, W. R., Inc.
   d. Murphy, Paul Plastics Co.
   e. Progress Unlimited, Inc.
   f. Tamms Industries, Inc.
   g. Vinylex Corp.

2. Profile: Ribbed with center bulb.


2.8 VAPOR RETARDERS

A. Plastic Vapor Retarder: ASTM E 1745, Class A. Include manufacturer’s recommended adhesive or pressure-sensitive tape.

1. Available Products:
   a. Stego Industries Inc; Stego Wrap Class A, 10 mils.

2.9 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

1. Available Products:
   a. Anti-Hydro International, Inc.; AH Curing Compound #2 DR WB.
b. Burke by Edoco; Aqua Resin Cure.
c. ChemMasters; Safe-Cure Clear.
d. Conspec Marketing & Manufacturing Co., Inc., a Dayton Superior Company; W.B. Resin Cure.
e. Dayton Superior Corporation; Day Chem Rez Cure (J-11-W).
f. Euclid Chemical Company (The); Kurez DR VOX.
g. Kaufman Products, Inc.; Thinfilm 420.
h. Lambert Corporation; Aqua Kure-Clear.
i. L&M Construction Chemicals, Inc.; L&M Cure R.
k. Nox-Crete Products Group, Kinsman Corporation; Resin Cure E.
l. Symons Corporation, a Dayton Superior Company; Resi-Chem Clear Cure.
m. Tamms Industries, Inc.; Horncure WB 30.
n. Unitex; Hydro Cure 309.

2.10 DAMPROOFING

A. Cold-Applied Dampproofing for Retaining Walls: Water-based emulsified-asphalt dampproofing and vapor-retarding coatings for use on "green" or slightly damp surfaces, reinforced with short fibers for application by brush or spray.
1. Available Products
   a. Sonneborn Hydrocide 700B

2.11 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber
B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 per ASTM D 2240.
C. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
D. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:
   1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
E. Overlay System: two-component, polymer-modified, portland-cement, fast-setting, trowel-grade mortar approved for thicknesses of 1/8 inch to 4 inches.
   1. Available Products
a. Sika Corporation: SikaTop 122 PLUS

2.12 CONCRETE MIXTURES, GENERAL

A. Concrete mix design shall comply with the requirements of the structural drawings.

B. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301:
   1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

C. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than Portland cement in concrete as follows:
   1. Fly Ash: 25 percent.

D. Limit water-soluble, chloride-ion content in hardened concrete to 0.30 percent by weight of cement.

E. Admixtures: Use admixtures according to manufacturer's written instructions:
   1. Use water-reducing, high-range water-reducing, or plasticizing admixture in concrete, as required, for placement and workability.
   2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
   3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.
   4. Use corrosion-inhibiting admixture in concrete mixtures where indicated.

2.13 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

B. Fabricate in accordance with ACI 315, providing concrete cover as specified or indicated.

C. Bending and straightening in accordance with ACI 318, Chapter 7, unless otherwise noted on the drawings. No bending or straightening of reinforcement will be permitted after partial embedment in concrete. Heating of reinforcement will be permitted only if the entire operation is approved.

D. Welding and tacking of reinforcing bars is not permitted, unless specifically shown on the structural drawings. When welding of reinforcement is indicated and required, provide welds in accordance with AWS D1.4.

E. Splicing
   1. Reinforcing bars shall be lap spliced for tension with lap lengths as noted on the structural drawings.
2. At the Contractor’s option, mechanical butt splicing using an exothermic welding process, and high strength sleeves or threaded splicing may be used, provided that the mechanical splices develop the same values of strength provided by the full penetration butt welds. Threaded splices shall be capable of developing in tension at least 125 percent of the specified yield strength (Fy) of the bar.

3. Welding or tack welding of reinforcing bars to other bars or to plates, angles, etc., is prohibited, except where specifically detailed on the approved shop drawings. Where welding is approved, it shall be done by AWS/WABO-Certified Welder using E9018 or approved electrodes. Welding procedures shall conform to the requirements of AWS D1.4.

4. Locate reinforcing splices not indicated on the drawings at points of minimum stress. Indicate location of splices on shop drawings.

### 2.14 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

2. Batch Tickets: Include the amount of water in the batch from the plant and the remaining water that may be added at the site, if any.

### PART 3 - EXECUTION

#### 3.1 FORMWORK

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

C. See Division 03 Section “Architectural Concrete” for specially finished formed concrete at exposed bridge and wall surfaces.

D. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:

2. Class B, 1/4 inch for rough-formed finished surfaces.

E. Construct forms tight enough to prevent loss of concrete mortar.

F. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.

1. Install keyways, reglets, recesses, and the like, for easy removal.
2. Do not use rust-stained steel form-facing material.
G. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.

H. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

I. Chamfer exterior corners and edges of permanently exposed concrete where shown on the drawings.

J. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

K. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

L. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

M. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

N. Void Form System Placement: Store and install void forms and accessories in accordance with the manufacturer's recommendations. Place a layer of protective cover board to distribute working loads, bridge small gaps, and protect void material from puncture and other damage during concrete placement. Protect void forms from moisture and replace wet or damaged pieces prior to concrete placement. Protect exposed edges of void forms with high density polyethylene plastic retainer to keep backfill material from migrating into voided area.

3.2 EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."

2. Install connection plates, angles, or other embedded items flush with concrete surface and at accurate locations per the approved embedded item placement drawings required by Part 1, "Submittals," section.

3.3 REMOVING AND REUSING FORMS

A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 12 hours after placing concrete, if concrete is hard enough to not be damaged by form-removal operations and curing and protection operations are maintained.
1. Leave formwork for beam soffits, joists, slabs, and other structural elements that supports weight of concrete in place until concrete has achieved at least 70 percent of its 28-day design compressive strength.

2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.

3. Leave formwork in place for a minimum of 7 days and at least 75 percent of 28-day design compressive strength, whichever is longer.

B. Remove formwork progressively so no unbalanced loading is imposed on structure.

C. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.

D. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Engineer.

E. Store reusable forms for exposed architectural concrete so as to prevent damage to contact surfaces.

F. Inspect all contact surfaces prior to concrete placement. Verify that surfaces are clean, smooth, and free from foreign matter or imperfections affecting the appearance of the finished concrete. Hand-trim sides and bottoms of earth forms. Remove loose dirt prior to placing concrete.

3.4 SHORES AND SUPPORTS

A. Comply with ACI 318 and ACI 301 for design, installation, and removal of shoring and reshoring.

B. Do not remove shoring or reshoring until measurement of slab tolerances is complete.

B. Keep reshores or backshores in place a minimum of 15 days after placing upper tier, or longer, if required, until concrete has attained its required 28-day strength and heavy loads due to construction

C. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

3.5 VAPOR RETARDERS

A. Plastic Vapor Retarders: Place, protect, and repair vapor retarders according to ASTM E 1643 and manufacturer's written instructions.

1. Lap joints 6 inches and seal with manufacturer's recommended tape.

3.6 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.

1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.
B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

E. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

F. Epoxy-Coated Reinforcement: Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M. Use epoxy-coated steel wire ties to fasten epoxy-coated steel reinforcement.

G. Defective Work: The following reinforcing steel work will be considered defective, and shall be removed and replaced by the Contractor at no additional cost to the Owner:

1. Bars with kinks or bends not shown on the drawings.
2. Bars damaged due to bending or straightening.
3. Bars heated for bending.
4. Reinforcement not placed in accordance with the drawings.

3.7 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Engineer.

1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete, or as indicated.
3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
5. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
6. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
7. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
8. Provide roughened surfaces at joints where shown on the drawings. Roughen to a full amplitude of approximately 1/4-inch.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.

2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated.

2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface where joint sealants, specified in Division 07 Section “Joint Sealants,” are indicated.

3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

E. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.8 WATERSTOPS

A. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of the Work. Field fabricate joints in waterstops according to manufacturer's written instructions.

3.9 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Engineer.

C. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.

2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.

3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

D. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

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


3. Screed slab surfaces with a straightedge and strike off to correct elevations.

4. Slope surfaces uniformly to drains where required.

5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

E. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.

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

3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

F. Hot-Weather Placement: Comply with ACI 301 and as follows:

1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.

2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

3.10 FINISHING FORMED SURFACES

A. See Division 03 Section “Architectural Concrete” for specially finished formed concrete at exposed bridge and wall surfaces.
B. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
   1. Apply to concrete surfaces not exposed to public view.

C. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
   1. Apply to concrete surfaces exposed to public view or to be covered with a coating or covering material applied directly to concrete.

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

3.11 FINISHING FLOORS AND SLABS

A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
   1. Apply a trowel finish to surfaces in Triangle Garage.
   2. Finish surfaces to the following tolerances, according to ASTM E 1155, for a randomly trafficked floor surface:
      a. Specified overall values of flatness, F(F) 35; and of levelness, F(L) 25; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 17; for slabs-on-grade.
   3. Finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding, 10-foot-long straightedge resting on 2 high spots and placed anywhere on the surface does not exceed 1/4 inch.

C. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces indicated. While concrete is still plastic, slightly scarify surface with fine broom. Tool joints with a sidewalk jointer.
   1. Apply a trowel and fine-broom finish to surfaces on Approach Ramp. Match finishes on adjacent SP1 slab surfaces.
   2. Comply with flatness and levelness tolerances for trowel finishes floor surfaces.

3.12 DAMPPROOFING

A. Cold-Applied Dampproofing: Apply two coats according to manufacturer’s requirements. Backfill schedule shall also comply with the manufacturer’s recommendations.
3.13 MISCELLANEOUS CONCRETE ITEMS

A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

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

3.14 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer’s written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.

D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
   a. Water.
   b. Continuous water-fog spray.
   c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
   a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
   b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project.

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.15 JOINT FILLING

A. Prepare, clean, and install joint filler according to manufacturer's written instructions.

1. Defer joint filling until concrete has aged at least one month. Do not fill joints until construction traffic has permanently ceased.

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.

C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.16 CONCRETE SURFACE REPAIRS (PATCHING)

A. Defective Concrete: Repair and patch defective areas when approved by Engineer. Remove and replace concrete that cannot be repaired and patched to Engineer's approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part Portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension in solid concrete, but not less than 1 inch in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brushcoat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.

2. Repair defects on surfaces exposed to view by blending white Portland cement and standard Portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.

3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Engineer.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.

2. After concrete has cured at least 14 days, correct high areas by grinding.

3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.

4. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.

5. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

6. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to Engineer's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to Engineer's approval.

3.17 CONCRETE REPAIR (STRUCTURAL)

A. This includes the materials, testing and workmanship to structurally repair cracks in new concrete. Epoxy resin adhesive shall be used in an injection mode to effect the repairs.

B. Cracks larger than 0.01-inch and which extend through the full depth of the slab or wall, or are subject to allowing water leakage through the crack, shall be repaired by epoxy injection as directed by the Owner's Representative and as specified herein. All costs associated with crack repairs shall be the responsibility of the Contractor. A determination of the cracks requiring repair shall be made by the Owner's Representative near the time of Substantial Completion, assuming that some of the drying shrinkage has had time to occur.

C. Submit the following information for the firm engaged for crack repair: Previous experience information, certificates and test reports, qualifications of applicators, epoxy Manufacturer's Certification, approval of selected applicator, and technical data on materials used.

D. Provide the following quality control tests for every lot of adhesive supplied:

1. Certification and Test Report: Manufacturer shall certify that every batch of material meets test requirements and shall furnish test reports.
E. Label Requirements: Include on each label the following information; Manufacturer's name, product name and lot number, ANSI hazard classification and recommended precautions for handling, and mix ratio by volume.

3.18 QUALITY CONTROL

A. All concrete work is subject to special inspection and testing. This section specifies the minimum testing and inspection required. Additional testing and inspection may be required by the Testing Agency, the Owner, or the Engineer/Architect if project conditions warrant.

B. Testing and Inspecting: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

C. Testing and Inspecting: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

D. Special Inspector Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, and qualified according to ASTM C 1077 and ASTM E 329 to conduct the testing indicated, as documented according to ASTM E 548.

E. Tests and inspections shall be in conformance with Division 1, Section “Testing and Inspection Services.”

F. Independent Testing Agency shall check batch tickets for compliance with required mix design(s).

G. Continuous Field Inspection: The Independent Testing Agency shall be present at all times during the placing of structural reinforced concrete. Work shall not proceed until all inspections are completed. Prior to placing concrete, the Inspector shall inspect:
   1. Accuracy, configuration, and cleanliness of all formwork
   2. Quantity, cleanliness, and placement of all reinforcing steel.
   3. Testing Agency need not be present during entire reinforcing steel placing operations, provided he has inspected for conformance with the approved placement drawings prior to closing of forms or the delivery of concrete to the job site.

H. Inspections:
   1. Steel reinforcement placement.
   2. Headed bolts and studs.
   3. Verification of use of required design mixture.
   4. Concrete placement, including conveying and depositing.
   5. Curing procedures and maintenance of curing temperature.

I. Verification of concrete strength before removal of shores and forms from beams and slabs.

J. Reinforcing Steel Testing: Independent Testing Agency will perform the following:
   1. All steel bars that can be positively identified as to heat number and mill analysis shall have one tensile test bending test for each 10 tons, or fraction thereof, for all #5 bars and larger.
2. All steel bars that cannot be identified shall have one tensile and one bend test made for each 2 1/2 tons, or fraction thereof, of each size and kind of reinforcing steel.

3. Testing procedure shall conform to ASTM A 615.

K. No concrete shall be placed until placement of reinforcement steel has been inspected and approved. Provide 48 hours notice to the Inspector prior to placing concrete.

L. Concrete Sampling: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.
   a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.

3. Air Content: ASTM C 231, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.

4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.

5. Compression Test Specimens: ASTM C 31/C 31M.
   a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.
   b. At the Contractor's expense and direction, cast and field-cure standard cylinder specimens as may be required for construction. Number of specimens and testing age shall be determined by the Contractor based on construction sequence requirements.

6. Compressive-Strength Tests: ASTM C 39/C 39M; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.
   a. Test field-cured specimens at the Contractor's direction.
   b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.

7. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.

8. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive...
strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

9. Test results shall be reported in writing to Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

10. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer but will not be used as sole basis for approval or rejection of concrete.

11. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Engineer. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by Engineer.

12. Additional testing and inspecting, at Contractor’s expense, will be performed to determine compliance of replaced or additional work with specified requirements.

13. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

M. Measure floor and slab flatness and levelness according to ASTM E 1155 within 48 hours of finishing.

END OF SECTION 03 30 00
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. References and standards listed herein are to be the latest edition available, unless specifically stated otherwise.

1.2 SUMMARY

A. Section Includes:

1. Cast-in-place, smooth finished, architectural concrete, including formwork, reinforcement accessories, concrete materials, concrete mix design, placement procedures, and finishes.

B. Related Sections:

1. Division 03 Section “Cast-in-Place Concrete” for material, fabrication, steel reinforcement, joint sealants, installation requirements, and field quality control.

2. Division 09 Section “Painting” for finish coat requirements at Approach Ramp. Coordinate with surface preparation specified in this section.

3. Division 09 Section “Graffiti-resistant Coatings” for finish coat requirements at site walls and bridge structure. Coordinate with surface preparation specified in this section.

1.3 DEFINITIONS

A. Architectural Concrete: Formed concrete that is exposed to view on surfaces of the completed structure, building, bridge, or within the landscape, and that requires special concrete materials, formwork, placement, or finishes to obtain specified architectural appearance.

1.4 SUBMITTALS

A. Product Data: For each type of manufactured material and product indicated.

B. Design Mixes: For each concrete mix. Include alternate mix designs when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

C. Shop Drawings:

1. Show formwork construction including form-facing joints, rustications, construction and contraction joints, form joint-sealant details, form tie location and patterns, inserts and embedments, cutouts, cleanout panels, and other items that visually affect cast-in-place architectural concrete.

2. Custom designed form liner showing original substrate material, formed reveals, extrusions, and other items that will visually affect the finished form liner.

D. Samples: For each of the following materials:

1. Form-facing panel.
2. Form ties.

3. Aggregate.

4. Chamfer and rustication strips.

E. Placement Schedule: Submit concrete placement schedule before start of architectural concrete placement operations. Include location of all joints including construction joints, and concrete pour joints. Schedule placement to minimize appearance of color changes.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An experienced cast-in-place architectural concrete contractor who is specialized in installing cast-in-place architectural concrete similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

B. Source Limitations for Cast-in-Place Architectural Concrete: Obtain each color, size, type, and variety of concrete material and concrete mix from one manufacturer with resources to provide cast-in-place architectural concrete of consistent quality in appearance and physical properties.

C. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 301, "Specification for Structural Concrete," Sections 1 through 5 and Section 6, "Architectural Concrete."

2. ACI 303.1, "Specification for Cast-in-Place Architectural Concrete."

3. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials," unless more stringent provisions are indicated.

D. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

E. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination".

1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place architectural concrete to attend, including the following:

   a. Contractor's superintendent.

   b. Independent testing agency responsible for concrete design mixtures.

   c. Ready-mix concrete manufacturer.


1.6 MOCK UP

A. Field Sample Panels: After approval of verification sample and before casting architectural
concrete, produce field sample panels to demonstrate the approved range of selections made under sample submittals.

1. Produce full-scale panels, cast vertically, approximately 48 inches tall by 96 inches long minimum, to demonstrate the expected range of finish, color, and texture variations for each type of site wall:
   a. Type C2 walls per the structural drawings (straight walls along Montlake Boulevard).
   b. Type C6 walls per the structural drawings (curved walls near the Landbridge).

2. Locate panels as indicated or, if not indicated, as directed by Landscape Architect.
   a. Provide at least one panel joint of each type in each sample panel.
   b. Provide at least 4 ties in each sample panel.
   c. Provide at least 1 skate deterrent in each sample panel.

3. Use custom designed form liner.

4. Demonstrate methods of curing, aggregate exposure, sealers, and coatings, as applicable.

5. Notify Landscape Architect seven days in advance of dates and times when mockups will be constructed.

6. In presence of Landscape Architect, damage part of an exposed-face surface for each finish, color, and texture, and demonstrate materials and techniques proposed for repair of tie holes and surface blemishes to match adjacent undamaged surfaces.

7. Obtain Landscape Architect’s approval of mockups before starting construction.

8. Maintain approved mockups during construction in an undisturbed condition as a standard for judging the completed pavement.

9. Demolish and remove the approved mockups from the site when directed by the Landscape Architect.

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS

A. General: Comply with Division 03 Section “Cast-in-Place Concrete” for formwork and other form-facing material requirements.

B. Form-Facing Panels for As-Cast Finishes: Custom form liners as shown on Civil Drawings.
   1. Panel finish: Comply with Division 03 Section “Cast-in-Place Concrete” for smooth-formed finish concrete.
   2. Panel patterns: As indicated per the Civil Drawings.

C. Rustication Strips: Rigid plastic, or dressed wood with sides beveled and back kerfed; nonstaining.

D. Chamfer Strips: Rigid plastic, elastomeric rubber, or dressed wood, 3/4 by 3/4 inch or size shown on drawings; nonstaining.
E. Form Joint Tape: Compressible foam tape, pressure sensitive, AAMA 810.1, minimum 1/4 inch thick.

F. Form Joint Sealant: Elastomeric sealant complying with ASTM C 920, Type M or S, Grade NS, that adheres to form joint substrates.

G. Sealer: Penetrating, clear, polyurethane wood form sealer formulated to reduce absorption of bleed water and prevent migration from wood of set-retarding chemicals.
   1. Provide Nox-Crete "Pre-Form," or approved.

H. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect architectural concrete surfaces and will not impair subsequent treatments of those surfaces.
   1. Provide Nox-Crete "Form Coating," or approved.

I. Form Ties: Factory-fabricated, ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
   1. Furnish ties with tapered tie cone spreaders that, when removed, will leave holes not larger than 1 inch in diameter on concrete surface.

J. Waterstops: As indicated under Division 03 Section “Cast-in-Place Concrete”.

K. Sandblast Abrasive: KleenBlast #3060

2.2 REINFORCEMENT ACCESSORIES

A. General: Comply with Division 03 Section “Cast-in-Place Concrete” for steel reinforcement and other requirements for reinforcement accessories.

2.3 CONCRETE MATERIALS

A. Portland Cement: ASTM C 150, Type I, color as indicated, of same type, brand, and source for entire Project.

B. Normal-Weight Coarse Aggregate: ASTM C 33, from the same source for entire Project, and as follows:
   2. Gradation: Uniformly graded.

C. Normal-Weight Fine Aggregate: ASTM C 33, manufactured or natural sand, from the same source for entire Project.

D. Water: Potable, complying with ASTM C 94, free of wash water from mixer washout operations.

E. Chemical Admixtures: Certified by manufacturer to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material and to be compatible with other admixtures and cementitious materials. Do not use admixtures containing calcium chloride.
   2. Water-Reducing Admixture: ASTM C 494, Type A.
3. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.

2.4 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, washed to prevent concrete staining, weighing approximately 9 oz./sq. yd. when dry.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

2.5 DAMPPROOFING

A. Cold-Applied Dampproofing: Water-based emulsified-asphalt dampproofing and vapor-retarding coatings for use on "green" or slightly damp surfaces, reinforced with short fibers for application by brush or spray.

1. Available Products
   a. Sonneborn Hydrocide 700B

2.6 CONCRETE MIXES

A. Prepare design mixes for each type and strength of cast-in-place architectural concrete determined by either laboratory trial mix or field test data bases. Proportion concrete according to ACI 211.1 and ACI 301.

B. Use a qualified independent testing agency for preparing and reporting proposed concrete mix designs for the laboratory trial mix basis.

C. Concrete mix design shall comply with the requirements of the structural drawings and Division 3 Section “Cast-in-Place Concrete”.

2.7 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver cast-in-place architectural concrete according to ASTM C 94, and furnish batch ticket information.

1. Clean equipment used to mix and deliver cast-in-place architectural concrete to prevent contamination from other concrete.

2. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 90 to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 FORMWORK

A. General: Comply with Division 03 Section “Cast-in-Place Concrete” for formwork, embedded items, and shoring and reshoring.

B. In addition to ACI 303.1 limits on form-facing panel deflection, limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:

1. Class A, 1/8 inch.
C. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast-in-place surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical. Kerf wood rustications, keyways, reglets, recesses, and the like, for easy removal.

1. Seal form joints and penetrations at form ties with form joint tape or form joint sealant to prevent cement paste leakage.

2. Do not use steel form-facing material.

D. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

E. Chamfer exterior horizontal edges of cast-in-place architectural concrete as indicated on drawings, vertical corners to be true.

F. Coat contact surfaces of wood rustications and chamfer strips with sealer before placing reinforcement.

G. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

H. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

I. Seal form joints and penetrations at form ties with form joint tape or form joint sealant to prevent mortar leaks.

J. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

K. Do not use form ties for walls shorter than 2 feet in height above grade.

L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

### 3.2 REINFORCEMENT AND INSERTS

A. General: Comply with Division 03 Section “Cast-in-Place Concrete” for fabricating and installing steel reinforcement.

B. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

### 3.3 REMOVING AND REUSING FORMS

A. Formwork, for sides of beams, walls, columns, and similar parts of the Work, that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete, provided concrete is hard enough to not be damaged by form-removal operations and provided curing and protection operations are maintained.

1. Schedule form removal to maintain surface appearance that matches approved sample panels.
B. Leave formwork that supports weight of concrete in place in accordance with requirements specified in Division 03 Section “Cast-In-Place Concrete”. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.

C. Clean and repair surfaces of forms to be reused in the Work. Do not use split, frayed, delaminated, or otherwise damaged form-facing material. Apply new form-release agent.

D. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for architectural concrete surfaces.

3.4 JOINTS

A. Construction Joints: Install construction joints true to line with faces perpendicular to surface plane of cast-in-place architectural concrete so strength and appearance of concrete are not impaired, at locations indicated or as approved by Landscape Architect.

B. Contraction Joints: Form weakened-plane contraction joints true to line with faces perpendicular to surface plane of cast-in-place architectural concrete so strength and appearance of concrete are not impaired, at locations indicated or as approved by Landscape Architect.

3.5 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

B. Do not add water to concrete during delivery.

C. Deposit concrete continuously between construction joints. Deposit concrete to avoid segregation.
   1. Deposit concrete in forms in horizontal layers no deeper than 36 inches and in a manner to avoid inclined construction joints. Place each layer while preceding layer is still plastic and in a manner to avoid inclined construction joints.
   2. Consolidate placed concrete with mechanical vibrating equipment in accordance with ACI 303.1. Use equipment and procedures for consolidating concrete recommended by ACI 309R.
   3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations no farther than the visible effectiveness of the vibrator. Place vibrators to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing concrete mix constituents to segregate.

D. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
   1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less
than 50 deg F and not more than 80 deg F at point of placement.

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

3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators, unless otherwise indicated and approved in concrete mix designs.

E. Hot-Weather Placement: Place concrete according to recommendations in ACI 305R and as follows, when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor’s option.

2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.

3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

F. Maintain uniformity of special finishes over construction joints, unless otherwise indicated.

3.6 Dampproofing

A. Cold-Applied Dampproofing: Apply two coats according to manufacturer’s requirements.

3.7 Architectural Concrete Finish

A. Smooth-Formed Finish: Provide as-cast concrete texture imparted by form-facing material. Remove fins and other projections exceeding specified limits on formed-surface irregularities. Repair and patch tie holes and defects.


B. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces.

1. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

C. As-Cast Custom Form Finish: Provide as-cast finish with projections and formed reveals as approved by Landscape Architect. Repair projections as necessary as forms are removed. Top of walls to have smooth trowelled surface.

D. Light sandblast finish per approved sample panel

E. Apply graffiti-resistant coating per manufacturer’s requirements. Apply graffiti-resistant coating to sample panel for review and comment prior to applying to permanently placed concrete.

3.8 Concrete Protecting and Curing

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and with ACI 301 for hot-
weather protection during curing.

B. Begin curing immediately after removing forms from concrete. Cure by one or a combination of the following methods that will not mottle, discolor, or stain concrete:

1. **Moisture Curing:** Keep exposed surfaces of cast-in-place architectural concrete continuously moist for not less than seven days with the following materials:
   2. Water.
   4. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
   5. **Moisture-Retaining-Cover Curing:** Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period; use cover material and waterproof tape.

### 3.9 FIELD QUALITY CONTROL

A. **General:** Comply with Division 3 Section "Cast-in-Place Concrete" for field quality-control requirements.

### 3.10 REPAIRS, PROTECTION, AND CLEANING

A. **Repair and cure damaged finished surfaces of cast-in-place architectural concrete when approved by Landscape Architect.** Match repairs to color, texture, and uniformity of surrounding surfaces and to repairs on approved mockups.

1. Remove and replace cast-in-place architectural concrete that cannot be repaired and cured to Landscape Architect’s approval.

B. **Protect corners, edges, and surfaces of cast-in-place architectural concrete from damage; use guards and barricades.**

C. **Protect cast-in-place architectural concrete from staining, laitance, and contamination during remainder of construction period.**

D. **Clean cast-in-place architectural concrete surfaces after finish treatment to remove stains, markings, dust, and debris.**

E. Wash and rinse surfaces according to concrete finish applicator’s written recommendations. Protect other Work from staining or damage due to cleaning operations.

1. Do not use cleaning materials or processes that could change the appearance of cast-in-place architectural concrete finishes.

**END OF SECTION 03 33 00**
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. References and standards listed herein are to be the latest edition available, unless specifically
   stated otherwise.

1.2 SUMMARY

A. This section includes materials and procedures for the installation of shotcrete by the wet mix
   process as shown on drawings.

B. Related Sections
   1. Division 01 Section "Submittals Procedures."
   2. Division 01 Section "Contractor Quality Control."
   3. Division 03 Section "Cast-in-Place Concrete."
   4. Division 07 Section “Waterproofing System.”
   5. Division 31 Section “Excavation Shoring.”
   6. Division 31 Section “Soil Nails and Wall Drainage.”

1.3 DEFINITIONS

A. Shotcrete: Mortar or concrete pneumatically projected onto a surface at high velocity.

B. Flashcoat: Two-inch thick fiber-reinforced shotcrete applied to a slope or vertical neat cut wall,
   as separate from the permanent structure installation.

C. Wet-Mix Shotcrete: Shotcrete with ingredients, including mixing water, mixed before
   introduction into delivery hose.

1.4 SUBMITTALS

A. General: Make submittals in accordance with Division 1 Section "Submittal Procedures."

B. Product Data: For proprietary materials and items, including reinforcement and forming
   accessories, prebagged shotcrete materials, admixtures, patching compounds, curing
   compounds, and others required by Engineer

C. Samples: Provide samples of the materials requested by Engineer, including names, sources,
   and descriptions.

D. Mix Design: Laboratory test reports for concrete materials and mix design data, 30 days
   minimum prior to shotcrete placement. Include complete list of materials, including admixtures
   and copies of test reports showing mix has been successfully tested to produce shotcrete with
   specified properties.
E. Materials Certificates: Signed by Manufacturer and Contractor certifying that each material item complies with or exceeds specified requirements. Provide certification item from admixture manufacturers that chloride content complies with specification requirements.

F. Nozzle Operator certifications in accordance with ACI CP-60.

G. Written description of all the required procedures for both materials and application, including methods for thickness control, with samples of pins, ground wires, and any other proposed fixture.

H. Shop Drawings: For details of fabricating, bending, and placement reinforcement. Include support and anchor details, number, and location of splices.
   1. Comply with submittal requirements of Section 03 30 00 “Cast-In-Place-Concrete.”

1.5 QUALITY ASSURANCE

A. Codes and Standards: Comply with provisions of following codes, specifications, and standards, except where more stringent requirements are shown or specified:
   1. American Concrete Institute (ACI) 301, "Specifications for Structural Concrete for Buildings."

B. Testing Service: The Owner will engage a testing laboratory acceptable to Engineer to perform material evaluation tests and to design shotcrete mixes.
   1. Materials and installed work may require testing and retesting of rejected materials and shall be done at the Contractor’s expense.

C. Preconstruction Testing: Comply with requirements of ACI 506.2 and as specified. Make 3 test panels at least 4 feet by 4 feet for each mix being considered and for each shooting position to be encountered in project, complying with the applicable provision of ASTM C 1140. Make test panels by each application crew performing shotcreting work. Fabricate test panels to same thickness as structure to be shotcreted, but not less than 6 inches. Test panel shall be shot, cured, sawn examined, and tested prior to commencement of work. It shall be shot at the same angle using the same nozzle operator and equipment with the same concrete mix design that will be used on the project.

D. The sample panel shall be representative of the project and simulate job conditions as closely as possible. The panel thickness and reinforcing shall reproduce the thickest and most congested area specified in the structural design.

E. Take a minimum of five 3-inch cubes or three 3-inch-diameter core specimens from panels for testing. Test specimens for strength in accordance with ASTM C 42.
   1. The method for taking compression samples shall be approved prior to shooting the test panel and sample shall be taken at the same time the test panel is shot for comparison with core tests from the panel.
   2. When the maximum size aggregate is larger than 3/8-inch, specimens shall consist of not less than three 3-inch diameter cores or three 3-inch cubes. When the maximum size
aggregate is 3/8-inch or smaller, specimens shall consist of not less than 2-inch diameter cores or two 2-inch cubes.

3. The average of three cores from a single panel shall be equal to or exceed 0.85 $f'_c$ with no single core less than 0.75 $f'_c$. The average of three cubes taken from a single panel shall equal or exceed $f'_c$ with no individual cube less than 0.88 $f'_c$. To check testing accuracy, locations represented by erratic core strengths may be retested.

F. Installer’s Qualifications: Prior to commencement of work, demonstrate that proposed shotcreting personnel, materials, and equipment are capable of batching, mixing, conveying, and uniformly applying shotcrete in accordance with specified requirements.

1. Use nozzle operator having current certification in accordance with the guidelines of ACI CP-60 for type of shotcrete required.

G. Prefabricated/Preinstallation Conference: Conform to the requirements of Seattle DPD Director’s Rule 13-2006.

H. Tolerances:

1. For permanent shotcrete facings, comply with the following:
   a. Plan location of ground wires or other alignment control devices used to define outside wall surface: +/- 1 inch.
   b. Plan location of as-build outside face of wall:
      1) Outward: 2 inches.
      2) Inward: 1 inch.
   c. Plan location of as-built inside face of wall where inside face is a formed surface:
      Per ACI 117 for cast-in-place concrete.
   d. Cover on reinforcing steel:
      1) To ground wires or other alignment control devices: +/- 1/2 inch.
      2) To earth: -1/2 inch, +2 inches.
      3) To formed surfaces: Per ACI 117 for cast-in-place concrete.
   e. Wall Thickness: -1/2 inch, +2 inches

2. For shotcrete flashcoast, wall thickness: -0 inches, +2 inches

PART 2 - PRODUCTS

2.1 FORMING AND REINFORCING MATERIALS

A. As specified in Section "Cast-in-Place Concrete."

2.2 SHOTCRETE MATERIALS

A. Portland Cement: ASTM C 150, Type I or Type II.
   1. Use one brand of cement throughout project, unless otherwise acceptable to Engineer.
   2. Fly Ash: ASTM C 618, Type C or Type F.

B. Normal Weight Aggregates: ASTM C 33; Class 4S and as herein specified. Provide aggregates from a single source for exposed concrete.
   1. For exterior exposed surface, do not use fine or coarse aggregates containing spall-causing deleterious substances.
2. Local aggregates not complying with ASTM C 33, but that have shown by special test or actual service to produce shotcrete of adequate strength and durability, may be used when acceptable to Engineer.

C. Water: Drinkable or conforming to Section "Cast-in-Place Concrete," Part 2 Products.

D. Ground Wire: High-strength steel wire, 0.8- to 1.0-millimeter diameter.

E. Prebagged Shotcrete Materials: Proprietary prebagged shotcrete materials may be used when proof of satisfactory applications is acceptable to the Engineer.

F. Admixtures, General: Provide admixtures for shotcrete that contain not more than 0.1 percent chloride ions.

G. Air-Entrained Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.
   1. Available Products: Subject to compliance with requirements, provide one of the following:
      b. "Darem AEA" or "Daravair," W.R. Grace & Company
      c. "MB-VR" or "Micro-Air," Master Builders, Inc.
      e. "Sika Aer," Sika Corporation

H. Water-Reducing Admixture: ASTM C 494, Type A.
   1. Available Products: Subject to compliance with requirements, provide one of the following:
      a. "Eucon WR-75," Euclid Chemical Company
      b. "WRDA," W.R. Grace & Company
      c. "Pozzolith Normal" or "Polyheed," Master Builders, Inc.
      e. "Plastwete 161," Sika Corporation

I. High-Range Water-Reduction Admixture (superplasticizer): ASTM C 494, Type F.
   1. Available Products: Subject to compliance with requirements, provide one of the following:
      a. "Eucon 37," Euclid Chemical Company
      b. "WRDA 19" or "Daracem," W.R. Grace & Company
      c. "Rheobuild," Master Builders, Inc.
      d. "Sikament," Sika Corporation
2.3 RELATED MATERIALS

A. Liquid Membrane-Forming Curing Compound: Liquid complying with ASTM C 309, Type I, Class A. Moisture loss not more than 0.055 grams/square centimeter when applied at 200 square feet/gallon.

1. Available Products: Subject to compliance with requirements, provide one of the following:
   a. "Spartan-Cote," The Burke Company
   b. "Day-Chem Cure & Seal," Dayton Superior
   c. "Eucocure," Euclid Chemical Company
   e. "L&M Cure," L&M Construction Chemicals
   f. "Masterkure CR (Clear)," Master Builders, Inc.
   h. "Kure-N-Seal," Sonneborn-Rexnord

B. Bonding Compound: Polyvinyl acetate or acrylic base.

1. Available Products: Subject to compliance with requirements, provide one of the following:
   a. "Acrylic Bondcrete," The Burke Company
   b. "Day-Chem Ad Bond," Dayton Superior Corporation
   c. "SBR Latex," Euclid Chemical Company
   d. "Daraweld C," W.R. Grace & Company
   e. "Hornweld," A.C. Horn, Inc.
   f. "Everbond," L&M Construction Chemicals
   g. "Acryl-Set," Master Builders, Inc.
   i. "Sonocrete," Sonneborn-Rexnord

C. Epoxy Adhesive: ASTM C 881, two-component material suitable for use on dry or damp surfaces. Provide material, "Type," "Grade," and "Class" to suit project requirements.

1. Available Products: Subject to compliance with requirements, products that may be incorporated in the work include, but are not limited to, the following:
   a. "Burke Epoxy M.V.," The Burke Company
   b. "Euco Epoxy 452 or 620," Euclid Chemical Company
   c. "Thiopoxy," W.R. Grace & Company
   e. "Concreseive 1001," Master Builders, Inc.
   f. "Sikadur 32 Hi-Mod," Sika Corporation
2.4 PROPORTIONING AND DESIGN OF MIXES

A. General: Prepare mix designs for each type and strength of shotcrete by either laboratory trial batch or field experience methods as specified in ACI 301. If trial batch is used, use an independent testing facility acceptable to the Engineer for preparing and reporting proposed mix designs. The testing facility shall not be the same as used for field quality control testing.

1. Limit use of fly ash to a maximum 15 percent of cement content by weight.
2. Submit written reports to Engineer and Structural Engineer of each proposed mix for each class of shotcrete at least 15 days prior to start of work. Do not begin shotcrete production until Engineer has reviewed the proposed mix designs.

B. Design mixes to provide normal weight shotcrete, as indicated on structural drawings and notes.

C. Aggregate Gradation: ACI 506R Gradation No. 1 with 3/8-inch maximum aggregate size.

D. Adjustment to Shotcrete Mixes: Contractor may request mix design adjustments when characteristic of materials, job conditions, weather, test results, or other circumstances warrant at no additional cost to Owner and as accepted by Engineer. Laboratory test data for revised mix design and strength results must be submitted to and accepted by Engineer before using in work.

E. Admixtures: Use water-reducing admixture or high-range water-reducing admixture (superplasticizer) in shotcrete as required for placement and workability.

1. Use air-entraining admixture in exterior exposed shotcrete, unless otherwise indicated.
2. Use admixtures for water-reducing in strict compliance with manufacturer’s directions.

2.5 SHOTCRETE EQUIPMENT

A. Mixing Equipment: Capable of thoroughly mixing shotcrete materials in sufficient quantities to maintain continuous placement.

B. Air Supply: Provide uniform, steady supply of clean, dry air to maintain constant nozzle velocity while operating blow pipe for cleaning away rebound.

C. Wet Mix Delivery Equipment: Capable of discharging aggregate-cement-water mixture accurately, uniformly, and continuously.

PART 3 - EXECUTION

3.1 BATCHING AND MIXING

A. General: Control mix proportions by weight batching or by volume batching meeting the requirements of ASTM C 685.

1. Use batching and mixing equipment capable of proportioning and mixing ingredients at a rate that provides adequate production and with an accuracy that ensures uniformity of batches.
2. Use weighing equipment capable of batching with the accuracy specified in ASTM C 94.

B. Ready-Mixed Materials: Comply with ASTM C 94, except it may be delivered to shotcrete equipment in a dry state if equipment is capable of adding water and mixing it satisfactorily with
dry ingredients; or comply with ASTM C 685 when ingredients are delivered dry, and proportioned and mixed at site.

3.2 SURFACE PREPARATION

A. Existing Concrete or Masonry: Remove unsound material before applying shotcrete. Chip or scarify areas to be repaired to extent necessary to provide sound substrate. Taper edges to leave no square shoulders at perimeter of cavity. Remove loose material from areas receiving shotcrete. Wet surfaces until damp, but without visible free water.

1. Sandblast existing surfaces that do not require chipping to remove paint, oil, grease or other contaminants; and to provide roughened surface for proper bonding of shotcrete.

B. Earth: Compact and trim to line and grade before placing shotcrete. Do not place shotcrete on frozen surfaces. Dampen surfaces just prior to shotcrete placement.

C. Rock: Clean rock surfaces of loose material, mud, and other foreign matter that will prevent bond of shotcrete.

3.3 INSTALLING FORMS

A. General: Design, erect, support, brace, and maintain forms in accordance with the requirements of Section "Cast-in-Place Concrete" as modified below to support loads that might be applied until such loads can be supported by in-place shotcrete. Construct forms so shotcrete members and structures are secured to prevent excessive vibration or deflection during shotcreting. Design forms to be readily removable without impact, shock, or damage to shotcrete surfaces and adjacent materials.

1. Design forms to be readily removable without impact, shock, or damage to shotcrete surfaces and adjacent materials.

2. Construct forms to required sizes, shapes, lines, and dimensions using ground wires and depth gauges to obtain accurate alignment, location, and grader in finished structures. Construct forms to prevent mortar leakage, but permit the escape of air and rebound during shotcreting. Provide for openings, offsets, blocking, screeds, anchorages and inserts, and other features required in the work.

3. Fabricate forms for easy removal without hammering or prying against shotcrete surfaces.

B. Ground Wires: Provide as required to establish indicated thickness and surface planes of shotcrete. Install ground wires at corners and offsets not established by forms. Pull ground wires taut and position adjustment devices to permit additional tightening.

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

3.4 PLACING REINFORCEMENT

A. General: Comply with the requirements of Section "Cast-in-Place Concrete" and the Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars," for details and methods of reinforcing placement and supports, and as herein specified.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials that reduce or destroy bond to shotcrete.
C. Accurately position support, and secure reinforcement against displacement by formwork, construction or shotcrete placement operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as required.

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

3.5 JOINTS

A. Construction Joints: Locate and install construction joints as indicated or, if not indicated, locate so as not to impair strength and appearance of the structure.

1. Place construction joints perpendicular to main reinforcement. Continue reinforcement across construction joints where not otherwise shown.

B. Contraction Joints: Construct contraction joints in shotcrete using saw cuts 1/8-inch (3-mm-) wide-by-1/3 slab depth or premolded plastic, hardboard, or fiberboard strip inserts 1/4-inch (6-mm) wide-by-1/3 shotcrete depth, unless otherwise indicated.

1. After shotcrete has cured, remove strip inserts and clean groove of loose debris.
2. Space joints at 15 feet (4.5 m) o.c. max horizontally and vertically.
3. Tool edges round on each side of strip inserts if floated or troweled finishes are required.
4. Joint configuration to be compatible with joint sealants. Joint sealant requirements are in Section 07 10 00 “Waterproofing System.”

3.6 INSTALLATION OF EMBEDDED ITEMS

A. General: Set and build into work anchorage devices and other embedded items required for other work that is attached to or supported by shotcrete. Use setting drawings, diagrams, instructions, and directions provided by suppliers of items to be attached.

3.7 ALIGNMENT CONTROL

A. Ground wires: Install ground wires to establish thickness and planes of shotcrete surfaces. Install ground wires at corners and offsets not established by forms. Pull ground wires taunt and position adjustment devices to permit additional tightening.

3.8 SHOTCRETE PLACEMENT

A. Preplacement Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded. Notify other crafts to permit installation of their work. Cooperate with other trades in setting such work. Moisten wood forms immediately before placing shotcrete where form coatings are not used.

1. Apply temporary protective covering to guard against spattering during placement.

B. General: Comply with ACI 304, “Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete,” and as herein specified.

C. Deposit shotcrete continuously or in layers of such thickness that shotcrete is not placed on material that has hardened sufficiently to cause the formation of seams or planes of weakness.
D. Cold Weather Placing: Protect shotcrete work from physical damage or reduced strength by frost, freezing, or low temperatures in compliance with ACI 306 and as specified.
   1. When air temperature has fallen to or is expected to fall below 40 degrees F, uniformly heat water and aggregates before mixing to obtain a shotcrete mixture temperature of not less than 50 degrees F and not more than 80 degrees F at point of placement.
   2. Do not use frozen materials or materials containing ice or snow. Do not place shotcrete on frozen subgrade or on subgrade containing frozen materials.
   3. Do not use calcium chloride, salt, and other materials containing antifreeze agents or chemical accelerators.
   4. Ensure that the materials and surrounding air temperature are a minimum 40 degrees F (5 degrees) prior to, during, and 7 days after the completion of work.

E. Hot Weather Placing: When hot weather conditions exist that would seriously impair the quality and strength of concrete, place shotcrete in compliance with ACI 305 and as specified.
   1. Cool ingredients before mixing to maintain shotcrete temperature at time of placement below 90 degrees F. Mixing water may be chilled or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Use of liquid nitrogen to cool shotcrete is Contractor's option.
   2. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature does not exceed the ambient air temperature immediately before embedment.
   3. Fog spray forms, reinforcing steel, and subgrade just before shotcrete is placed.
   4. Use water-reducing retarding admixture (Type D) when required by high temperatures, low humidity, or other adverse placing conditions.

F. Suspend shotcrete operations during high winds, rainy weather, or near freezing temperatures when the work cannot be protected.

3.9 SURFACE FINISHES
A. General: Provide natural gun finish to unexposed surfaces, unless otherwise indicated in Section "Cast-in-Place Concrete."
   1. Flash Coat: After screeding, apply a 1/8-inch to 1/4-inch coat of shotcrete using fine screened sand. Keep application nozzle to a greater distance than required for normal shotcreting.
   2. Provide wood float finish after application of flash coat.

3.10 CURING AND PROTECTION
A. General: Protect freshly placed shotcrete from premature drying and excessive cold or hot temperatures.
B. Start initial curing as soon as free water has disappeared from shotcrete surface after placing and finishing. Weather permitting, keep continuously moist for not less than 7 days.
C. Continue curing for at least 7 days in accordance with ACI 301 procedures.
D. Curing Methods: Perform curing of shotcrete by curing and sealing compound, by moist curing, by moisture-retaining cover curing, and by combinations thereof.
E. Curing Formed Surfaces: Cure-formed shotcrete surfaces by moist curing with forms in place for full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.

3.11 REMOVAL OF FORMS

A. General: Forms not supporting weight of concrete may be removed after curing at not less than 50 degrees F for 24 consecutive hours after gunning, provided shotcrete is sufficiently hard to not be damaged by form removal operations, and provided curing and protection operations are maintained.

B. Forms, including earth form support of wall during the construction process, supporting the weight of concrete may not be removed in less than 7 days and not until shotcrete has attained design minimum compressive strength at 7 days. Determine potential compressive strength of in-place shotcrete by testing field-cured specimens representative of shotcrete or members.

C. Form-facing material may be removed 4 days after placement only if backshores have been arranged to permit removal without loosening or disturbing backshores and supports. Backshoring shall be in accordance with Section "Cast-in-Place Concrete" and ACI 347.

3.12 REUSE OF FORMS

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

3.13 REPAIR OF DEFECTS

A. General: Remove and replace shotcrete that lacks uniformity that exhibits segregation, honeycomb overspray, rebound, delamination, or that contains dry patches, single voids in excess of 1/2-inch in any direction, or sand pockets.

B. Remove and replace shotcrete which is of adequate strength.

3.14 QUALITY CONTROL

A. Testing Laboratory: Owner will provide testing laboratory to furnish continuous inspection of work specified, and make tests required by International Building Code (IBC) as amended by the Seattle Building Code, current version and Division 1 Section “Quality Requirements” of these specifications.

B. Special Inspector: Testing laboratory shall provide qualified “Special Inspector” who will perform the inspection services.

1. The Special Inspector shall be certified by the City of Seattle in reinforced concrete. The Special Inspector shall be trained to inspect shotcrete by his/her inspection agency, and it shall be the responsibility of that agency to provide supervision adequate to assure that the Inspector is following their instructions and inspection procedures.

2. The Inspector shall follow the general inspection procedures outlined by the IBC 2003 Sections 109 and Chapter 17 and the recommendations of ACI 506. The Inspector’s notebook shall contain copies of these documents, and other sampling and testing standards referenced.

C. Procedures for inspecting shotcrete shall include instructions for the Inspector to:
1. Verify that reinforcing steel conforms to project specifications and the IBC 2003. Particular care shall be given to assure resteel is tied securely and is clean.

2. Certify that concrete truck delivery tickets show that the mix delivered is the same as the approved mix. If the batch weights do not appear on the first rip ticket, the Inspector shall ask the concrete truck driver to call his/her dispatcher for the weights and the Inspector shall write them on the ticket. No material shall be placed until the information is recorded. Subsequent tickets shall show the cement content, maximum size aggregate and admixtures (if any), or the truck shall be rejected.

3. Check each load of concrete visually for obvious problems such as wrong size aggregate.

4. Check forms previously placed shotcrete or other material shotcrete is to be placed against to assure it is free of dirt, standing water, oil, grease, debris, rebound, or any other material that could interfere with the bonding of the shotcrete.

5. Check to see that concrete is thoroughly wetted before application of shotcrete, that bonding agent has been applied when specified, and that free water does not remain on the surface.

6. Verify that the nozzle operator, blow-off man, pump, air compressor, and nozzle are the approved personnel and equipment for the project.

7. Verify that ground wires are located at intervals sufficient to ensure proper thickness throughout and that they are maintained tight.

8. Verify that the nozzle operator’s helper is in continuous attendance and keeps rebound blown out so it is not incorporated into work. (Additional workers may be required to remove rebound if it cannot be removed by the air blow pipe.)

9. Verify that joints are properly cleaned and sloped.

10. Verify that no rebound is used to patch holes or otherwise reintroduced into the project.

11. Verify that resteel does not move during application of shotcrete.

12. Verify that any area which sloughs off is removed and reshot.

13. Verify that samples for compressive strength tests are shot and stored in accordance with the approved procedure for taking test specimens.

14. Verify that cores are drilled in accordance with the approved shotcrete procedure and in the locations specified by the Structural Engineer.

15. Verify that specified curing procedures are followed and that no curing compounds are used in areas where additional shotcrete coats will be applied.

D. In addition to the general information for all inspection reports, the Shotcrete Inspector shall report the names of the nozzle operator and blow-off man; the brand names and types of pump, compressor, and nozzle; and type(s) of test samples taken.

E. The Special Inspector or his/her Supervisor shall report to City of Seattle and the Structural Engineer any substitutions in the personnel and/or equipment in the approved shotcrete procedure or any shotcrete which does not meet the job specifications.

F. Testing During Construction: Test shotcrete for compressive and flexural strength by one or more of the following methods:

1. Test Panels: Made by shotcrete nozzle operator who will do the production work.
a. Make one test panel with minimum dimensions of 18 inches by 18 inches by 10 inches, gunned in same position as work represented, during the course of the work, complying with the applicable provisions of ASTM C 1140.

b. Make test panel once each shift or once for each 50 cubic yards of shotcrete placed through nozzle, whichever is more frequent.

c. Moist cure panels, unless otherwise directed by Engineer. Cut a minimum of 3-inch nominal diameter cores or three 3-inch cubes from each panel.

2. Samples From In-Place Shotcrete: Cut 3-inch nominal diameter cores from structure and test in accordance with ASTM C 42. Do not cut into steel reinforcement.

a. Take a set of cores once each shift or one for each 50 cubic yards of shotcrete placed through nozzle, whichever is more frequent.

b. Repair core holes with an approved dry pack of nonshrinking grout.

c. One set of cores is three individual cores samples.

3. Strength Evaluation: Shotcrete will be considered acceptable as follows:

a. Mean compressive strength of any grout of three cores taken from structure or test panel equals or exceeds 0.85 f’c (85 percent of specified compressive strength), with no individual core less than 0.75 f’c (75 percent of specified compressive strength).

b. Mean compressive strength of any group of three cubes taken from structure or test panel equals or exceeds f’c (100 percent of specified compressive strength), with no individual cube less than 0.88 f’c (88 percent of specified compressive strength).

G. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive rejection.

H. Additional Tests: The Testing Agency will make additional tests of in-place concrete when test results indicate specified concrete strength and other characteristics have not been attained in the structure, as directed by Engineer. Testing Agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42 or by other methods as directed.

1. Cores Tests: If any strength test falls below the specified compressive strength by more than 500 psi, or if tests indicate deficiencies in protection or curing, the Testing Agency or Engineer will require taking and testing or test cores. Costs shall be borne by the Contractor.

2. Core taking and testing procedures shall be in accordance with ASTM C 42. Cores shall be at least 2 inches in diameter. At these 3 representative cores shall be taken from each member or area of concrete placed that is considered potentially deficient. The location of the cores shall be determined by the Engineer. If, before testing, one or more of the cores shows evidence of having been damaged subsequent to or during removal from the structure, it shall be replaced with a new core.

3. Concrete in the area represented by a core test will be considered adequate if the average strength of the cores is equal to or at least 85 percent of the specified strength and if no single core is less than 75 percent of the specified strength. If strength of cores tested fall below this limit, the Contractor shall pay for any special analysis by the Structural Engineer-of-Record to establish whether the actual concrete strength is acceptable for the affected structural element. Take measures as directed by Engineer
to correct deficiency. Engineer's decision and directions will be considered final and binding.

a. Repair core holes in concrete found to be acceptable with an approved dry pack of nonshrinking grout.

END OF SECTION 03 37 13
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. References and standards listed herein are to be the latest edition available, unless specifically stated otherwise.

1.2 SUMMARY

A. Post-tensioned concrete shall comply with WSDOT Standard Specification Section 6-02.3(26), and all of its subsections.

B. This Section includes the following:
   1. Furnishing post-tensioning reinforcement and accessories including ducts, anchorages, distribution plates, pocket formers, support bars, and bar chairs.
   2. Installing post-tensioning tendons.
   3. Performing post-tensioning operations including stressing and grouting tendons.

C. Related Sections include the following:
   1. Division 03 Section "Cast-in-Place Concrete" for cast-in-place concrete, steel reinforcement, placement of nonprestressed steel reinforcement, and concrete strength testing of laboratory- and field-cured cylinders.

1.3 SUBMITTALS

A. Submit shop drawings, technical data, calculations, and procedures to the Engineer in accordance with WSDOT Standard Specification Section 6-02.3(16) and 6-02.3(26)A.

B. Supplier and Installer Qualifications: Select a system manufacturer with experience in post-tensioning concrete box girder bridges that were designed and constructed according to AASHTO LRFD Construction specifications. Submit the following:
   1. Certificate of compliance with OSHA and other applicable industry standards for safety.
   2. In-house capability to design end anchorage assemblies, local zone and general zone design according to AASHTO specifications, sealed by a Structural Engineer licensed in the state of Washington.
   3. Certificate of compliance with AASHTO LRFD Construction specifications for testing of the end anchorage assemblies, performed by an independent testing laboratory, and sealed by a Professional Engineer licensed in the state of Washington.
   4. In-house QC/QA implementation for manufacturing, assembling, storage, delivery, installation, stressing and grouting supervision.
   5. Names, qualification and experience of the field personnel to be assigned to assist the Contractor to supervise installation, stressing and grouting.
6. The technician that supervises all grouting operations must be a valid American Segmental Bridge Institute (ASBI) Certified Grouting Technician. Provide verification of the technician’s ASBI Certification.

7. Proof of continuous post-tensioning operations. Firms with less than 10 years of experience may be approved if sufficient related project experience is demonstrated, but in any event a minimum of 7 years of experience is required.

8. List of post-tensioned bridges completed within the past 5 years including owner and identifying bridge information.

1.4 QUALITY ASSURANCE

A. Do not place concrete in post-tensioned members until ducts and conventional reinforcement steel have been inspected and approved. Notify Inspector 48 hours prior to placing concrete.

1.5 FIELD MEASUREMENTS

A. Verify that field conditions are as shown on drawings and shop drawings.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Provide strand packed at the source to prevent physical damage to the strand and protect the strand from moisture and corrosion during transportation and storage.

1.7 PRECONSTRUCTION MEETING

A. Arrange and hold a preconstruction meeting with representatives of the General Contractor, the Supplier, the Installer, the Structural Engineer-of-Record, the Special Inspection Agency, and the Building Department. Identify and clarify the special inspection requirements for the project.

1. Hold meeting prior to placing concrete for the first item that will directly support a post-tensioned element.

2. Take minutes of the preconstruction meeting and distribute to the attendees within 7 days of the meeting.

B. Discuss the following items at the preconstruction meeting:

1. The Special Inspection Checklist prepared by the Special Inspector.

2. The 48-hour minimum notification of the Special Inspector prior to concrete placement.

3. The 4-hour minimum allowance from the time that the Special Inspector has approved a post-tensioned element as ready to place and the time the concrete placement commences.

4. The preconstruction meeting shall also comply with all requirements of Director’s Rule 20-2006.

PART 2 - PRODUCTS

2.1 POST-TENSIONING MATERIALS

A. Prestressing Reinforcement: Meet the requirements of WSDOT Standard Specification Section 6-02.3(26)F.

B. Post-Tensioning Anchorage: Meet the requirements of WSDOT Standard Specification 6-02.3(26)A and 6-02.3(26)D.
C. Post-Tensioning Ducts: Meet the requirements of WSDOT Standard Specification Section 6-02.3(26).E.

D. Grout: Meet the requirements of WSDOT Standard Specification Section 6-02.3(26).H.

2.2 ACCESSORIES AND RELATED MATERIALS

A. Supporting Accessories: Tendons shall be supported by tying to conventional reinforcing and/or standard reinforcing steel accessories, as recommended by the post-tensioning material supplier. If standard reinforcing steel accessories are recommended, they shall meet the requirements contained in Section "Cast-in-Place Concrete.

B. Bonding Agent: Division 3 Section "Cast-in-Place Concrete."

PART 3 - EXECUTION

3.1 FABRICATION

A. Fabricate post-tensioning strands in accordance with detailed shop drawings approved by the Structural Engineer-of-Record.

B. Post-tensioning strands shall be of the nonfixed length reels or reeless packs.

C. Protect all prestressing strand from rust or other corrosion prior to placement. Provide sufficient protection for exposed prestressing strand at the ends of the members to prevent deterioration by corrosion.

3.2 INSTALLATION

A. Install post-tensioning system in accordance with the WSDOT Standard Specification Section 6-02.3(26).

B. Coordinate installation of mild steel reinforcement with the installation of post-tensioning ducts. Proper duct location has priority.

C. Install ducts to resist buoyancy forces.

D. Install the hardware including ducts, tendons, end anchorage assemblies and special reinforcing according to the Contract Documents and the instructions of the system manufacturer. Provide a qualified on-site representative of the system manufacturer, who is skilled and thoroughly experienced in the use of the system to supervise or provide appropriate guidance of the work. The system manufacturer's representative will provide the Engineer pertinent information as required. The system manufacturer's representative must be available full-time during post-tensioning hardware installation for inspecting and approving all installation prior to concrete placement, stressing, anchoring all tendons and grouting operations.

1. As a minimum, the following items require inspection and approval by the system manufacturer's representative:
   a. Installation of all hardware;
   b. Instructions to the Contractor regarding concrete placement around the ducts, end-anchorage assemblies and other appurtenances; and
   c. Supervision of stressing procedures, record keeping, certification of stressing results and grouting operations.

2. The representative of the system manufacturer that supervises all grouting operations must be a valid American Segmental Bridge Institute (ASBI) Certified Grouting
Technician. Do not place any concrete in the bridge abutments and superstructure until the hardware installation is approved by the Engineer and the system manufacturer’s representative. Reject all unidentified strands or anchorage assemblies. Provide all ducts or anchorage assemblies with inlet/outlet pipes. Provide concrete test cylinders at both abutments. Do not begin stressing until testing of concrete cylinders verifies minimum bridge concrete strength for jacking has been obtained. Do not begin the stressing before the concrete strength has reached the f’ci shown in the Contract Documents and a minimum of 72 hours after completing the slab pour. Complete the stressing within 7 days after completing the slab pour. Vibrate the concrete slab, as required, to obtain proper consolidation and compaction of the concrete specified in the Contract Documents. Proper vibration at the abutments and around the end anchorage assemblies is especially critical and should be considered a “confined” area. Exercise care to obtain concrete consolidation around the end anchorages without disturbing the reinforcing or post-tensioning assemblies.

3.3 CONCRETE PLACEMENT

A. Take precautions to assure complete consolidation and densification of concrete behind all post-tensioning anchorages.

3.4 TENSIONING

A. Comply with the requirements of WSDOT Standard Specification Section 6-02.3(26)G.

B. Cut tendons only after approved by the Engineer. Cut off excess tendon so that 1- to 1 1/4-inch of tendon protrudes beyond the wedges.

C. The tendon may be cut by means of oxyacetylene cutting, abrasive wheel, or hydraulic shears.

1. If oxyacetylene cutting is used, care shall be taken to avoid directing the flame toward the wedges.

2. The tendon cutting procedure shall not damage the coating of encapsulated anchorages.

3.5 GROUTING

A. Comply with the requirements of WSDOT Standard Specification Section 6-02.3(26)H.

B. Protection of End Anchorages: Clean exposed end anchorages, strands and other metal accessories of rust, misplaced mortar, grout and other such materials as soon as possible after tensioning and grouting is completed. Immediately following the cleaning operation, apply a coat of zinc-rich epoxy paint, minimum thickness of 4 mils.

3.6 ANCHOR POCKET FILLING

A. Fill all end anchorage anchor pockets as shown in the Contract Documents. Apply an approved epoxy resin bonding agent according to the manufacturer’ prior to placing an approved non-shrink, non-metallic grout. Apply grout according to the grout manufacturer’s instructions. Finish the outside exposed surfaces of the anchor pockets smooth and flush with the surrounding concrete surface. Select grout to match the color of the surrounding concrete slab.

B. Grout anchorage rocket within 7 days of tendon stressing.

3.7 INSPECTION AND MONITORING

A. General: Special inspection will be conducted by an Independent Testing Agency. Refer to Division 1 Section “Testing and Inspection Services” for the requirements pertaining to services, reports, payments, Contractor’s responsibilities, etc.
B. Special Inspector: Independent Testing Agency will perform the following:

1. Observe that procedures for the handling and storage of strands do not result in damage to strands.

2. Inspector need not be present during the post-tensioning installation, provided he has inspected for conformance with the approved placement and shop drawings prior to closing of forms or the delivery of concrete to the job site. This inspection shall include ducts profiles, plan locations and clearances, and integrity of duct systems.

3. During concrete placement, ensure that ducts are not disturbed from their specified profile and location.

4. Monitor stressing operations, including cutting of strand tails and grouting of anchor pockets.

5. Submit report in a format acceptable to the Building Official and the Structural Engineer. At a minimum, record for each tendon:
   a. Calculated elongation from approved placement drawings, including allowable range.
   b. Actual field elongation.

6. Report shall also include:
   a. Calibration gauge pressure and jack up force for each jack used in stressing.
   b. Required and actual concrete strength at time of stressing.

3.8 DESHORING

A. The slab shall not be deshored until after stressing is complete and cylinder tests indicate the concrete in place has reached the specified compression strength.

END OF SECTION 03 38 00
PART 1 - GENERAL

1.1 SUMMARY
A. This Section includes the following:
   1. Precast architectural concrete wall copings.
   2. Precast architectural concrete benches.
B. Related Sections include the following:
   1. Section 01 25 00 – Substitution Procedures
   2. Section 01 33 00 – Submittal Procedures
   3. Section 07 92 00 – Joint Sealants
   4. Section 09 96 23 – Graffiti Resistant Coatings

1.2 PERFORMANCE REQUIREMENTS
1. Structural Performance: Comply with municipal building codes, regulations, or other governing agencies having jurisdiction.

1.3 SUBMITTALS
A. Product Data: For each type of product indicated.
B. Design Mixes: For each type and color concrete mix required including backup mix.
C. Shop Drawings: Detail fabrication and installation of precast architectural concrete units. Indicate member locations, plans, elevations, dimensions, shapes, cross sections, limits of each finish, and types of reinforcement, including special reinforcement.
   1. Indicate locations and extent and treatment of dry joints if two-stage casting is proposed.
   2. Indicate welded connections by AWS standard symbols. Detail loose and cast-in hardware, inserts, connections, and joints, including accessories.
   3. Indicate locations and details of anchorage devices to be embedded in other construction.
   4. Indicate locations and details of thin brick units and joint treatment.
   5. Indicate locations and details of anchors and treatment of joints.
   6. Comprehensive engineering analysis signed and sealed by the qualified professional engineer responsible for its preparation.
D. Samples: For each type and finish indicated on exposed surfaces of precast architectural concrete units. Submit 3 samples, illustrating full range of finish, color, and texture variations expected; approximately 12 by 12 by appropriate thickness. Include typical edge condition in sample. Submit prior to fabrication.
E. Welding Certificates: Copies of certificates for welding procedures and personnel.
F. Material Test Reports: From a qualified testing agency indicating and interpreting test results of the following for compliance with requirements indicated:
1. Concrete materials.
2. Reinforcing materials.
3. Admixtures.
4. Water-absorption test reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Firm experienced in performing precise architectural concrete systems similar in material, design and complexity to those required for this Project.
   1. Not less than five years experience.
   2. Not less than two comparable scale projects successfully completed and with a record of successful in-service performance for not less than 10 years.
   3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when installation is in progress.

B. Fabricator Qualifications: A firm that complies with the following requirements and is experienced in manufacturing precast architectural concrete units similar to those indicated for this Project and with a record of successful in-service performance for not less than 10 years.
   1. Assumes responsibility for engineering precast architectural concrete units to comply with performance requirements. This responsibility includes preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer including, reinforcement, precast mix design, and method of attachment to other work.
   2. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of precast architectural concrete that are similar to those indicated for this Project in material, design, and extent.
   3. Participates in PCI's Plant Certification program and is designated a PCI-certified plant for Group A, Category A1--Architectural Cladding and Load Bearing Units or in APA's Plant Certification Program for Production of Architectural Precast Concrete Products and is designated an APA-certified plant.
   4. Has sufficient production capacity to produce required units without delaying the Work.

C. Design Standards: Comply with ACI 318 and the design recommendations of PCI MNL 120, "PCI Design Handbook--Precast and Prestressed Concrete."

D. Quality-Control Standard: For manufacturing procedures and testing requirements, quality-control recommendations, and dimensional tolerances for types of units required, comply with PCI MNL 117, "Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products."

E. Product Options: Drawings indicate size, profiles, and dimensional requirements of precast concrete units and are based on the specific types of units indicated. Other fabricators' precast concrete units complying with requirements may be considered.

G. Preinstallation Conference: Conduct conference at Project site to comply with requirements of Section 01 31 19 Project Meetings.

1.5 MOCK UP

A. Precast benches: provide (1) end segment of bench; can be incorporated into work if approved.

B. Precast cap: provide (1) full size cap end segment; can be incorporated into work if approved.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver precast architectural concrete units to Project site in such quantities and at such times to ensure continuity of installation. Store units at Project site to prevent cracking, distorting, warping, staining, or other physical damage, and so markings are visible.

B. Lift and support units only at designated lifting and supporting points as shown on Shop Drawings.

1.7 SEQUENCING

A. Furnish anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, templates, instructions, and directions, as required, for installation.

PART 2 - PRODUCTS

2.1 MOLD MATERIALS

A. Molds: Provide molds and, where required, form-facing materials of metal, plastic, wood, or another material that is nonreactive with concrete and dimensionally stable to produce continuous and true precast concrete surfaces within fabrication tolerances and suitable for required finishes.

2.2 REINFORCING MATERIALS

A. Galvanized Reinforcing Bars: ASTM A 767/A 767M, Class II zinc coated, hot-dip galvanized after fabrication and bending, as follows:

1. Steel Reinforcement: ASTM A 615/A 615M, Grade 60 or ASTM A 706/A 706M, deformed.

B. Plain-Steel Wire: ASTM A 82, galvanized.

C. Deformed-Steel Wire: ASTM A 496.

D. Supports: Manufacturer's bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place according to CRSI's "Manual of Standard Practice," PCI MNL 117, and as follows:

1. For zinc-coated reinforcement, use galvanized wire or dielectric-polymer-coated wire bar supports.
2.3 CONCRETE MATERIALS

A. Portland Cement: ASTM C 150, Type I or Type III, gray, of same type, brand, and source.

B. Normal-Weight Aggregates: Except as modified by PCI MNL 117, ASTM C 33, with coarse aggregates complying with Class 5S.
   1. Coarse Aggregates: Selected, hard, and durable; free of material that reacts with cement or causes staining.
      a. Gradation: To match design reference sample.
   2. Fine Aggregates: Selected, natural or manufactured sand of the same material as coarse aggregate, unless otherwise approved by Architect.

C. Coloring Admixture: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures, temperature stable, nonfading, and alkali resistant.
   1. Color: Integral color to be approved by Architect.

D. Water: Potable; free from deleterious material that may affect color stability, setting, or strength of concrete and complying with chemical limits of PCI MNL 117.

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

F. Water-Reducing Admixture: ASTM C 494, Type A.

G. Retarding Admixture: ASTM C 494, Type B.

H. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.

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


2.4 STAINLESS-STEEL CONNECTION MATERIALS

A. Stainless-Steel Plate: ASTM A 666, Type 304, of grade suitable for application.

B. Stainless-Steel Bolts and Studs: ASTM F 593, alloy 304 or 316, hex-head bolts and studs; stainless-steel nuts; and flat, stainless-steel washers.


2.5 GROUT MATERIALS

A. Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, plasticizing and water-reducing agents, complying with ASTM C 1107, of consistency suitable for application.

2.6 CONCRETE MIXES

A. Prepare design mixes for each type of concrete required.
B. Design mixes may be prepared by a qualified independent testing agency or by qualified precast plant personnel at precast architectural concrete fabricator's option.

C. Limit water-soluble chloride ions to the maximum percentage by weight of cement permitted by ACI 318.

D. Normal-Weight Concrete Mixes: Proportion mixes by either laboratory trial batch or field test data methods according to ACI 211.1, with materials to be used on Project, to provide normal-weight concrete with the following properties:
   2. Maximum Water-Cementitious Materials Ratio: 0.45.

E. Water Absorption: 12 to 14 percent by volume, tested according to PCI MNL 117.

F. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content complying with PCI MNL 117.

G. When included in design mixes, add other admixtures to concrete mixes according to manufacturer's written instructions.

2.7 MOLD FABRICATION

A. Molds: Accurately construct molds, mortar tight, of sufficient strength to withstand pressures due to concrete-placement operations and temperature changes.

B. Maintain molds to provide completed precast architectural concrete units of shapes, lines, and dimensions indicated, within fabrication tolerances specified.
   1. Edge and Corner Treatment: Provide ½" chamfer, typical at exposed edges.

2.8 FABRICATION

A. Cast-in Anchors, Inserts, Plates, Angles, and Other Anchorage Hardware: Fabricate anchorage hardware with sufficient anchorage and embedment to comply with design requirements. Accurately position for attachment of loose hardware, and secure in place during precasting operations. Locate anchorage hardware where it does not affect position of main reinforcement or concrete placement.

B. Furnish loose steel plates, clip angles, seat angles, anchors, dowels, cramps, hangers, and other hardware shapes for securing precast architectural concrete units to supporting and adjacent construction.

C. Cast-in reglets, slots, holes, and other accessories in precast architectural concrete units to receive cramps, dowels, reglets, waterstops, flashings, and other similar work as indicated.

D. Cast-in openings larger than 10 inches in any dimension.

E. Reinforcement: Comply with recommendations in CRSI's "Manual of Standard Practice” and PCI MNL 117 for fabricating, placing, and supporting reinforcement.
   1. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy the bond with concrete.
2. Accurately position, support, and secure reinforcement against displacement during concrete-placement and consolidation operations. Completely conceal support devices to prevent exposure on finished surfaces.

3. Place reinforcement to maintain at least 3/4-inch minimum coverage. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Direct wire tie ends away from finished, exposed concrete surfaces.

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

F. Reinforce precast architectural concrete units to resist handling, transportation, and erection stresses.

G. Mix concrete according to PCI MNL 117 and requirements in this Section. After concrete batching, no additional water may be added.

H. Place concrete in a continuous operation to prevent seams or planes of weakness from forming in precast concrete units. Comply with requirements in PCI MNL 117 for measuring, mixing, transporting, and placing concrete.

I. Thoroughly consolidate placed concrete by internal and external vibration without dislocating or damaging reinforcement and built-in items. Use equipment and procedures complying with PCI MNL 117.

J. Comply with ACI 306.1 procedures for cold-weather concrete placement.

K. Comply with ACI 305R recommendations for hot-weather concrete placement.

L. Identify pickup points of precast architectural concrete units and orientation in structure with permanent markings, complying with markings indicated on Shop Drawings. Imprint or permanently mark casting date on each precast architectural concrete unit on a surface that will not show in finished structure.

M. Cure concrete, according to requirements in PCI MNL 117, by moisture retention without heat or by accelerated heat curing using low-pressure live steam or radiant heat and moisture.

N. Discard precast architectural concrete units that are warped, cracked, broken, spalled, stained, or otherwise defective unless repairs are approved by Architect.

2.9 FABRICATION TOLERANCES

A. Fabricate precast architectural concrete units straight, smooth, and true to size and shape with exposed edges and corners precise and true so each finished panel complies with PCI MNL 117 product tolerances as well as position tolerances for cast-in items.

B. Position Tolerances: For cast-in items measured from datum line location, as indicated on Shop Drawings.

1. Weld Plates: Plus or minus 1 inch.
2. Inserts: Plus or minus 1/2 inch.
3. Handling Devices: Plus or minus 3 inches.
4. Reinforcing Steel and Welded Wire Fabric: Plus or minus 1/4 inch where position has structural implications or affects concrete cover; otherwise, plus or minus 1/2 inch.
5. Reinforcing Steel Extending out of Member: Plus or minus 1/2 inch of plan dimensions.
6. Tendons: Plus or minus 1/4 inch, vertical; plus or minus 1 inch, horizontal.
7. Location of Rustication Joints: Plus or minus 1/8 inch.
8. Location of Opening within Panel: Plus or minus 1/4 inch.
10. Flashing Reglets at Edge of Panel: Plus or minus 1/8 inch.
11. Electrical Outlets, Hose Bibs: Plus or minus 1/2 inch.
13. Allowable Rotation of Plate, Channel Inserts, Electrical Boxes: 2-degree rotation or 1/4 inch maximum over the full dimension of the unit.

2.10 FINISHES
A. Finish exposed-face surfaces of precast architectural concrete units as follows:
   1. Light sandblast finish on all exposed faces to match Landscape Architect’s sample.
B. Finish unexposed surfaces of precast architectural concrete units by float finish.

PART 3 - EXECUTION
3.1 EXAMINATION
A. Examine substrates and conditions for compliance with requirements for installation tolerances, true and level bearing surfaces, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.
B. Do not install precast concrete units until supporting concrete has attained minimum design compressive strength.

3.2 INSTALLATION
A. Install clips, hangers, and other accessories required for connecting precast architectural concrete units to supporting members and backup materials.
B. Install precast architectural concrete. Provide temporary supports and bracing as required to maintain position, stability, and alignment as units are being permanently connected.
   1. Install bearing pads as precast concrete units are being erected.
   2. Maintain horizontal and vertical joint alignment and uniform joint width as erection progresses.
   3. Remove projecting hoisting devices and use sand-cement grout to fill voids within recessed hoisting devices flush with surface of concrete.
C. Anchor precast architectural concrete units in position by bolting, welding, grouting, or as otherwise indicated. Remove temporary shims, wedges, and spacers as soon as possible after anchoring and grouting are completed.
D. Welding: Perform welding in compliance with AWS D1.1 and AWS D1.4, with qualified welders.
   1. Protect precast architectural concrete units and bearing pads from damage by field welding or cutting operations and provide noncombustible shields as required.
   2. Repair damaged steel surfaces by cleaning and applying a coat of galvanizing repair paint to galvanized surfaces.

E. At bolted connections, use lock washers or other acceptable means to prevent loosening of nuts.

F. Grouting Connections: Grout connections where required or indicated. Retain grout in place until hard enough to support itself. Pack spaces with stiff grout material, tamping until voids are completely filled. Place grout to finish smooth, level, and plumb with adjacent concrete surfaces. Keep grouted joints damp for not less than 24 hours after initial set. Promptly remove grout material from exposed surfaces before it affects finishes or hardens.

3.3 ERECTION TOLERANCES

A. Install precast architectural concrete units level, plumb, square, true, and in alignment without exceeding the noncumulative erection tolerances of PCI MNL 117, Appendix I.

3.4 REPAIRS

A. Repair exposed exterior surfaces of precast architectural concrete units to match color, texture, and uniformity of surrounding precast architectural concrete if permitted by Architect.

B. Remove and replace damaged precast architectural concrete units if repairs do not comply with requirements.

3.5 CLEANING

A. Clean exposed surfaces of precast concrete units after erection to remove weld marks, other markings, dirt, and stains.
   1. Wash and rinse according to precast concrete fabricator's written recommendations. Protect other work from staining or damage due to cleaning operations.
   2. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes.

END OF SECTION 03 45 00
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. References and standards listed herein are to be the latest edition available, unless specifically stated otherwise.

1.2 SUMMARY

A. This section includes unit masonry assemblies consisting of the following:
   1. Concrete masonry units.
   2. Mortar and grout.
   3. Reinforcing steel.
   4. Miscellaneous masonry accessories.
   5. Masonry-cell insulation.

B. Products installed, but not furnished, under this section include the following:
   1. Steel angles for unit masonry furnished under Division 05 Section “Structural Steel Framing.”

1.3 DEFINITIONS

A. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.4 PERFORMANCE REQUIREMENTS

A. Provide unit masonry that develops the following net-area compressive strengths (f’m) at 28 days. Determine compressive strength of masonry by testing masonry prisms according to ASTM C 1314.
   1. For Concrete Unit Masonry: f’m = 2,500 psi.

1.5 SUBMITTALS

A. Product Data: For each different masonry unit, accessory, and other manufactured product specified.

B. Shop Drawings: Show fabrication and installation details for the following:
   1. Reinforcing Steel: Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, “Details and Detailing of Concrete Reinforcement.” Show elevations of reinforced walls.

C. Qualification Data: For firms and persons specified in “Quality Assurance” article.
D. Material Test Reports: From a qualified testing agency indicating and interpreting test results of the following for compliance with requirements indicated:

1. Each type of masonry unit required.
   a. Include size variation data for block, verifying that actual range of sizes falls within specified tolerances.
   b. Include test results, measurements, and calculations establishing net area compressive strength of masonry units.

2. Grout mixes complying with compressive strength requirements of ASTM C 476. Include description of type and proportions of grout ingredients.

E. Material Certificates: Signed by manufacturers certifying that each of the following items complies with requirements:

1. Each type of masonry unit required.
   a. Include size variation data for brick, verifying that actual range of sizes falls within specified tolerances.
   b. Include test data, measurements, and calculations establishing net area compressive strength of masonry units.

2. Each cement product required for mortar and grout, including name of manufacturer, brand, type, and weight slips at time of delivery.

3. Each combination of masonry unit type and mortar type. Include statement of net area compressive strength of masonry units, mortar type, and net area compressive strength of masonry determined according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602.

4. Each material and grade indicated for reinforcing bars.

5. Each type and size of anchor, tie, and metal accessory.

F. Cold Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with cold weather requirements.

1.6 QUALITY ASSURANCE

A. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, through one source from a single manufacturer for each product required.

B. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from one manufacturer for each cementitious component and from one source or producer for each aggregate.

C. Preconstruction Testing Service: Owner will engage a Qualified Independent Testing Agency to perform preconstruction testing indicated below. Payment for these services will be made by Owner. Retesting of materials failing to meet specified requirements shall be done at Contractor’s expense.

1. Concrete Masonry Unit Test: For each concrete masonry unit indicated, per ASTM C 140.

D. Fire Resistance Ratings: Where indicated, provide materials and construction identical to those of assemblies with fire resistance ratings determined per ASTM E 119 by a Testing and Inspecting Agency, by equivalent concrete masonry thickness, or by another means, as acceptable to authorities having jurisdiction.
E. Sample Panels: Before installing unit masonry, build sample panels using materials indicated for the completed work to verify selections made under sample submittals and to demonstrate aesthetic effects. Build sample panels for each type of exposed unit masonry assembly in sizes approximately 48 inches long by 48 inches high by full thickness.

1. Locate panels in the locations indicated or, if not indicated, as directed by Architect.
2. Clean exposed faces of panels with masonry cleaner indicated.
3. Protect approved sample panels from the elements with weather-resistant membrane.
4. Maintain sample panels during construction in an undisturbed condition as a standard for judging the completed work.
5. Approval of sample panels is for color, texture, and blending of masonry units; tooling of joints; aesthetic qualities of workmanship; and other material and construction qualities specifically approved by Architect in writing.
   a. Approval of sample panels does not constitute approval of deviations from the contract documents contained in sample panels, unless such deviations are specifically approved by Architect in writing.
6. Demolish and remove sample panels when directed.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Deliver preblended, dry mortar mix in moisture-resistant containers designed for lifting and emptying into dispensing silo. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in a metal dispensing silo with weatherproof cover.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.8 PROJECT CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day’s work. Cover partially completed masonry when construction is not in progress.
   1. Extend cover a minimum of 24 inches down both sides and hold cover securely in place.

B. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
   1. Protect base of walls from rain-splashed mud and from mortar splatter by coverings spread on ground and over wall surface.
   2. Protect sills, ledges, and projections from mortar droppings.
3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.

4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

C. Cold Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

1. Cold Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 degrees F and above and will remain so until masonry has dried, but not less than 7 days after completing cleaning.

D. Hot Weather Requirements: Protect unit masonry work when temperature and humidity conditions produce excessive evaporation of water from mortar and grout. Provide artificial shade and wind breaks and use cooled materials as required.

1. When ambient temperature exceeds 100 degrees F, or 90 degrees F with a wind velocity greater than 8 mph, do not spread mortar beds more than 48 inches ahead of masonry. Set masonry units within one minute of spreading mortar.

PART 2 - PRODUCTS

2.1 CONCRETE MASONRY UNITS

A. General: Provide shapes indicated and as follows:

1. Provide special shapes for lintels, corners, jambs, sash, control joints, headers, bonding, and other special conditions.

2. Provide square-edged units for outside corners, unless indicated as bullnose.

B. Concrete Masonry Units: ASTM C 90 and as follows:

1. Unit Compressive Strength: Provide units with minimum average net area compressive strength of 2,150 psi single unit.

2. Weight Classification: Medium weight.

3. Provide Type II, nonmoisture-controlled units.

4. Exposed Faces: Manufacturer's standard color and texture, unless otherwise indicated.

2.2 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold weather construction. Provide natural color or white cement as required to produce mortar color indicated.

B. Hydrated Lime: ASTM C 207, Type S.

C. Mortar Cement: ASTM C 1329.

D. Aggregate for Mortar: ASTM C 144; except for joints less than 1/4-inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.

E. Aggregate for Grout: ASTM C 404.
F. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494, Type C, and recommended by the manufacturer for use in masonry mortar of composition indicated.

G. Water: Potable.

H. Available Products: Subject to compliance with requirements, products that may be incorporated into the work include, but are not limited to, the following:
   1. Cold-Weather Admixture
      a. Accelguard 80; Euclid Chemical Co.
      c. Trimix-NCA; Sonneborn, Div. of ChemRex, Inc.

2.3 REINFORCING STEEL
   A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M, Grade 60.

2.4 MISCELLANEOUS ANCHORS
   A. Anchor Bolts: Steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153, Class C; of diameter and length indicated and in the following configurations:
      1. Headed bolts.
      2. Nonheaded bolts, bent in manner indicated.

2.5 MISCELLANEOUS MASONRY ACCESSORIES
   A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene or urethane.
   B. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells with loops for holding reinforcing bars in center of cells. Units are formed from 0.142-inch steel wire, hot-dip galvanized after fabrication.
      1. Provide units with either two loops or four loops as needed for number of bars indicated.

2.6 MASONRY CLEANERS
   A. Job Mixed Detergent Solution: Solution of 1/2-cup dry measure tetrasodium polyphosphate and 1/2-cup dry measure laundry detergent dissolved in 1-gallon of water.
   B. Proprietary Acidic Cleaner: Manufacturer's standard strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.
      1. Available Products: Subject to compliance with requirements, products that may be used to clean unit masonry surfaces include, but are not limited to, the following:
         a. Cleaners for Concrete Masonry Units:
            1) 202V Vana-Stop; Diedrich Technologies, Inc.
            2) Masonry Cleaner Type L; Fabrikem Manufacturing Ltd.
            3) Heavy Duty Concrete Cleaner; ProSoCo, Inc.
2.7 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.
   1. Do not use calcium chloride in mortar or grout.
   2. Add cold weather admixture (if used) at the same rate for all mortar, regardless of weather conditions, to ensure that mortar color is consistent.

B. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification.
   1. Limit cementitious materials in mortar to portland cement, mortar cement, and lime.
   2. For reinforced masonry and where indicated, use Type S.
   3. For exterior, above-grade, load-bearing and nonload-bearing walls and parapet walls; for interior load-bearing walls; for interior nonload-bearing partitions; and for other applications where another type is not indicated, use Type S.

C. Grout for Unit Masonry: Comply with ASTM C 476.
   1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 5 of ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
   2. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143.

D. Epoxy Pointing Mortar: Mix epoxy pointing mortar to comply with mortar manufacturer's directions.

2.8 SOURCE QUALITY CONTROL

A. Owner will engage a qualified independent testing agency to perform source quality control testing indicated below:
   1. Payment for these services will be made by Owner.
   2. Retesting of materials failing to meet specified requirements shall be done at Contractor's expense.

B. Concrete Masonry Unit Tests: For each type of concrete masonry unit indicated, units will be tested according to ASTM C 140.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
   1. For the record, prepare written report, endorsed by the Installer, listing conditions detrimental to performance.
   2. Verify that foundations or supporting slabs are within tolerances specified.

B. Verify that reinforcing dowels are properly placed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.
D. Before installation, examine rough-in and built-in construction to verify actual locations of piping connections.

3.2 INSTALLATION, GENERAL
A. Thickness: Build single wythe walls to the actual widths of masonry units using units of widths indicated.
B. Build chases and recesses to accommodate items specified in this section and in other sections of the specifications.
C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to the opening.
D. Cut masonry units with motor-driven saws to provide clean, sharp, unchipped edges. Cut units as required to provide a continuous pattern and to fit adjoining construction. Where possible, use full-size units without cutting. Allow units cut with water-cooled saws to dry before placing, unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.
E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.
1. Mix units from several pallets or cubes as they are placed.

3.3 CONSTRUCTION TOLERANCES
A. Comply with tolerances in ACI 530.1/ASCE 6/TMS 602 and the following:
B. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/4-inch in 20 feet, nor 1/2-inch maximum.
C. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4-inch in 10 feet, nor 1/2-inch maximum.
D. For conspicuous horizontal lines, such as exposed lintels, sills, parapets, and reveals, do not vary from level by more than 1/4-inch in 20 feet, nor 1/2-inch maximum.

3.4 LAYING MASONRY WALLS
A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less than half-size units, particularly at corners, jambs, and, where possible, at other locations.
B. Bond Pattern for Exposed Masonry: Lay exposed masonry in the following bond pattern; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.
1. One-half running bond with vertical joint in each course centered on units in courses above and below.
C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 2 inches. Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.
D. Stopping and Resuming Work: In each course, rack back one-half unit length for one-half running bond or one-third unit length for one-third running bond; do not tooth. Clean exposed
surfaces of set masonry, wet clay masonry units lightly if required, and remove loose masonry units and mortar before laying fresh masonry.

E. Built-in Work: As construction progresses, build in items specified under this and other sections of the specifications. Fill in solidly with masonry around built-in items.

F. Fill space between hollow metal frames and masonry solidly with mortar, unless otherwise indicated.

G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath in the joint below and rod mortar or grout into core.

H. Fill cores in hollow concrete masonry units with grout 24 inches under bearing plates, beams, lintels, posts, and similar items, unless otherwise indicated.

I. Build nonload-bearing interior partitions full height of story to underside of solid floor or roof structure above, unless otherwise indicated.
   1. Install compressible filler in joint between top of partition and underside of structure above.

3.5 MORTAR BEDDING AND JOINTING

A. Lay hollow masonry units as follows:
   1. With full mortar coverage on horizontal and vertical face shells.
   2. Bed webs in mortar in starting course on footings and in all courses of piers, columns, and pilasters, and where adjacent to cells or cavities to be filled with grout.

B. Tool exposed joints slightly concave when thumbprint hard using a jointer larger than the joint thickness, unless otherwise indicated.

3.6 ANCHORING MASONRY TO STRUCTURAL MEMBERS

A. Anchor masonry to structural members where masonry abuts or faces structural members to comply with the following:
   1. Provide an open space not less than 1-inch in width between masonry and structural member, unless otherwise indicated. Keep open space free of mortar or other rigid materials.
   2. Anchor masonry to structural members with flexible anchors embedded in masonry joints and attached to structure.
   3. Space anchors as indicated, but not more than 24 inches on center vertically and 36 inches on center horizontally.

3.7 CONTROL AND EXPANSION JOINTS

A. General: Install control and expansion joints in unit masonry where indicated. Build-in related items as masonry progresses. Do not form a continuous span through movement joints, unless provisions are made to prevent in-plane restraint of wall or partition movement.

B. Form control joints in concrete masonry as follows:
   1. Fit bond breaker strips into hollow contour in ends of concrete masonry units on one side of control joint. Fill resultant core with grout and rake joints in exposed faces.
2. Install temporary foam plastic filler in head joints and remove filler when unit masonry is complete.

C. Build in horizontal, pressure-relieving joints where indicated. Construct joints by either leaving an air space or inserting a compressible filler of width required for installing sealant and backer rod specified in Division 7 Section "Joint Sealants."

3.8 LINTELS

A. Provide masonry lintels where shown and where openings of more than 12 inches for brick size units and 24 inches for block size units are shown without structural steel or other supporting lintels.

B. Provide minimum bearing of 8 inches at each jamb, unless otherwise indicated.

3.9 REINFORCED UNIT MASONRY INSTALLATION

A. Temporary Formwork and Shores: Construct formwork and shores to support reinforced masonry elements during construction.
   1. Construct formwork to conform to shape, line, and dimensions shown. Make it sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
   2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other temporary loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements of ACI 530.1/ASCE 6/TMS 602.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained sufficient strength to resist grout pressure.
   1. Comply with requirements of ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.

3.10 FIELD QUALITY CONTROL

A. Where indicated as being designed for reduced stresses, special inspection and testing of masonry is not required.

B. Owner will engage a Qualified Independent Testing Agency to perform field quality control testing indicated below.
   1. Payment for these services will be made by Owner.
   2. Retesting of materials failing to meet specified requirements shall be done at Contractor's expense.

C. Testing Frequency: Tests and Evaluations listed in this article will be performed during construction for each 5,000 square feet of wall area or portion thereof.

D. Mortar properties will be tested per ASTM C 780.

E. Grout will be sampled and tested for compressive strength per ASTM C 1019.

F. Concrete Masonry Unit Tests: For each type of concrete masonry unit indicated, units will be tested according to ASTM C 140.
G. Special Inspection: Inspection according to Seattle Building Code, Chapter 17.

3.11 REPAIRING, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units. Install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application.

C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
   1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
   2. Test cleaning methods on sample wall panel. Leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
   3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent, polyethylene film, or waterproof masking tape.
   4. Wet wall surfaces with water before applying cleaner. Remove cleaners promptly by rinsing the surfaces thoroughly with clear water.
   5. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2 applicable to type of stain on exposed surfaces.

3.12 MASONRY WASTE DISPOSAL

A. Recycling: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from project site.

B. Excess Masonry Waste: Remove excess, clean masonry waste that cannot be used as fill, as described above, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 04 22 00
PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. References and standards listed herein are to be the latest edition available, unless specifically stated otherwise.

1.2 SUMMARY
   A. This section includes structural steel and grout.
   B. Related Sections include the following:
      1. Division 05 Section “Decorative Metal Railings” for guardrails and handrails.

1.3 SUBMITTALS
   A. Product Data: For each type of product indicated.
   B. Shop Drawings: Show fabrication of structural steel components.
   C. Welding certificates.
   D. Mill test reports.
   E. Source quality control test reports.

1.4 QUALITY ASSURANCE
   A. Fabricator Qualifications: A qualified fabricator who participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category Sbd.
   B. Welding: Qualify procedures and personnel according to AWS D1.1, “Structural Welding Code-Steel.”
   C. Comply with applicable provisions of AISC's "Code of Standard Practice for Steel Buildings and Bridges."
   D. Preinstallation Conference: Conduct conference at project site.

PART 2 - PRODUCTS

2.1 STRUCTURAL STEEL MATERIALS
   A. W-Shapes: ASTM A 992/A 992M.
   B. Channels, Angles, Shapes: ASTM A 36/A 36M.
   C. Plate and Bar: ASTM A 36/A 36M.
   D. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade B, structural tubing.
   E. Welding Electrodes: Comply with AWS requirements.
2.2 BOLTS, CONNECTORS, AND ANCHORS

A. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy hex steel structural bolts; ASTM A 563 heavy hex carbon steel nuts; and ASTM F 436 hardened carbon steel washers.

2. Direct Tension Indicators: ASTM F 959, Type 325 compressible washer-type.

B. Shear Connectors: ASTM A 108, Grades 101 through 1020, headed stud type, cold-finished carbon steel; AWS D1.1, Type B.

C. Unheaded Anchor Rods: ASTM F 1554, Grade 36.


D. Headed Anchor Rods: ASTM F 1554, Grade 36, straight.


E. Threaded Rods: ASTM A 36/A 36M.


2.3 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.4 FABRICATION


B. Welded Headed Stud Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed stud shear connectors according to AWS D1.1 and manufacturer's written instructions.

2.5 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug-tightened.

B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.
2.6 GALVANIZING

A. Hot-Dip Galvanized Finish: For the steel indicated to be galvanized, apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/ A 123M.
   1. Fill vent holes and grind smooth after galvanizing.
   2. Galvanize lintels ledgers attached to structural-steel frame and located in exterior walls.

2.7 SOURCE QUALITY CONTROL

A. Owner will engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports. Comply with testing and inspection requirements of Part 3, Article “Field Quality Control.” Special inspection is not required for work performed by an approved fabricator per IBC Section 1704.2.2.

B. Correct deficiencies in work that test reports and inspections indicate does not comply with the contract documents.

C. In addition to visual inspection, shop-welded shear connectors will be tested and inspected according to requirements in AWS D1.1 for stud welding.

PART 3 - EXECUTION

3.1 ERECTION

A. Examination: Verify elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments, with steel erector present, for compliance with requirements.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Set structural steel accurately in locations and to elevations indicated and according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and "Load and Resistance Factor Design Specification for Structural Steel Buildings."

   1. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of base plate before packing with grout.
   2. Promptly pack grout solidly between bearing surfaces and base plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

D. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."

3.2 FIELD CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
   1. Joint Type: Snug tightened.
B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.


3.3 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to inspect field welds and high-strength bolted connections.

B. Bolted Connections: Bolted connections will be inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

C. Welded Connections: Field welds will be visually inspected according to AWS D1.1.

1. In addition to visual inspection, field welds will be tested according to AWS D1.1 and the following inspection procedures, at testing agency’s option:

   a. Liquid Penetrant Inspection: ASTM E 165.

   b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.

   c. Ultrasonic Inspection: ASTM E 164.

   d. Radiographic Inspection: ASTM E 94.

D. Correct deficiencies in work that test reports and inspections indicate does not comply with the contract documents.

3.4 REPAIRS AND PROTECTION

A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A 780 and manufacturer’s written instructions.

END OF SECTION 05 12 00
PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
1. Guardrail – Type RA
2. Handrail – Type RB
3. Guardrail – Type RD
4. Guardrail – Type RC
5. Miscellaneous angles, plates, backing plates, embedments, sleeves and other items not specified in other Sections but shown or required to complete the work.

B. This section also includes requirements regarding the surface preparation of architecturally exposed structural steel (AESS). This requirement applies to any items noted on the Drawings as AESS.

C. Coordinate related work specified in other parts of the Project Manual, including but not limited to following:
   - Section 09 90 00 – Painting and Coating
   - Section 09 97 13 – Exterior Steel Coatings
   - Section 26 51 00 – Exterior Lighting
   - Section 32 90 00 – Planting

1.2 SUBMITTALS

A. Shop Drawings: Show fabrication and installation of handrails and guardrails. Include plans, elevations, sections, component details, and attachments to other Work:
1. Show dimensions, sizes, thicknesses, gauges, finishes, anchorages, joining methods and fabrication details.
2. Include erection, reinforcement, embedment details and other pertinent information.
3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, show size, length and type of each weld. Identify grinding and profile of welds as defined herein.
4. Indicate finishes for all materials.

B. Samples: All samples to indicate specified finishes.
1. Minimum 12” long sample of high performance coated steel.
   a. Samples to be in colors as specified for rail types RA, RB, RD, and RC.

C. Product Data: For the following:
1. Non-shrink grout.

D. Welding certificates.

1.3 QUALITY ASSURANCE

A. Manufacturer / Fabricator / Installer Qualifications:
1. Company specializing in ornamental metal design, fabrication, and installation.
2. Able to document minimum 10 years experience fabrication and installing custom commercial quality ornamental metal railing systems of type, scope and quality specified by this Section.
3. Experienced in fabricating AESS similar to what is indicated for this project with a record of successful in-service performance, as well as sufficient production capacity to fabricate AESS without delaying the work.
4. Able to document capacity to apply metal finish systems of type specified by this Section.
5. Experienced in installing AESS work similar in material, design, and extent to that indicated for this project and with a record of successful in-service performance.

B. Quality of workmanship for exposed steel to be Class 1 as defined by NAAMM.
   1. Class 1 (Architectural Metals):
      a. Exposed surfaces are finished smooth with pits, mill marks, nicks and scratches filled or ground off. Defects should not show when finished.
      b. Welds should be concealed where possible. Exposed welds are ground to small radius with uniform sized cove unless otherwise noted.
      c. Distortions should not be visible to the eye.
      d. Exposed joints are fitted to a hairline finish.
      e. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

C. Mockups: At least 4 weeks prior to fabricating AESS, the Contractor shall construct mock-ups to demonstrate aesthetic effects, as well as qualities of materials and execution. A mockup for each of the following elements shall be constructed and comply with the following requirements:
   1. Locate mock-ups on-site or in Fabricator’s shop if shop is within 50 miles of greater Seattle area.
   2. Rail Type RA Mockup:
      a. Provide a 12'-0" length mockup of Rail Type RA incorporating all indicated vertical and horizontal elements at dimensions as shown in the Drawings. Include LED light fixture, LED driver, low-voltage wiring and any required components for a finished and complete functioning system.
      b. Provide mockup in specified finishes.
   3. Rail Type RB, RC, and RD Mockups:
      a. Provide 4'-0" length mockups of Rail Types RB, RC, and RD incorporating all indicated vertical and horizontal elements at dimensions as shown in the Drawings.
      b. Provide mockups in specified finishes.
   4. Provide at least 1 week notice in advance of date and times when mockups will be available for review.
   5. Mockups approved as “No Exceptions Taken” and in an undisturbed and undamaged condition may become part of the completed work.

D. Welding:
   1. Perform in accordance with regulatory agencies.
   2. Welding qualifications: Qualify welding processes and welding operators in accordance with AWS D1.1, D1.2 and D1.3 as applicable. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved.

E. Comply with applicable provisions of the following specifications and documents:

1.4 STORAGE AND HANDLING
A. Store all materials specified under this section in a dry, well-ventilated, weathertight location. Keep all railing components off of ground by using pallets, platforms or other supports.

B. Protect all materials specified under this section from damage and mishandling. Protect materials from construction activities while stored at site.

C. Bent, scratched, or otherwise damaged items are not acceptable.

1.6 PROJECT CONDITIONS

A. Field Measurements: Verify all component rough-in and finish dimensions by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

   1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating components without field measurements. Coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.7 COORDINATION

A. Coordinate installation of anchorages for all components specified under this section. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.8 SEQUENCING AND SCHEDULING

A. Pre-Installation Conference: Conduct a pre-installation conference at the project site in accordance with requirements of Division 1 Section "Project Meetings." Coordinate requirements for shipping, handling, installation, painting and any other AESS requirements for railings.

B. Schedule installation so handrails and guardrails are mounted only on completed walls and surfaces or are installed concurrently with adjacent finish materials. Do not support temporarily by any means that does not satisfy structural performance or AESS requirements.

PART 2 - PRODUCTS

2.1 GUARDRAIL TYPE RA

A. High-performance coated steel guardrail posts, pickets, horizontals, and light shelf.

2.2 HANDRAIL TYPE RB

A. High-performance coated steel handrail posts, pickets, and horizontals.

2.3 HANDRAIL TYPE RD

A. High-performance coated steel handrail posts, pickets, and horizontals.

2.4 HANDRAIL TYPE RC

A. High-performance coated steel handrail posts, pickets, and horizontals, to match SP1 guardrail.
2.5 METALS

A. For fabrication of ferrous metal work which will be exposed to view, provide metal free from pitting, seam marks, roller marks, stains, discolorations, and other imperfections on finished units.

B. Steel: Provide steel in the form indicated, complying with the following requirements:
   1. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

2.6 WELDING MATERIALS, FASTENERS, AND ANCHORS

A. Welding Electrodes and Filler Metal: Provide type and alloy of filler metal and electrodes as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.

B. Fasteners for Interconnecting Handrail and Guardrail Upright Components: Use fasteners fabricated from same basic metal as fastened metal, unless otherwise indicated. Do not use metals that are corrosive or incompatible with materials joined.
   1. Provide tamper-proof mechanical fasteners for interconnecting handrail and guardrail components and for attaching them to other work, unless otherwise indicated.

C. Expansion Anchors: Expansion anchors fabricated from corrosion-resistant materials with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.

2.7 FABRICATION

A. General: Fabricate handrails and guardrails, to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.

B. Assemble handrails and guardrails in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

C. Fabricate AESM handrails and guardrails with exposed surfaces smooth, square, and of surface quality consistent with the approved mockup.
   1. Fabrication Tolerance: Fabricate steel to one-half the normal tolerance as specified in the 2010 AISC “Code of Standard Practice”, Section 10.

D. Shop-Welded Connections: Comply with AWS D1.1. Appearance and quality of welds shall be consistent with the approved mockup. Assemble and weld built-up sections by methods that will maintain alignment of members without warp exceeding the tolerance of this section. Fabricate handrails and guardrails for connecting members by welding. Cope components at perpendicular and skew connections to provide close fit, or use fittings designed for this purpose. Weld connections to comply with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove flux immediately.
4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.
5. Welds Ground Smooth: Grind welds smooth. For groove welds, the weld shall be made flush to the surfaces each side and be within 1/16 inch to 0 inch of plate thickness.
6. Contouring and Blending of Welds: Where fillet welds are indicated to be ground contoured or blended, oversize welds as required and grind to provide a smooth transition and match profile on approved mockup.
7. Continuous Welds: Where welding is noted on the drawings, provide continuous welds of a uniform size and profile.
8. Minimize Weld Show-Through: At locations where welding on the far side of an exposed connection occurs, grind distortion and marking of the steel to a smooth profile with adjacent material.

E. Brackets, Flanges, Fittings, and Anchors: Provide brackets, flanges, miscellaneous fittings, and anchors to interconnect components as required to other work, unless otherwise indicated.

F. Provide inserts and other anchorage devices for connecting handrails, guardrails, and uprights to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by handrails and railings. Coordinate anchorage devices with supporting structure.

G. Shear and punch metals cleanly and accurately. Remove burrs from exposed cut edges.

H. Ease exposed edges to a radius of approximately 1/32 inch, unless otherwise indicated.

I. Cut, reinforce, drill, and tap components, as indicated, to receive finish hardware, screws, and similar items.

J. Provide weep holes or another means to drain entrapped water in hollow sections of handrail that are exposed to exterior or to moisture from condensation or other sources.

K. Fabricate joints that will be exposed to weather in a watertight manner.

L. Close exposed ends of handrail with prefabricated end fittings.

2.8 FINISHES

A. Steel Finish System:
1. 3-part Tnemec High Performance Coating.
   a. Refer to Section 09 97 13 Exterior Steel Coatings.
2. Rail Finish Colors, refer to Section 09 97 13 Exterior Steel Coatings:
   a. Rail Type RA: MTL-2
   b. Rail Type RA Light Shelf: MTL-3
   c. Rail Type RB: MTL-2
   d. Rail Type RC: MTL-1
   e. Rail Type RD: MTL-2

PART 3 - EXECUTION
3.1 EXAMINATION

A. Verify installation conditions as satisfactory to receive work of this Section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

1. Examine areas and conditions, with Installer present, for compliance with requirements for correct and level finished grade, mounting surfaces, installation tolerances, and other conditions affecting performance.

B. Examine assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements have been clearly marked for Installer. Locate reinforcements and mark locations if not already done.

3.2 INSTALLATION, GENERAL

A. Fit exposed connections together to form tight, hairline joints.

B. Perform cutting, drilling, and fitting required to install all Work noted under this section. Set all components specified under this section accurately in location, alignment, and elevation; measured from established lines and levels and free from rack.

1. Do not weld, cut, or abrade surfaces of components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.

2. Set posts plumb within a tolerance of 1/16 inch in 3 feet.

3. Align rails so variations from level for horizontal members and from parallel with rake of steps and ramps for sloping members do not exceed 1/8 inch in 12 feet.

C. Adjust handrails and guardrails before anchoring to ensure matching alignment at abutting joints. Space posts at interval indicated, but not less than that required by structural loads.

D. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing handrails and uprights and for properly transferring loads to in-place construction.

3.3 HANDRAIL AND GUARDRAIL CONNECTIONS

A. Field-Welded Connections: Use fully welded joints for permanently connecting handrail and guardrail components. Comply with requirements for welded connections in "Fabrication" Article whether welding is performed in the shop or in the field.

1. Welds Ground Smooth: Grind welds smooth. For groove welds, the weld shall be made flush to the surfaces each side and be within 1/16 inch to 0 inch of plate thickness.

2. Contouring and Blending of Welds: Where fillet welds are indicated to be ground contoured or blended, oversize welds as required and grind to provide a smooth transition and match profile on approved mockup.

3. Continuous Welds: Where welding is noted on the drawings, provide continuous welds of a uniform size and profile.

4. Minimize Weld Show-Through: At locations where welding on the far side of an exposed connection occurs, grind distortion and marking of the steel to a smooth profile with adjacent material.
3.4 ANCHORING HANDRAILS AND GUARDRAILS

A. Anchor post flanges to concrete substrate with expansion anchors or cast embedments with concrete slabs as indicated in Drawings.

B. Leave anchorage joint exposed; mechanically remove surplus anchoring material; and leave 1/8-inch build-up, sloped away from post.

3.5 PROTECTION

A. Protect finishes of all finish components specified under this section from damage during construction with temporary protective coverings approved by metal fabricator. Remove protective coverings at the time of Substantial Completion.

B. Clean and restore finishes damaged during installation and construction period so no evidence remains of installation or correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units as required.

3.6 WASTE MANAGEMENT

A. Conform to waste management plan as specified in Section 01 74 00, Construction Waste Management and Disposal.

END OF SECTION 05 73 00
PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes
   1. Hot applied rubberized asphalt membrane waterproofing system at locations scheduled at the end of this Section.
   2. Protective covering.
   3. Drainage matting.
B. Related Sections
   1. Division 01 Section "Submittals Procedures."
   2. Division 01 Section "Quality Requirements."
   3. Division 03 Section "Cast-in-Place Concrete."
C. Drawings, the provisions of the Agreement, the General Conditions, and Division 1 specification sections apply to all work of this Section.

1.2 SYSTEM DESCRIPTION
A. Waterproofing system shall be capable of preventing moisture migration to the building interior, in the applications indicated, when installed in accordance with the Contract Documents.

1.3 REFERENCES
A. American Society of Testing and Materials (ASTM):
   1. D92 - Test Method for Flash and Fire Points by Cleveland Open Cup.
   4. D4258 - Practice for Surface Cleaning Concrete for Coating.
   5. D4259 - Practice for Abrading Concrete.
B. Canadian General Standards Board:
   1. CAN/CGSB-37.50 - Hot Applied, Rubberized Asphalt for Roofing and Waterproofing
   2. CAN/CGSB-37.51 - Application of Rubberized Asphalt, Hot-Applied, for Roofing and Waterproofing

1.4 SUBMITTALS
A. Submit product data and samples in accordance with Division 1 Section “Submittals Procedures”
B. Product Data: Submit manufacturer's complete product data for each product proposed, including, membrane materials, flashing, and other related components of the system.
C. Shop Drawings: Submit details for this specific installation indicating flashing requirements, including details for substrate joints and cracks, sheet flashings, penetrations, and other termination conditions. Include special details to indicated application at special conditions.
D. Quality Control Submittals:
   1. Qualification Data: Submit installer qualifications verifying years of experience; include list of completed projects having similar scope of work identified by name, location, date, reference names and phone numbers.
   2. Warranty Draft: Concurrent with initial product data submittal, submit draft of warranties for Architect’s review. Draft shall include all specified exceptions and inclusions.
E. Closeout Submittal:
   1. Submit warranty in accordance with Section 017700.
F. LEED Submittals:
   1. Make LEED submittals in accordance with Section 013543.
   2. MR 4.1 and 4.2 Recycled Content Credit:
      a. Submit a signed LEED Letter Template stating % of Post-Consumer and % of Pre-
Consumer Recycled Content of the waterproof membrane.

b. Provide cost data as necessary to verify the credit.

1.5 QUALITY ASSURANCE

A. Qualifications of Installer:
   1. Approved in writing by system manufacturer.
   2. Minimum of 5 years experience in installation of waterproofing systems of type specified.

B. Pre-installation Conference:
   1. Schedule prior to installation of systems. Conduct in accordance with provisions of Section 013119.
   2. Attendance:
      a. Owner’s Representative.
      b. Architect.
      c. Waterproofing installer.
      d. Membrane manufacturer’s technical representative.
   3. Agenda:
      a. Review all installation details.
      b. Review installation requirements for other work including concrete conditions, penetrations, and joint conditions.
      c. Review installation requirements including environmental conditions, crack preparation, water and trash removal, storage of materials, and protection of surrounding surfaces.
      d. Establish waterproofing protection procedures after installation.
      e. Resolve conditions which would prevent satisfactory installation of waterproof membrane.

1.6 PROJECT/SITE CONDITIONS

A. Unless otherwise specifically approved by waterproofing materials manufacture, maintain temperatures above 40 degrees F for 24 hours before application.

B. Coordinate installation sequence to ensure waterproofing system will be covered with concrete topping within 30 days of membrane installation.

C. Do not apply waterproofing to damp, frozen, dirty, dusty, or deck surfaces unacceptable to manufacturer.

1.7 WARRANTY

A. Furnish warranties under provisions of Section 017700.

B. Provide 5 year warranty, cosigned by the General Contractor, the installer, and the waterproofing materials manufacturer, including coverage of materials and installation, and including removal and replacement of covering materials, against failure of waterproofing installation to resist penetration of moisture, except where such failures are the result of structural failures of building. Hairline cracking of concrete due to temperature change or shrinkage shall not be considered as structural failure.

PART 2 - PRODUCTS

2.1 MANUFACTURERS


B. Subject to compliance with specification requirements, the following manufacturers are acceptable:
   1. none – New waterproofing to match existing waterproofing.

2.2 MATERIALS

A. System: American Hydrotech, Inc. (Chicago, IL; 312/377-4998) "Monolithic Membrane 6125-EV FR"

B. Membrane: Hot, fluid applied, rubber/asphalt composition containing no less than 25 percent recycled content:
   1. Water Resistance: No delamination, blistering, emulsion, or deterioration after 5 days at 122 deg F.
2. Elongation: Minimum 1000 percent; ASTM D 1191.
3. Flash Point: ASTM D92; 500°F minimum.
5. Flow: 3 mm maximum at 60 deg C; ASTM D 1191 and CAN/CGSB-37.50.
6. Toughness: Not less than J; CAN/CGSB-37.50.
7. Ratio of Toughness to Peak Load: Not less than 0.040; CAN/CGSB-37.50.
9. Water-Vapor Permeability: ASTM E96, 0.03 perms maximum.
10. Water Absorption: 0.35-g maximum mass gain or 0.18-g maximum mass loss; CAN/CGSB-37.50.
11. Pinholing: Not more than 1 pinhole; CAN/CGSB-37.50.
12. Low Temperature Flexibility: ASTM D746, no delamination or cracking at -25°C.
13. Crack Bridging Capability: No cracking, splitting, or loss of adhesion; CAN/CGSB-37.50.
14. Heat Stability: Meet the requirements of CAN/CGSB-37.50 for penetration, flow, low-temperature flexibility, and viscosity when heated for 5 hours at manufacturer's recommended application temperature.
15. Viscosity Test: 2 to 15 seconds; CAN/CGSB-37.50.

C. Fabric Reinforcement:

D. Primers, Surface Conditioners, Fillers, and Sealants: As recommended by membrane manufacturer.
E. Flashing, Reinforcement, Adhesives, and Sealants: As recommended by membrane manufacturer.
F. Protection Layer (Root Barrier):
1. Vertical: American Hydrotech HydroFlex 30 set into the warmed surface.
2. Horizontal (where less than 6 inches of soil over the top):
   a. American Hydrotech HydroFlex 30 set into the warmed surface,
   b. Covered by Hydrotech Root Stop, 10 mil HDPE root barrier.
3. Horizontal (where 6 inches or greater soil over the top):
   a. (Replace 2, a & b with the following): Hydroflex RB II root barrier. Also install where exposed in base flashing conditions.

G. Drainage Mat: American Hydrotech, Inc. "Hydrodrain 700," or approved; three-dimensional plastic matting with manufacturer's standard woven geotextile filter fabric bonded to one side.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Verify surfaces are solid, free of frozen matter, loose particles, cracks, pits, rough projections, and foreign matter detrimental to adhesion and application of waterproofing.
B. Verify items which penetrate surfaces to receive waterproofing are securely installed.
C. Notify the Architect of all unacceptable conditions, and do not commence work in those areas, until the unacceptable conditions have been resolved. Commencement of application constitutes acceptance of conditions.

3.2 PREPARATION
A. Clean and prepare surfaces to receive waterproofing in accordance with manufacturer's instructions.
B. Apply mastic to seal penetrations, small cracks, and honeycomb in substrate.
C. Protect adjacent surfaces not designated to receive waterproofing.
D. Apply surface conditioners and related components in strict accordance with manufacturer's recommendation.

3.3 JOINT AND CRACK TREATMENT
A. Prepare, treat, rout, and fill joints and cracks in substrate according to CAN/CGSB-37.51 and the waterproofing materials manufacturer's recommendations. Remove dust and dirt from joints and cracks prior to coating surfaces.
B. Prepare vertical and horizontal surfaces at terminations and penetrations through waterproofing and at drains and sleeves according to CAN/CGSB-37.51 and waterproofing manufacturer's recommendations.

3.4 MEMBRANE APPLICATION
A. Apply primer at manufacturer's recommended rate, over prepared substrate and allow to dry.
B. Apply membrane in accordance with manufacturer's instructions at rate to provide a continuous, monolithic membrane of 90 mils thickness, followed by application of reinforcing fabric, followed by another continuous monolithic membrane of 125 mils thickness, for total system thickness of 215 mils.
C. Continue membrane up vertical surfaces adjacent to and above horizontal applications minimum 6 inches, unless otherwise noted.
D. Seal items projecting through membrane.
E. Install membrane detail/flashings in strict accordance with manufacturer's instructions.
F. Install protection course with overlapped joints while membrane is still hot. Overlap adjoining sheet edges minimum of 3 inches.

Drainage Matting:
1. Install drainage matting continuously over waterproofed horizontal slabs and vertical walls.
2. Use adhesives and mechanical fasteners recommended by manufacturer and that do not penetrate waterproofing and as follows.
   a. Install with matting interlocked at the edges.
   b. Install with fabric side up.
   c. Lap fabric at joints.
   d. Fold fabric under to cover all exposed edges.
3. Provide additional protection as necessary to protect waterproof membrane system from subsequent construction damage.
4. Install the drainage matting immediately after completion of testing operations.

3.5 FIELD QUALITY CONTROL
A. Waterproofing materials factory representatives shall inspect all surfaces to receive membranes, prior to their installation. Installation procedures shall be approved and witnessed by a representative of the waterproofing material manufacturer.
B. On completion of membrane installation, prior to installation of drainage matting, provide membrane leak detection system and service by International Leak Detection (ILD), Rosemont IL, (866)282-LEAK, [(800)282-5325], info@leak-detection.com [for comparable system and service from a single manufacturer approved by Architect prior to bidding], with the following characteristics.
   1. Membrane Leak Detection System: Conductor cable, placed on top of membrane, delivering direct current tension to membrane surface, enabling inspection and isolation of points of moisture infiltration through membrane to conductive substrate under membrane.
C. Provide leak detection at all areas of new waterproofing installation and tie-ins to existing waterproofing membrane.
D. Test each area before overlying construction is placed.
E. If breaches in the membrane are found, patch using new waterproofing and protection course materials; repeat testing. Repair damage to building.
3.6 PROTECTION

A. Close off area to prevent unauthorized traffic or work over membrane until final topping is applied.

B. Protect installed insulation from damage due to ultraviolet light exposure, physical abuse, and other causes. Provide temporary coverings where insulation will be subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

3.7 SCHEDULE

A. Apply waterproofing to the following surfaces:
   1. Below grade horizontal surfaces to patch existing membrane where new penetrations are made.
   2. Vertical foundation walls.

END OF SECTION
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes: Joint sealers and backing materials for sealing exterior joints in construction.

B. Related Sections:
   1. Division 32 Section "Rigid Paving" for sealing joints in the City of Seattle right-of-way.

1.3 DEFINITIONS

1. “Sealant”, "joint sealer", and “caulking” are interchangeable terms for the purposes of this contract.

1.4 PRECONSTRUCTION TESTING

A. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.

   1. Use manufacturer's standard test method to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
   2. Submit not fewer than eight pieces of each kind of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
   3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
   4. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.
   5. Testing will not be required if joint-sealant manufacturers submit joint preparation data that are based on previous testing, not older than 24 months, of sealant products for adhesion to, and compatibility with, joint substrates and other materials matching those submitted.

B. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates as follows:

   1. Locate test joints where indicated on Project or, if not indicated, as directed by Engineer.
   2. Conduct field tests for each application indicated below:
      a. Each kind of sealant and joint substrate indicated.
   3. Notify Engineer seven days in advance of dates and times when test joints will be erected.
   4. Arrange for tests to take place with joint-sealant manufacturer's technical representative present.

1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.

5. Report whether sealant failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.

6. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

1.5 SUBMITTALS

A. Product Data: For each joint-sealant product indicated.

B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

C. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch wide joints formed between two 6-inch long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

D. Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.

E. Qualification Data: For qualified Installer.

F. Product Certificates: For each kind of joint sealant and accessory, from manufacturer.

G. Sealant, Waterproofing, and Restoration Institute (SWRI) Validation Certificate: For each sealant specified to be validated by SWRI's Sealant Validation Program.

H. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that sealants comply with requirements.

I. Preconstruction Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:

1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.
J. Preconstruction Field-Adhesion Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified in "Preconstruction Testing" Article.

K. Field-Adhesion Test Reports: For each sealant application tested.

L. Warranties: Sample of special warranties.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Source Limitations: Obtain each kind of joint sealant from single source from single manufacturer.

C. Product Testing: Test joint sealants using a qualified testing agency.
   1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.
   2. Test according to SWRI's Sealant Validation Program for compliance with requirements specified by reference to ASTM C 920 for adhesion and cohesion under cyclic movement, adhesion-in-peel, and indentation hardness.

D. Mockups: Install sealant in mockups of assemblies specified in other Sections that are indicated to receive joint sealants specified in this Section. Use materials and installation methods specified in this Section.

1.7 PROJECT CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:
   1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
   2. When joint substrates are wet.
   3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
   4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.8 WARRANTY

A. Special Installer's Warranty: Manufacturer's standard form in which Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
   1. Warranty Period: Two years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer's standard form in which joint-sealant manufacturer agrees to furnish joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.
1. Warranty Period: Ten years from date of Substantial Completion.

C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:

1. Movement of the structure caused by structural settlement or errors attributable to design or construction resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
2. Disintegration of joint substrates from natural causes exceeding design specifications.
3. Mechanical damage caused by individuals, tools, or other outside agents.
4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

B. VOC Content of Interior Sealants: Provide sealants and sealant primers for use inside the weatherproofing system that comply with the following limits for VOC content when calculated according to 40 CFR 59, Part 59, Subpart D (EPA Method 24):

1. Architectural Sealants: 250 g/L.
2. Sealant Primers for Nonporous Substrates: 250 g/L.
3. Sealant Primers for Porous Substrates: 775 g/L.

C. Liquid-Applied Joint Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied joint sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.

1. Suitability for Immersion in Liquids. Where sealants are indicated for Use I for joints that will be continuously immersed in liquids, provide products that have undergone testing according to ASTM C 1247. Liquid used for testing sealants is deionized water, unless otherwise indicated.

D. Stain-Test-Response Characteristics: Where sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.

E. Colors of Exposed Joint Sealants: As selected by Landscape Architect from manufacturer's full range.

2.2 POLYURETHANE JOINT SEALANTS

A. Type A: Flatwork and other areas subject to traffic.

1. Multicomponent, Nonsag, Traffic-Grade, Polyurethane Joint Sealant: ASTM C 920. Type M, Grade NS, Class 25, for Use T.
a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   1) BASF Building Systems; Sonolastic NP 2.
   2) Sika Corporation, Construction Products Division; Sikaflex 2C-NS TG.
   3) Tremco Incorporated; Vulkem 227.

B. Type B: Vertical joints and walls.
      a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
         1) BASF Building Systems; Sonolastic NP 2.
         2) Sika Corporation, Construction Products Division; Sikaflex 2C-NS.
         3) Tremco Incorporated; Vulkem 227.

2.3 JOINT SEALANT BACKING

A. General: Provide sealant backings of material that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin), and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

2.4 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer’s written instructions and the following requirements:
1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.

2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
   a. Concrete.
   b. Masonry.

3. Remove laitance and form-release agents from concrete.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
   1. Do not leave gaps between ends of sealant backings.
   2. Do not stretch, twist, puncture, or tear sealant backings.
   3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

D. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
   1. Place sealants so they directly contact and fully wet joint substrates.
   2. Completely fill recesses in each joint configuration.
   3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
E. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
3. Provide concave joint profile per Figure 8A in ASTM C 1193, unless otherwise indicated.
4. Provide flush joint profile where indicated per Figure 8B in ASTM C 1193.
5. Provide recessed joint configuration of recess depth and at locations indicated per Figure 8C in ASTM C 1193.
   a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

3.4 FIELD QUALITY CONTROL

A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:

1. Extent of Testing: Test completed and cured sealant joints as follows:
   a. Perform 10 tests for the first 1000 feet of joint length for each kind of sealant and joint substrate.
   b. Perform 1 test for each 1000 feet of joint length thereafter.

   a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.

3. Inspect tested joints and report on the following:
   a. Whether sealants filled joint cavities and are free of voids.
   b. Whether sealant dimensions and configurations comply with specified requirements.
   c. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion passes sealant manufacturer's field-adhesion hand-pull test criteria.

4. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.
5. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.

B. Evaluation of Field-Adhesion Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.5 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.6 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.7 JOINT-SEALANT SCHEDULE

A. Type A Joint-Sealant Application: Exterior joints in horizontal traffic surfaces.

1. Joint Locations:
   b. Joints between plant-precast architectural concrete paving units.
   c. Joints between different materials listed above.
   d. Other joints as indicated.

2. Polyurethane Joint Sealant: Multicomponent, non sag, traffic grade.

3. Joint-Sealant Color: As selected by Landscape Architect from manufacturer's full range of colors.

B. Type B Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal non-traffic surfaces.

1. Joint Locations:
   b. Joints between different materials listed above.
   c. Perimeter joints between materials listed above and frames of doors and louvers.
   d. Other joints as indicated.

3. Joint-Sealant Color: As selected by Landscape Architect from manufacturer’s full range of colors.

END OF SECTION 07 92 05
PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Preparation and painting of exterior concrete where indicated.

B. Related Sections: The work of the following Sections is related to the work of this Section. Other Sections, not referenced below, may also be related to the proper performance of this work.
   1. Section 03 30 00, Cast-In-Place Concrete
   2. Section 03 33 00, Architectural Concrete

1.2 DEFINITIONS
A. DFM (dry film mils): Minimum thickness, measured in mils, of a coat of paint in the cured state.
B. Gloss Levels: The following terms are used to specify specular gloss of finish coats in accordance with those listed by MPI (Master Painter Institute) when measured in accordance with ASTM D523.

<table>
<thead>
<tr>
<th>Gloss Level</th>
<th>Description</th>
<th>Gloss @ 60 degrees</th>
<th>Sheen @ 85 degrees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1</td>
<td>Traditional matte finish - flat</td>
<td>Maximum 5 units</td>
<td>Maximum. 10 units</td>
</tr>
<tr>
<td>Level 2</td>
<td>High side sheen flat – a ‘velvet-like’ finish</td>
<td>Maximum 10 units</td>
<td>10-35 units</td>
</tr>
<tr>
<td>Level 3</td>
<td>Traditional ’eggshell-like’ finish</td>
<td>10-25 units</td>
<td>10-35 units</td>
</tr>
<tr>
<td>Level 4</td>
<td>‘Satin-like’ finish</td>
<td>20-35 units</td>
<td>Minimum 35 units</td>
</tr>
<tr>
<td>Level 5</td>
<td>Traditional semi-gloss</td>
<td>35-70 units</td>
<td></td>
</tr>
<tr>
<td>Level 6</td>
<td>Traditional gloss</td>
<td>70-85 units</td>
<td></td>
</tr>
<tr>
<td>Level 7</td>
<td>High gloss</td>
<td>More than 85 units</td>
<td></td>
</tr>
</tbody>
</table>

1.3 SUBMITTALS
A. Procedures: Section 01 33 00, Submittal Procedures.
B. Product Data: Submit complete list of products proposed for use, including technical data on each product to verify compliance; organize list to indicate painting systems to be used with each substrate.
   1. Submit paint list with paint manufacturer, paint name, coverage and VOC content listed.
2. Submittal shall contain any proposed revisions to Contract Specifications (for example surface preparation, and method of application) which painting contractor feels are necessary in their execution of the Contract.

3. All proposed revisions must be approved by the Engineer prior to proceeding with the Work.

4. The submission of paint product data is to be in conjunction with steel submittals where the steel is being painted. This is to confirm that the shop applied steel primer is compatible with the intermediate coat and final paint coats. This submittal will not be considered complete and acceptable if either product is not compatible with each other.

C. Samples: Using approved paint products, prepare and submit samples of each type of finish, gloss level, and color for approval. Label samples with color number, product name and date. Provide three samples of each color and sheen.

1. Prepare paint samples on 8-1/2 inch by 11-inch heavy, durable non porous paper.

2. Adjustments to the overall sheen in one or more of the colors may be required. Such adjustments (if any) shall be made at no additional cost. Additional samples will be required should adjustments be made.

3. Initial color samples which have been approved are subject to final acceptance at time of field mock-up examination.

D. Contract Closeout Submittal: Include the following at time of Project Closeout:

1. Extra Materials: Coordinate submittal of extra maintenance materials with requirements of Section 01 77 00, Closeout Procedures and herein, for quantities and other requirements.

2. Color Mix: Submit color mix formula for each required paint color. Mix formula must be in measured increments of 48ths of an ounce; include the manufacturer's color and number identification, color chip, location list where said colors were applied and paint manufacturer of base.

1.4 QUALITY ASSURANCE

A. Single Source:

1. To the maximum extent practicable, select a single manufacturer to provide all materials required by this Section, using additional manufacturers to provide systems not offered by the selected principal manufacturer.

2. For each individual system, provide primer and other undercoat paint produced by same manufacturer as finish coat. Use only thinners approved by paint manufacturer and use only within recommended limits.

B. Visual Standards: Each distinct area of the finished Work shall be free of variations in color and sheen, runs, sags, holidays, blistering, checking, cracking, scratches and other signs of poor workmanship. Deep tone and accent color walls shall be free from joint banding, flashing, photographing, and uneven appearance.
C. Mockups: Apply benchmark samples of each paint system indicated and each color and finish selected to verify preliminary selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1.5 DELIVERY, STORAGE & HANDLING

A. Deliver materials to building in sealed, original, labeled containers bearing manufacturer's name, type of material, brand name, color designation, and instructions for mixing and thinning.

B. Store materials when not in actual use in a place specifically assigned for that purpose which is dry and out of direct sunlight. Store materials in a manner so as not to exceed the manufacturer's temperature limitations.

1.6 PROJECT CONDITIONS

A. Environmental Conditions: Air temperature and substrate temperature and relative humidity shall be within the manufacturer's established limits. Do not apply exterior paint when the following conditions exist, unless requirements of paint manufacturers are more restrictive.

1. Temperature: If surface and ambient temperature is above 90 degrees F, or below 50 degrees F.

2. Weather: Do not apply paint in snow, rain, fog, when excessively windy or during mist; or when relative humidity exceeds 85 percent; or at temperatures less than 5 degrees F above the dew point; or to damp or wet surfaces.

B. Lighting: Do not proceed with work under this section unless adequate lighting is available. Provide lighting level of at least 50 candlepower per square foot, measured mid-height at substrate surface.

C. Ventilation: Provide adequate ventilation as required for the type of paint and cleaning materials used. If necessary, consult paint manufacturer for recommendations.

D. Protection: Protect surrounding areas against damage due to painting operations. At a minimum, surrounding areas shall be covered with polyethylene sheeting and waterproof masking tape. Sound Transit will not be responsible for the Contractor's selection or method of protection.

1. Protective coverings shall be secured against wind and shall be vented to prevent collection of moisture on covered surfaces.

2. Provide "wet paint" signs as required to protect newly painted surfaces.

E. Precautions: Take all precautions to prevent fire; open containers of flammable materials only when needed; keep rubbing cloths and oily rags in tightly closed containers and remove from site daily. Dispose of hazardous materials in accordance with all local, State and Federal regulations.

F. Coordination: Review other sections of herein in which prime paints are to be provided to ensure compatibility of total coating system for various substrates. Notify Engineer in writing of any anticipated problems using specified coating systems with substrates primed by others.

1.7 EXTRA MATERIALS
A. Supply five gallons of each paint type and color; store where directed.

B. Label each container with color and color mix number in addition to the manufacturer’s label.

PART 2 - PRODUCTS

2.1 PAINT MATERIALS - GENERAL

A. Manufacturers: Refer to Paint Schedules at end of this Section for manufacturer’s product names and paint systems which are included to establish the required level of quality. Additionally the following list of manufacturer’s are acceptable, contingent upon meeting level of paint quality indicated and for which a substitution request is not required.

   1. ICI Dulux Paints / Devoe Performance Coatings
   2. Benjamin-Moore
   4. Sherwin Williams:
   5. Tnemec Company.

B. Paint Grade: Professional grade coatings meeting the equivalent performance requirements listed in the Master Painter Institute Approved Product List and suitable for its intended use.

C. Colors: Each paint color must be accurately mixed to ensure color continuity. No allowance will be granted for mismatched paint of the same color when viewed under normal lighting conditions.

D. Provide primer and finish coats, which are compatible with each other and with prime coats provided under other Sections. Provide barrier coats over incompatible primers or remove and re-prime as required.

E. Thinner: Type as recommended by the paint manufacturer. Use thinner only when recommended by the paint manufacturer, and then only in a quantity as indicated on the label.

F. Waterborne Acrylic Stain: One of the following or approved:

   1. Chemprobe/Tnemec Series 617 "Conformal Stain WB".
   2. United Coatings "Canyon Tone Stain".
   3. Tamms "Aqua Stain".

2.2 PAINT COLORS

A. Match the following concrete paint from SP1:

   1. PNT-1: Concrete Gray

      a. WSDOT "Washington Gray"
PART 3 - EXECUTION

3.1 EXAMINATION

A. General: Examine surfaces to receive paint finish for conditions that will adversely affect execution, performance, or quality of work and which cannot be put into an acceptable condition through reasonable preparatory work as specified herein.

1. Surfaces which are unfit to receive the work of this section shall be repaired, replaced or re-finished such that they are acceptable and such that the work of this section may be done as specified. It shall be the responsibility of the Contractor to ensure that these provisions are strictly enforced.

2. Commencement of Work constitutes acceptance of surfaces and conditions.

B. Concrete:

1. Alkali Content Testing: Test for alkalinity by performing appropriate tests, and neutralize as required for pH reading between 6.8 and 8.0, unless otherwise recommended by paint manufacturer. Test for pH following test method as described in ASTM D4262, utilizing litmus paper.

2. Moisture Content Testing: Test for moisture content by performing appropriate tests. Maximum moisture content shall not exceed 17 percent as determined by a moisture meter, unless otherwise required by paint manufacturer.

3.2 SURFACE PREPARATION (GENERAL)

A. General: Surface preparations and cleaning procedures shall be in strict accordance with the instructions and specifications of the paint manufacturer and with the requirements herein.

3.3 SURFACE PREPARATION

A. Concrete: Clean surfaces free from dirt, grease, oil, efflorescence, and other foreign substances. Remove mortar droppings, glaze, and scale.

3.4 CLEANING PRIOR TO PAINTING

A. Remove dust and loose deleterious materials from all surfaces before beginning painting operations. Program the cleaning and painting so that dust and other contaminants from the cleaning process will not fall in wet, newly painted surfaces.

3.5 APPLICATION OF PAINT

A. Mixing: Mix paint materials in accordance with the manufacturer's instructions and directions. Mix often enough during application to keep the paint uniform and to ensure complete dispersion of pigment and a uniform composition.

1. Prepare multiple component coatings using all of the contents of the container for each component as packaged by the manufacturer. Mixing of partial kits will not be permitted. Multiple component coatings that have been mixed shall not be used beyond their pot life. Only the components specified and furnished by the manufacturer, including thinner if required, shall be mixed.
B. Application: Apply paint in accordance with the manufacturer's directions. Use techniques best suited for substrate and type of material being applied. Brushes and rollers shall be of a type best suited for the type of material being applied.
   1. Apply intermediate and finish coats within the manufacturer's recommended top coating time periods.

C. Apply each coat of paint as a continuous film of uniform thickness, free from holidays, sags, crawls, pinholes, blisters, unevenness in color, or other evidence of poor workmanship. Repaint thin spots or areas missed in the application and allow to dry before applying next coat of paint.
   1. Give special attention to ensure that surfaces, such as edges, corners, crevices, welds and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
   2. Each coat shall be free of dirt, dust, moisture, and other contaminates prior to application of next coat.

D. Allow each coat of paint to thoroughly dry, full thickness of the film, before application of the succeeding coat. Paint is considered dry for recoating when the next coat can be applied without the development of all detrimental film irregularities such as wrinkling, lifting, or loss of adhesion of the previous coat.

E. Coverage for each paint material is specified as either the total minimum dry film thickness in mils, or the spreading rate in square feet per gallon over the surface designated. Actual coverage rate will vary depending upon the texture and porosity of the surface, and climatic conditions.
   1. The number of coats specified is the minimum required, irrespective of the coating thickness.
   2. In the event the required paint thickness is not achieved, or coating shows through, apply additional coats until the color appearance is uniform and required thickness is obtained. Cost for additional coats to prevent show through shall be borne by the Installer.
   3. Do not exceed manufacturer's recommended maximum film build-up per coat (wet mils).

F. Make edges of paint adjoining other materials or colors clean and sharp with no overlapping.

G. Do not paint over code-required labels or equipment identification or nomenclature plates.

3.6 DAMAGED PAINT SURFACES
A. General: Before final acceptance of the work by the Engineer, repair or re-finish painted surfaces which have been damaged at no additional cost.

B. Areas of chipped, peeled, or abraded paint shall be hand or power sanded, feathering the edges. Prime and finish coat the areas using the same material as originally scheduled. Depending on the extent of repair and its appearance, an overall finish coat may be required by the Engineer to achieve uniform appearance.

3.7 CLEAN-UP
A. General: During the progress of the work, remove from the project all discarded paint materials, rubbish, cans and rags. Leave premises clean and in orderly condition.

B. Cleaning: Upon completion of painting work, clean any and all paint-spattered surfaces. Remove spattered paint by proper methods of washing and scraping, using care not to scratch or otherwise damage finished surfaces.

3.8 PAINT SCHEDULE - EXTERIOR SURFACES

A. Typical Exposed Concrete (other than bridge soffit). Waterborne acrylic stain.
   1. Primer: None required.
   2. Two Finish Coats: Waterborne acrylic stain.

END OF SECTION 09 90 00
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. References and standards listed herein are to be the latest edition available, unless specifically stated otherwise.

1.2 SUMMARY

A. This section includes materials and procedures for the installation of graffiti-resistant coatings as shown on drawings.

B. Related Sections

1. Section 01 25 00 – Substitution Procedures
2. Section 01 33 00 – Submittal Procedures
3. Section 03 30 00 – Cast In Place Concrete
4. Section 03 33 10 – Architectural Cast In Place Concrete
5. Section 03 45 00 – Precast Architectural Concrete
6. Section 09 90 00 – Painting

1.3 SUBMITTALS

A. General: Make submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Product Data: Manufacturer’s specifications and technical data including the following:

1. Detailed specification of construction and fabrication.
2. Manufacturer’s installation instructions.
3. Certified test reports indicating compliance with performance requirements specified herein

C. Samples: Provide samples of the materials requested by Architect, including names, sources, and descriptions.

D. Quality Control Submittals:

3. Field Quality Control Submittals as specified in Part 3.
4. Manufacturer’s field reports.

1.4 QUALITY ASSURANCE

A. Regulatory and Safety Requirements: Products must have independent laboratory analysis that material does not contain any known carcinogens. Materials shall comply with State and local regulations concerning AIM (Architectural, Industrial and Maintenance) coatings regarding Volatile Organic Content (VOC).
B. Manufacturer’s Qualification: Not less than 5 years experience in the actual production of specified products.

C. Installer’s Qualifications: Firm experienced in installation or application of systems similar in complexity to those required for this Project, plus the following:
   1. Acceptable to or licensed by manufacturer.
   2. Not less than 3 years experience with systems
   3. Successfully completed not less than 5 comparable scale projects using this system.

D. Product Qualifications: The anti-graffiti coating shall meet the following requirements:
   1. Active Content: Organofluorosilane.
   2. Solvent: None, water-borne.
   3. VOC Content: less than 50 grams per liter.
   5. Breathability: ASTM D1653 greater than 95% water vapor transmission.
   6. Surface Appearance: No appreciable difference compared to non-coated surface.
   7. Excellent Ultraviolet light stability.

1.5 DELIVERY STORAGE AND HANDLING

A. Packing and Shipping: Deliver products in original unopened packaging with legible manufacturer’s identification.

B. Storage and Protection: Comply with manufacturer’s recommendations.

1.6 PROJECT CONDITIONS

A. Environmental Requirements:
   1. Maintain ambient temperature above 40 degrees F during and 24 hours after installation.
   2. Do not proceed with application on materials if ice or frost is covering the substrate.
   3. Do not proceed with application if ambient temperature of surface exceeds 100 degree F.
   4. Do not proceed with the application of materials in rainy conditions or if heavy rain is anticipated with 4 hours after application.

B. Sealer Coordination:
   1. Verify compatibility with curing compounds, patching materials, repair mortar, paints, sealants, to be used on masonry surfaces to ensure compatibility with the anti-graffiti coating.

1.7 SPECIAL WARRANTIES

A. The system manufacture shall furnish the Owner a written single source performance warranty that the Anti-Graffiti Coating System will be free of defects related to workmanship or material deficiency for a five (5) year period from the date of completion of the work provided under this section.
   1. All defective areas shall be retreated by the system manufacturer as determined by the Engineer.
2. The Anti-Graffiti manufacturer shall be responsible for providing labor and material to reseal areas where coating effectiveness does not meet the specified limits.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Graffiti-resistant Coating for cast in place concrete and precast concrete:
   1. Protectosil Anti Graffiti, Evonik Degussa Corporation 1-800-828-0919
   2. Approved equal

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine areas and conditions under which Work is to be performed and identify conditions detrimental to proper or timely completion.
   1. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Protection: Install coverings to protect adjacent surfaces

B. Surface Preparation
   1. Surfaces to receive sealer shall be cleaned of dirt, oil, graffiti, grease, laitance, and other contaminants. All other surfaces shall be cleaned by mid-pressure water (1500 psi) and commercial paint strippers. Pressure washing is the minimum cleaning that will be accepted; other methods, such as blasttracking, mobile power scrubbing and sandblasting may be submitted.
   2. Remove dirt, dust and materials that will interfere with the proper and effective application of the anti-graffiti coating. It is the responsibility of the Contractor to prepare the surfaces of the concrete as recommended by the Anti-graffiti Manufacturer and acceptable to the Engineer.
   3. Check the compatibility of all caulking and patching material to be used with the anti-graffiti coating.
   4. Sealants, patching materials, and expansion joints shall have been installed and approved.

3.3 SURFACE FINISHES

A. General: Provide natural gun finish to unexposed surfaces, unless otherwise indicated in Section "Cast-in-Place Concrete."
   1. Flash Coat: After screeding, apply a 1/8-inch to 1/4-inch coat of shotcrete using fine screened sand. Keep application nozzle to a greater distance than required for normal shotcreting.
   2. Provide wood float finish after application of flash coat.

3.4 FIELD QUALITY CONTROL

A. Before an anti-graffiti coating will be accepted a field test evaluation will be done. The cost of the field testing will be the responsibility of the contractor. The owner’s representative will approve the test area prior to starting the project.
1. Install graffiti-resistant coatings on a three foot by three foot sample of each substrate material to which the final coating will be applied.

2. Retain each field quality control sample (mock-up) for the duration of the project so that it may be used as a field quality control standard after review by the project architect or project engineer.

3.5 APPLICATION

A. Product shall be applied as per manufacturer’s application instructions and recommendations for this specific project. Provide written copy of manufacturer’s recommendations.

B. Apply at temperature and weather conditions recommended by the manufacture or written in this specification.

C. Surface residue shall be brushed out thoroughly until they completely penetrate into the surface.

D. Protect treated areas from rain and other surface water for a period of not less than four hours after application.

E. Provide adequate ventilation and follow all safety regulations for the City, County and State.

3.6 CLEANING

A. As Work Progresses: Clean spillage from adjacent surfaces using materials and methods as recommended by anti-graffiti manufacturer.

B. Remove protective coverings from adjacent surfaces when no longer needed.

3.7 COMPLETION

A. Work that does not conform to specified requirements shall be corrected and/or replaced as directed by the Owners Representative at contractor’s expense without extension of time.

END OF SECTION 09 26 23
PART 1 - GENERAL

1.1 SUMMARY

A. Related Documents: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, including sustainable requirements, apply to this Section.

B. This section includes the following items:
   1. High performance coatings for exterior ferrous metals.

C. Related Sections:
   1. 05 73 00 Decorative Metal Railings
   2. 09 90 00 Painting

1.2 SUBMITTALS

A. Product Data: Manufacturer’s technical data sheets for each coating.
   1. Application instructions including mixing, surface preparation, compatible primers and topcoats, recommended wet and dry film thickness, recommended application methods.
   2. Manufacturer’s recommendations for use; including limitations.

B. Samples:
   1. Color samples supplied by manufacturer for each finish material.

1.3 DELIVERY, STORAGE AND HANDLING

A. Handling – Painted Members:
   1. Do not handle freshly painted members until paint has cured in accordance with manufacturer’s recommendations for “to handle” curing. Adjust time requirements for ambient and surface temperature and relative humidity.
   2. Packing and Shipping: Provide protective wrappings, cartons, dunnage between members, crating and the like as required to prevent damage to coating in shipping, delivery, and handling at the site.
   3. Lifting – Shop and site:

1.4 MAINTENANCE

A. Extra Materials:
   1. Furnish factory-sealed one gallon containers of each color and type of paint finish coat used on project in the following quantities:
      a. One gallon of each color.

PART 2 - PRODUCTS

2.1 PRODUCTS – GENERAL

A. Acceptable Manufacturers – Paint Products:
   1. Tnemec Company, Inc.
   2. Carboline.
B. Recooating: No “recoat window”; cured product requires no sanding or chemical treatment to receive subsequent paint coating (of primer, intermediate, or finish coating).

C. Cure time: Dry to handle or recoat in one hour maximum at 70 degrees F; may be accomplished using accelerator.

2.2 SHOP PRIMER, BASIS OF DESIGN

A. Moisture-cured zinc-rich MIO Urethane:
   1. Salt spray resistance at minimum recommended thickness: Not less than 8500 hours per ASTM B 117 for single coat.
   2. AISC rated “Class B” for use on faying surfaces.
   3. VOC: Less than 330 g/l.
   4. DFT: 2.5 to 3.5 mils.
   5. Basis of design product: Tnemec 394 “PerimePrime”.

2.3 SHOP INTERMEDIATE COAT, BASIS OF DESIGN

A. Polyamidoamine epoxy:
   1. VOC: 285 g/l.
   2. Approved by finish coat manufacturer for use between zinc-rich primer or zinc-coated surface and fluoropolymer topcoat.
   3. DFT: 2.0 to 10.0 mils. per coat.
   4. Basis of design product: Tnemec Series 1C N-69 Hi-Build Epoxoline II.
   5. Color: 32 GR

2.4 SHOP FINISH COAT, BASIS OF DESIGN

A. Advanced Thermoset Solution Fluoropolymer:
   2. VOC: 407 g/l or less.
   3. Volume of Solids: 54%, +/- 2%.
   4. DFT: 2.0 to 3.0 mils.
   5. Basis of design product: Tnemec Series 1C 1078 “Fluoronar Metallic”.
   6. Colors:
      a. MTL-2: 72 MT “Dark Bronze”, for use at Rail Types RA, RB, and RD
      b. MTL-3: 90 MT “Light Gold”, for use at Rail Type RA Light Shelf only.

2.5 SHOP INTERMEDIATE AND FINISH COAT, BASIS OF DESIGN FOR RAIL TYPE RC

A. Rail Type RC Finish coordinate and match guardrail as installed for SP1:
   1. Manufacturer: PPG Industries
   2. Series: Duranar Sunstorm
   3. Product #: UC70092F
   4. Colors: Silversmith Exotic, MTL-1 as noted per Drawings.
   5. Apply over UC51742 primer only.

2.6 FASTENERS

A. Bolts, Nuts, and Washers: "Dacromet" coated or other corrosion-protected system which provides the following properties:
   1. Minimum 1500 hours salt-spray resistance per ASTM B 117.
2. Compatible with intermediate and finish coats without additional preparation, pre-treatment, or primer.

2.7 SHOP SURFACE PREPARATION

A. Steel: Power Tool Clean; SSPC SP-3.
   1. Intricate fabricated shapes may be pickled per SSPC SP-8 in lieu of blast cleaning tool cleaning.


C. Fasteners (Including Nuts and Washer): Zinc plated and pretreated per ASTM D 1730.

2.8 MIXING AND THINNING

A. Remove and discard any skin formed on surface of coatings in containers.
   1. Discard any containers where skin comprises two percent or more of the remaining material.
   2. Do not add thinner except as specifically recommended (not merely permitted) by the coating manufacturer for proper coating application under the circumstances prevailing in the facility when application equipment recommended by the coating manufacturer is employed.
   3. Use only the quantities and the types of thinner recommended.

B. Mix materials using mechanical mixers in accordance with coating manufacturer’s instructions. Agitate mixed materials during application if recommended by manufacturer.

C. Combine multi-component paints in quantities needed for use within the manufacturer’s recommended pot life at the anticipated application temperatures. Discard remaining mixed material after pot life has expired.

PART 3 - EXECUTION

3.1 SHOP AND FIELD REPAIRS OF DAMAGED COATINGS

A. Welds: Grind smooth. Sand flush with adjacent surfaces.

B. Damaged areas:
   1. Primer damage: Surface preparation: SSPC SP-3; “feather” onto undamaged surface of subsequent shop coats.
   2. Intermediate or topcoat damage (primer intact): Sand or abrade to remove damaged coating without removing primer.

C. Solvent clean areas to receive coating.

D. Apply primer, intermediate coats, and top coat as specified.
   1. Intermediate or topcoat damage (primer intact): Primer recoating not required.

E. Wet-sand primer and intermediate coats to blend repaired area with undamaged coating.

3.2 SHOP APPLIED COATINGS

A. Bolted Connections:
   1. Clean with power wire brush and air blast.
2. Apply coatings as specified above.

B. Shop applied finish (or intermediate) Coats: Apply coatings to surfaces that are clean and properly prepared in accordance with manufacturer’s instructions. Remove dirt, dust, grease, oils, and foreign matter. Prepare surface for proper texture necessary to optimum coating adhesion and intended finished appearance.
   1. Remove hardware, cover plates, and similar items before applying coatings.
      a. After application of coatings, install removed items. Use only skilled workmen for removal and replacement of such items.
   2. Provide protection for non-removable items not scheduled for coating.
   3. Protect surfaces not scheduled for coating.
      a. Clean, repair, or replace to the satisfaction of the Architect any surfaces inadvertently spattered or coated.
   4. Apply coatings in accordance with coating manufacturer’s instructions and using application method best suited for obtaining full, uniform coverage of surfaces to be coated.

3.3 CLEANING AND PROTECTION

A. Cleaning:
   1. Clean work area on a daily basis; dispose of spent materials and empty containers.
   2. Remove all trace of coatings from adjacent surfaces not scheduled to be coated. Remove by appropriate methods that do not damage surfaces.

B. Protection:
   1. Protect work against damage until fully cured. Provide signs identifying wet surfaces until surfaces are adequately cured.
   2. Shortly before final completion of the project, examine surfaces for damage to coatings and restore coatings to new, undamaged condition.
   3. Touch-up of minor damage will be acceptable where result is not visibly different from surrounding surfaces. Where result is different either in color, sheen, or texture, recoat entire surface.

END OF SECTION 09 97 13
PART 1 - GENERAL

1.1 SECTION INCLUDES
A. Work includes but is not limited to the following:
   1. Cabinets as required by governing Codes, ordinances, and as indicated.

1.2 RELATED SECTIONS
A. Coordinate related work specified in other parts of the Project Manual, including but not limited to the following:
   1. Section 10 44 16 – Fire Extinguishers

1.3 SYSTEM DESCRIPTION
A. Definition of Types:
   1. Fire Extinguisher Cabinets: Surface-mounted types, enameled steel box with steel door and trim and glazing panel.

1.4 SUBMITTALS
A. Submit in accordance with the requirements of Section 01 33 00 – Submittal Procedures and the following:
   1. Submit shop drawings of manufacturer’s product data for proper installation. Include details showing mounting methods, relationship of box and trim to surrounding construction, door hardware, cabinet type, trim style, and panel style.

1.5 QUALITY ASSURANCE
A. Regulatory Requirements:
   1. Applicable Building Code: Seattle Fire Code

1.6 DELIVERY, STORAGE, AND HANDLING
A. In accordance with requirements of Section 01 50 00 and the following:
   1. Acceptance at site: Before storing on site, verify that cabinets are unmarred.
   2. Protection: Protect from abrasion and other damage at all times.

PART 2 - PRODUCTS

2.1 GENERAL
A. Provide fire extinguisher cabinets and installation throughout parking garage in sufficient quantity to meet requirements of the Seattle Fire Code.

2.2 MANUFACTURERS
A. Larsen’s Manufacturing Company, phone 800.527.7367; J.L. Industries, phone 800.554.6077; American Specialties, Inc., phone 914.476.9000; or other reviewed and approved manufacturers. Larsen’s Manufacturing Company is specified for type, quality, and construction required.

B. Model/Types designed to accommodate extinguishers specified/10 44.16.
1. Surface Mounted in Garage and Maintenance Areas (FEC-3)
   a. Model 2409-SM. Cold-rolled steel box with manufacturer’s white baked enamel finish. Provide full clear, one piece, with white baked enamel finish. Provide doors with tempered safety glass. Provide manufacturer’s standard satin finish pull handle with a self-adjusting roller catch.

2. Post Mounted in Maintenance Areas (FEC-4)
   a. Model 846 brackets.

PART 3 - EXECUTION

3.1 EXAMINATION

   A. Verify installation conditions as satisfactory to receive work of this Section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.2 INSTALLATION

   A. Install in accordance with manufacturer’s directions.

   B. Anchor cabinets and brackets firmly into position. Cabinets are to be mounted so that the top of the fire extinguisher in the cabinet is not more than 60” above the floor.

3.3 ADJUSTING AND CLEANING

   A. Clean daily in accordance with Sections 01 57 00 and 01 74 23 and the following:
      1. Clean cabinet and cabinet glazing free of dust and marks.
      2. Adjust cabinet doors that do not swing or operate freely.
      3. Refinish or replace cabinets and doors damaged during installation.
      4. Provide final protection and maintain conditions that ensure that cabinets and doors are without damage or deterioration at the time of Substantial Completion.

3.4 LOCATIONS

   A. Install at locations protected from vehicular traffic. Provide installations within 75 feet of travel from any point within garage.

   B. Paint wall field where cabinets are installed. Area painted shall be 60” high by 48” wide minimum.

3.5 WASTE MANAGEMENT

   A. Conform to waste management plan as specified in Section 01 74 00.
      1. Separate cardboard and paper packaging, pallet materials, and metals used in shipping fire extinguisher cabinets for later disposal and recycling at firms listed in the King County “Construction Recycling Directory” latest edition.
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Work includes but is not limited to the following:
   1. New portable units as required that can be removed from cabinets in the event of fire.

1.2 RELATED SECTIONS

A. Coordinate related work specified in other parts of the Project Manual, including but not limited to
   the following:
   1. Section 10 44 13 – Fire Extinguisher Cabinets

1.3 REFERENCES

A. Comply with the requirements of Section 01 42 00 and as listed herein. See Section 01 42 00 for
   listed association, council, institute, society, and the like organization for its full name and address.
   1. NFPA 10 Standard for Portable Fire Extinguishers
   2. UL Underwriters’ Laboratories Standards

1.4 SYSTEM DESCRIPTION

A. Definition: Extinguisher units to be placed in specified cabinets or on wall brackets.

1.5 SUBMITTALS

A. Submit in accordance with the requirements of Section 01 33 00 – Submittal Procedures and the
   following:
   1. Product Data: Submit completely definitive brochures. Include physical dimensions, operational
      features, color and finish, location, and details. Include rating and classification.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Referenced Codes.
   2. Conform to NFPA 10 requirements for extinguishers.

1.7 DELIVERY, STORAGE, AND HANDLING

A. In accordance with requirements of Section 01 50 00 and the following:
   1. Acceptance at site: To be in unmarred condition.
   2. Protection: Protect from abrasion and other damage at all times.

1.8 OPERATION AND MAINTENANCE DATA

A. Submit manufacturer’s operation and maintenance data under provisions of Section 01 33 00.
B. Include test, refill or recharge schedules, procedures, and re-certification requirements.
PART 2 - PRODUCTS

2.1 GENERAL

A. Comply with “Quality Assurance” provisions, “References,” Specifications, and manufacturer’s data. Where these may be in conflict, the more stringent requirements govern.

2.2 MANUFACTURERS

A. Larsen’s Manufacturing Company, phone 800.527.7367; J.L. Industries, phone 800.554.6077; Amerex Corp., phone 205.655.3271; or other reviewed and approved fire extinguishers. Larsen’s Manufacturing Company is specified for type, quality, and construction required.

B. Fire Extinguishers:

1. Standard Fire Extinguishers: Units to be 10 pound, Model MP5, or as reviewed or required by local agencies, multi-purpose dry-chemical, under pressure type for Classes A, B, and C fires. Enameled steel container with pressure-indicating gauge. Color: Red.
   a. Furnish only new fire extinguishers approved and labeled by Underwriters’ Laboratories in compliance with UL Rating 2A-10B:C.
   b. Furnish portable fire extinguishers by only one manufacturer.

C. Fill and service extinguishers in accordance with all applicable governing authorities.

D. Brackets: Larsen’s Optional Bracket #846.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fire extinguishers for proper charging and tagging. Remove and replace damaged, defective, or undercharged units.

3.2 INSTALLATION

A. Follow manufacturer’s directions.

B. Fire extinguishers shall be maintained per Seattle Fire Department standards and shall be easily visible and readily accessible by any occupant at all times.

3.3 ADJUSTMENT AND CLEANING

A. Adjust as required. Units to be fully charged when installed.

B. Leave installations clean and premises free from any residue of work of this Section.

3.4 LOCATIONS

A. Place in fire-extinguisher cabinets or on wall brackets specified/10 44.13.

3.5 WASTE MANAGEMENT

A. Conform to waste management plan as specified in Section 01 74 00.
   1. Separate cardboard and paper packaging, pallet materials, and metals used in shipping fire extinguisher cabinets for later disposal and recycling at firms listed in the King County “Construction Recycling Directory” latest edition.
END OF SECTION 10 44 16
PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Trash and Recycling Receptacles
   2. Benches
   3. Skate Deterrents

1.2 RELATED REQUIREMENTS

A. Section 03 30 00 – Cast-in-Place Concrete
B. Section 05 50 00 – Metal Fabrications

1.3 SUBMITTALS

A. Shop Drawings: Submit the following in accordance with Section 013300, “Submittals.”
   1. Provide shop drawings that include installation details, material descriptions, and field-assembly requirements, for the following:
      a. Trash and Recycling Receptacles
      b. Benches
      c. Skate Deterrents
   2. Product Data: For each type of product indicated.

B. Samples for Verification: For each component show type of exposed finish required and pattern with size indicated below:

C. Maintenance Data: For site furnishings indicated to include in maintenance manuals.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of site furnishing through one source from a single manufacturer.

B. All specified items shall be accepted by the Owner prior to installation.

C. Follow manufacturer’s recommendations for installation of materials and products unless otherwise detailed on the Drawings. In the event of a conflict between the Manufacturer’s recommendation and the Contract Documents, notify the Owner for clarification prior to installation.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver materials and products in containers that protect them from damage and mishandling. Protect materials while stored at site.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Trash and Recycling Receptacles; Basis of Design:
   a. Model: “SLURB-36URB-Updrop” to match University Standard
   b. Manufacturer: Forms + Surfaces
   c. Telephone: Mike Benz 425-213-3490; 1-800-553-7722; Fax 412-781-7840
   e. Mounting: Surface mounted.
   f. Quantity and locations as noted on Drawings.

2. Benches; Basis of Design:
   a. Name: “Maggie”, 8’-6” long, with center arm.
   b. Manufacturer: Landscape Forms Inc., 431 Lawndale Ave, Kalamazoo MI. 49048
   c. Telephone: 800-430-6209, Fax 269-381-3455
   d. Mounting: Surface mounted
   e. Finish: Powdercoat finish; custom RAL color TBD by Landscape Architect.
   f. Quantity and location as noted on Drawings.

3. Skate Deterrents; Basis of Design:
   a. Name: “Childress”, approx. 1” width by 6” length, to accommodate 1/8” wall edge radius.
   c. Telephone: 619-447-6374, Fax 619-447-6396
   d. Mounting: Surface mounted with (2) manufacturer provided anchor pins set in epoxy.
   e. Material: White Tombasil
   f. Quantity and location as noted on Drawings.

2.2 MATERIALS, GENERAL

A. Metals: Free from surface blemishes and complying with the following:

1. Plates, Shapes, and Bars: ASTM A 36/A 36M.
5. White Tombasil: UNS C99700.
6. Tubing: Cold-formed steel tubing complying with ASTM A 500.
7. Mechanical Tubing: Cold-rolled, electric-resistance-welded carbon or alloy steel tubing complying with ASTM A 513, or steel tubing fabricated from steel complying with ASTM A 569/A 569M and complying with dimensional tolerances in ASTM A 500; zinc coated internally and externally.
8. Sheet: Commercial steel sheet complying with ASTM A 569/A 569M.
9. Expanded Metal: From carbon-steel sheets, deburred after expansion, and complying with ASTM F 1267.

B. Anchors, Fasteners, Fittings, and Hardware: Stainless steel or Manufacturer's standard, corrosion-resistant-coated or noncorrodible materials; commercial quality; tamperproof, vandal and theft resistant; concealed, recessed, and capped or plugged. Provide as required for site furnishings' assembly, mounting, and secure attachment.

1. Antitheft Hold-Down Brackets: For securing site furnishings to substrate; two per unit or per manufacturer's specification.

C. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout, recommended in writing by manufacturer, for exterior applications.

D. Erosion-Resistant Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with potable water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended in writing by manufacturer for exterior applications.

2.3 FABRICATION

A. Metal Components: Form to required shapes and sizes with true, consistent curves, lines, and angles. Separate metals from dissimilar materials to prevent electrolytic action.

B. Welded Connections: Weld connections continuously. Weld solid members with full-length, full-penetration welds and hollow members with full-circumference welds. At exposed connections, finish surfaces smooth and blended so no roughness or unevenness shows after finishing and welded surface matches contours of adjoining surfaces.

C. Pipes and Tubes: Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cylindrical cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of handrail and railing components.

D. Steel Components: Stainless steel and aluminum.

E. Exposed Surfaces: Polished, sanded, or otherwise finished; smooth all surfaces, free from burrs, barbs, splinters, and sharpness; all edges and ends rolled, rounded, or capped.

F. Factory Assembly: Assemble components in the factory to the greatest extent possible to minimize field assembly. Clearly mark units for assembly in the field.

2.4 FINISHES, GENERAL

A. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for correct and level finished grade, mounting surfaces, installation tolerances, and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with manufacturer’s written installation instructions, unless more stringent requirements are indicated. Complete field assembly of site furnishings, where required.

B. Unless otherwise indicated, install site furnishings after landscaping and paving have been completed.

C. Install site furnishings level, plumb, true, and securely anchored at locations indicated on Drawings.

D. Embedments Set into Voids in Concrete: Form or core-drill holes for installing embedments in concrete to depth and diameter recommended in writing by manufacturer of site furnishings unless indicated otherwise on Drawings. Clean holes of loose material, insert posts, and fill annular space between embedment and concrete with nonshrink, nonmetallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer’s written instructions, with top smoothed and shaped to shed water.

3.3 CLEANING

A. After completing site furnishing installation, inspect components. Remove spots, dirt, and debris. Repair damaged finishes to match original finish or replace component.

B. Follow Manufacturer’s instructions.

3.4 PROTECTION

A. Protect site furnishings from damage due to other construction operations.

END OF SECTION 12 93 00
PART 1 - GENERAL

1.1 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.2 DESCRIPTION

A. Intent of drawings and Specifications is to obtain complete systems tested, adjusted, and ready for operation.

B. Except as otherwise defined in greater detail, the terms "provide", "furnish" and "install" as used in Division 26 Contract Documents shall have the following meanings:
   1. "Provide" or "provided" shall mean "furnish and install".
   2. "Furnish" or "furnished" does not include installation.
   3. "Install" or "installed" does not include furnishing.

C. Include incidental details not usually shown or specified, but necessary for proper installation and operation.

D. Check, verify and coordinate work with drawings and specifications prepared for other trades. Include modifications, relocations or adjustments necessary to complete work or to avoid interference with other trades.

E. Included in this Contract are electrical connections to equipment provided by others. Refer to Architectural, Mechanical, Plumbing, and final shop drawings for equipment being furnished under other sections for exact locations of electrical outlets and various connections required.

F. Information given herein and on drawings is as exact as could be secured but is not guaranteed. Do not scale drawings for dimensions.

G. Where structural and landscape features govern location of work, refer to structural and civil drawings.

H. Perform work in "neat and workmanlike" manner as defined in ANSI/NECA 1, Standard Practices for Good Workmanship in Electrical Contracting.

1.3 RELATED WORK

A. Utility Services:
   1. Determine utility connection requirements to Seattle street lighting system and include in Base Bid all costs to Owner.
   2. Include costs for temporary street lighting along NE Pacific Place and overhead, temporary routing of service to temporary NE Pacific Place roadway.

B. Temporary Services:
   1. Division 01 - Temporary Facilities and Controls.

C. Continuity of Service:
   1. No service shall be interrupted or changed without permission from Engineer and Owner. Obtain written permission before work is started for work impacting University of Washington.
2. When interruption of services is required, Owner and other concerned parties shall be notified and shall determine a time.
3. No service shall be interrupted or changed without permission from Seattle City Light, Seattle Department of Transportation, and Engineer for work impacting city streets.

D. Demolition:
1. Division 01 - Selective Demolition
2. Division 02 – Selective Site Demolition
3. Perform required demolition to accomplish new work.
   a. Remove abandoned wiring to source of supply or as indicated.
   b. Remove exposed abandoned conduit.
   c. Disconnect and remove luminaries as indicated. Remove brackets, stems, hangers, and other accessories. Return to Owner.
   d. Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.
4. Accomplish work in neat workmanlike manner to minimize interference; annoyance or inconvenience such work might impose on Owner or other Contractors.
5. Unless otherwise noted, remove from premises materials and equipment removed in demolition work.
6. Equipment noted to be removed and turned over to Owner, shall be delivered to Owner at place and time Owner designates.
   a. Light poles removed shall be returned to owner
   b. Luminaries removed shall be separated from light pole and returned to owner.
7. Where materials are to be turned over to Owner or reused and installed by Contractor, it shall be Contractor's responsibility to maintain condition of materials and equipment equal to that existing before work began. Repair or replace damaged materials or equipment at no additional cost to Owner.
8. Where demolition work interferes with Owner's use of premises, schedule work through Engineer, Owner and with other Contractors to minimize inconvenience to Owner. Owner must approve schedule before Contractor begins such work.

E. Cleaning and Repair
1. Clean and repair existing materials and equipment that remain or are to be reused.
2. Panelboards.
   a. Replace damaged circuit breakers and provide closure plates for vacant positions.
   b. Provide typed circuit directory showing revised circuiting arrangement.

F. Concrete Work:
1. Provide cast-in-place concrete as required by Contract Documents unless otherwise noted.
2. Concrete shall comply with Division 03 - Concrete.
3. Provide anchor bolts, metal shapes and templates to be cast in concrete or used to form concrete as required for anchoring and supporting electrical equipment.

G. Painting:
1. Furnish equipment with factory-applied finish coats or paint equipment per Division 09 – Finishes unless specified otherwise.
2. Furnish equipment with factory applied prime finish unless otherwise specified.
3. If factory finish on equipment furnished by Contractor is damaged in shipment or during construction, refinish equipment to satisfaction of Owner.
4. Furnish one can of touch up paint for each final factory-applied finish coat of product.

1.4 REQUIREMENTS OF REGULATORY AGENCIES

A. Rules and regulations of Federal, State and local authorities and utility companies, in force at time of execution of Contract shall become part of this specification.

1.5 REFERENCE STANDARDS

A. Agencies or publications referenced herein refer to the following:
   1. AEIC Association of Edison Illuminating Companies
   2. ANSI American National Standards Institute
   3. ASME American Society of Mechanical Engineers
   4. ASTM American Society for Testing and Materials
   5. BICSI Building Industry Consulting Services International
   6. EIA Electronic Industries Association
   7. FIPS Federal Information Processing Standards
   8. FCC Federal Communications Commission
   9. ICEA Insulated Cable Engineers Association
   10. IEEE Institute of Electrical & Electronics Engineers
   11. IESNA Illuminating Engineering Society of North America
   12. NEC National Electrical Code
   13. NECA National Electrical Contractors Association
   14. NEMA National Electrical Manufacturers Association
   15. NESC National Electrical Safety Code
   16. NETA National Electrical Testing Association
   17. NIST National Institute of Standards & Technology
   18. OSHA Occupational Safety and Health Administration
   19. TIA Telecommunications Industries Association
   20. UL Underwriters Laboratories, Inc.

B. Work shall be in accordance with latest edition of codes, standards or specifications unless noted otherwise.

1.6 LISTING

A. Install materials bearing UL label or UL listing, unless UL label or listing is not available for that type of material.

B. Other nationally recognized testing agencies, acceptable to AHJ, are approved.

1.7 ENClosures

A. Typical NEMA Enclosures and Usage
   1. NEMA 3 - Outdoors. Sleet, snow, rain. Windblown dust.
   2. NEMA 3X - Same as NEMA 3 plus corrosion resistant.
   3. NEMA 3R - Outdoors. Rain, snow, sleet.
   4. NEMA 3RX - Same as NEMA 3R plus corrosion resistant.
1.8 SUBMITTALS

A. Shop Drawings (Product Data):
   1. Refer to Division 01 - Submittal Procedures.
   2. Note that for satisfying submittal requirements for Division 26, "Product Data" is usually more appropriate than true "Shop Drawings" as defined in Division 01. However, the expression "Shop Drawings" is generally used throughout Specification.
   3. Submit shop drawings for equipment and systems as requested in respective specification sections. Submittals which are not requested may not be reviewed.
   4. Specifically mark general catalog sheets and drawings to indicate specific items submitted and its correlation to specific designation for product in drawings.
   5. Specifically indicate proper identification of equipment by name and/or number, as indicated in specification and shown on drawings.
   6. When manufacturer's reference numbers are different from those specified, provide correct cross-reference number for each item. Clearly mark and note submittal accordingly.
   7. Submit complete record of required components when luminaires, equipment and items specified include accessories, parts and additional items under one designation.
   8. Include wiring diagrams for electrically powered or controlled equipment.
   9. Where submittals cover products containing non-metallic materials, include "Material Safety Data Sheet" (MSDS) from manufacturer stating physical and chemical properties of components and precautionary considerations required.
   10. Submit shop drawings or product data as soon as practicable after signing contracts. Submittals must be approved before installation of materials and equipment.
   11. Submittals that are not complete, not permanent, or not properly checked by Contractor, will be returned without review.
   12. "Coordination Drawings", which are normally prepared by Contractor to coordinate work among various trades and to facilitate installation, shall not be submitted for Division 26 work unless specifically requested in technical sections. These types of drawings typically include dimensioned piping, ductwork or electrical raceway layouts.
   13. Unless specifically requested in Division 26 technical sections, submittals of coordination drawings will be returned without review.

B. Certificates and Inspections:
   1. Obtain and pay for inspections required by authorities having jurisdiction and deliver certificates approving installations to Owner unless otherwise directed.

C. Record Documents:
   1. Refer to General Conditions of Contract and Division 01 – Closeout Procedures. Prepare complete set of record drawings in accordance with Division 01.
   2. Use designated set of prints of Contract Documents as prepared by Engineer to mark-up for record drawing purposes.

1.9 JOB CONDITIONS

A. Cutting and Patching:
   1. Refer to General Conditions of the Contract.
   2. Perform cutting and patching required for complete installation of systems, unless otherwise noted. Patch and restore work cut or damaged to original condition. This includes openings remaining from removal or relocation of existing system components.
   3. Provide materials required for patching unless otherwise noted.
4. Do not pierce beams or columns without permission of Engineer and then only as directed. If openings are required through walls or floors where no sleeve has been provided, hole shall be core drilled to avoid unnecessary damage and structural weakening.

5. Where alterations disturb lawns, paving, walks, etc., replace, repair or refinish surfaces to condition existing prior to commencement of work. This may include areas beyond construction limits.

B. Housekeeping and Cleanup:
   1. Refer to Division 01 - Closeout Procedures.
   2. As work progresses or as directed by Owner, periodically remove waste materials from building and leave area of work broom clean. Upon completion of work, remove tools, scaffolding, broken and waste materials, etc. from site.

1.10 WARRANTY

A. Refer to Division 01 Warranties.

B. Refer to technical sections for warranty requirement for each system.
   1. Where no warranty requirements are called out, warrant for 1 year after acceptance by Owner equipment, materials, and workmanship to be free from defect.

C. Repair, replace, or alter systems or parts of systems found defective at no extra cost to Owner.

D. In any case, wherein fulfilling requirements of any guarantee, if this contractor disturbs any work guaranteed under another contract, this contractor shall restore such disturbed work to condition satisfactory to Owner and guarantee such restored work to same extent as it was guaranteed under such other contract.

E. Warranty shall include labor, material, and travel time.

PART 2 - PRODUCTS

2.1 PRODUCT SUBSTITUTIONS

A. Refer to Division 01 – Substituution Procedures.

PART 3 - EXECUTION

3.1 GENERAL

A. Verify elevations and dimensions prior to installation of materials.

3.2 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the site under provisions of Division 01.

B. Store and protect products under provisions of Division 01

C. Store in clean, dry space.

D. Maintain factory wrapping or provide cover to protect units from dirt, water, construction debris, and traffic.

E. Handle in accordance with manufacturer’s written instructions.
F. Handle carefully to avoid damage to components, enclosure, and finish. Lift only with lugs provided for the purpose.

G. Provide supplemental heat if required to prevent moisture contamination.

3.3 FLOOR, WALL, ROOF AND CEILING OPENINGS

A. Coordinate location of openings, chases, furred spaces, etc. with appropriate Contractors. Provide sleeves and inserts that are to be installed into structure.

B. Provide Schedule 40 carbon steel pipe with integral water stop for steel sleeves required below grade or to exterior.

C. Submit to Structural Engineer for review and approval size and location of core-drilled holes prior to execution.

D. Submit product data and installation details for penetrations of building structure. Include schedule indicating penetrating materials, (steel conduit, PVC conduit, cables, cable tray, etc.), sizes of each, opening sizes and sealant products intended for use.

E. Where penetrations of fire-rated assemblies are involved, seal penetrations with appropriate firestopping systems.

F. Submit complete penetration layout drawings showing openings in building structural members including floor slabs, bearing walls, shear walls, etc. Indicate and locate, by dimension, required openings including those sleeved, formed or core drilled. Submit drawings for approval prior to preparing openings in structural member.

G. Provide 1/2" clearance around penetration openings intended for raceways and cables. Where fire resistant penetrations are required, size openings in accordance with written recommendations of firestopping systems manufacturer.

H. Seal non fire-rated floor penetrations with non-shrink grout equal to Embeco by Master Builders, or urethane caulk, as appropriate.

I. Seal non-rated wall openings with urethane caulk.

J. Where penetrations occur through exterior walls into building spaces, use steel sleeves with integral water stop, similar to type "WS" wall sleeves by Thunderline Corporation. Seal annular space between sleeves and pipe with "Link-Seal" modular wall and casing seals by Thunderline Corporation, or sealing system by another manufacturer approved as equal by Engineer. Sealing system shall utilize Type 316 stainless steel bolts, washers and nuts.

K. Finish and trim penetrations as shown on details and as specified.

3.4 EQUIPMENT ACCESS

A. Install raceways, junction and pull boxes, and accessories to permit access to equipment for maintenance. Relocate raceways or accessories to provide maintenance access at no additional cost to Owner.

B. Install equipment with sufficient maintenance space for removal, repair or changes to equipment. Provide ready accessibility to equipment and wiring without moving other future or installed equipment.
3.5 EQUIPMENT SUPPORTS

A. Provide supporting steel not indicated on drawings as required for installation of equipment and materials including angles, channels, beams, hangers, etc.

B. Provide steel shell with plug type concrete anchors for attaching equipment to concrete. Plastic, rawhide or anchors using lead are not allowed.

C. Do not support equipment or luminaires from metal roof decking.

3.6 SUPPORT PROTECTION

A. In occupied areas, mechanical and electrical rooms and areas requiring normal maintenance access, guard certain equipment to protect personnel from injury.

B. Provide minimum 1/2" thick Armstrong Armaflex insulation or similar product applied with Armstrong 520 adhesive on lower edges of equipment, and electrical supporting devices suspended less than 7 ft above floors, platforms or catwalks in these areas.

C. Protect threaded rods or bolts at supporting elements as described above. Trim threaded rods or bolts such that they do not extend beyond supporting element.

3.7 ACCEPTANCE TESTING

A. Contractor shall perform acceptance testing.

B. When testing is to be witnessed by Engineer or Inspector, notify them at least 10 days prior to testing date.

C. When equipment or systems fail to meet minimum test requirements, replace or repair defective work or materials as necessary and repeat inspection and test until equipment or systems meet test requirements. Make repairs with new materials.

D. Contractor is responsible for certifying in writing equipment and system test results. Certification shall include identification of portion of system tested, date, time, test criteria and name and title of person signing test certification documents.

E. Maintain copies of certified test results, including those for any failed tests, at project site. At completion of project, include copies of test records and certifications in O&M Manuals.

3.8 START-UP

A. Systems and equipment shall be started, tested, adjusted, and turned over to Owner ready for operation. This includes "Owner-Furnished, Contractor-Installed" (OFCI) and "Contractor-Furnished, Contractor-Installed" (CFCI) systems and equipment.

B. Follow manufacturer's pre-start-up checkout, start-up, trouble shooting and adjustment procedures.

C. Contractor shall provide services of technician/mechanic knowledgeable in start-up and checkout of types of systems and equipment on project.

D. Provide start-up services by manufacturer's representative where specified or where Contractor does not have qualified personnel.

E. Coordinate start-up with all trades.
3.9 CLEANING

A. Clean systems after installation is complete.

B. Vacuum debris from panelboards, switchboards, motor starter and disconnect switch enclosures, junction boxes and pull boxes two weeks before energization and again prior to completion.

C. Clean luminaire lenses and lamps at time of installation and clean lens exteriors just prior to final inspection.

D. Thoroughly clean equipment of stains, paint spots, dirt and dust. Remove temporary labels not used for instruction or operation.

END OF SECTION 26 00 00
PART 1 - GENERAL

1.1 RELATED WORK
   A. Section 26 05 53 - Electrical Systems Identification

1.2 REFERENCE
   A. Work under this section is subject to requirements of Contract Documents including General
      Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION
   A. Section includes conductors and cables rated 600 V and less, connectors, splices, and terminations
      rated 600 V and less, sleeves and sleeve seals for cables.
   B. Conductor and conduit sizes in these contract documents are based on copper wire and only
      copper wire shall be used.

1.4 REFERENCE STANDARDS
   A. ASTM A 53/A 53M – Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and
      Seamless.
   C. ASTM B 8 – Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard,
      Medium-Hard, or Soft.
   D. NEMA WC 3 – Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical
      Energy (ICEA S-19-81).
   E. NEMA WC 5 – Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of
      Electrical Energy (ICEA S-61-402).
   F. NEMA WC 70 – Non-Shielded Power Cable 2000 V or less for the Distribution of Electrical Energy
      (ICEA S-95-668).
   G. NFPA 70 – National Electrical Code.
   H. UL 44 – Thermoset-Insulated Wires and Cables.
   I. UL 83 – Thermoplastic-Insulated Wires and Cables.
   J. UL 486A-486B – Wire Connectors.
   K. UL 486C – Splicing Wire Connectors.
   L. UL 486D – Standard for Insulated Wire Connector Systems for Underground Use or in Damp or
      Wet Locations.
   M. UL 486E – Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper
      Conductors.
   N. UL 1569 – Standard for Metal-Clad Cables.
1.5 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Manufacturer’s Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation.

C. Test Reports: Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.

D. Closeout Submittals:
   1. Project Record Documents:
      a. Record actual locations of components and circuits.
   2. Operation and Maintenance Data:
      a. Include manufacturer’s recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Comply with NFPA 70 for components and installation.
   2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

B. Wire and cable boxes and reels shall bear the date of manufacture.
   1. Date of manufacture shall not precede contract date by more than one year.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Protect from dirt, fumes, water, corrosive substances, and construction debris.

1.8 WARRANTY

A. Refer to Division 01 and Section 26 00 00 – General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 1 yr warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. American Insulated Wire Corp.; a Leviton Company

B. General Cable Corporation

C. Senator Wire & Cable Company
2.2 DESCRIPTION

A. NEMA WC 70; single copper conductor insulated wire; 600 V rated insulation; 90°C maximum operating temperature for dry and wet or damp locations.
   1. Thermoset-insulated wires and cables: NEMA WC 3, UL 44; Type XHHW-2.

2.3 REMOTE CONTROL AND SIGNAL CIRCUITS

A. Class 1
   1. Copper conductor, single insulated wire.
   2. Insulation type XHHW rated 90°C, 600 V insulation class.
   3. UL 83 listed, ASTM B 1 for solid conductors; ASTM B 8 for stranded conductors.

B. Classes 2 and 3
   1. Copper conductor, multiple twisted conductors covered with an overall non-metallic jacket unless otherwise noted.
   2. Insulation type XLE, rated 105°C, 300 V insulation class.
   3. UL listed for use in space in which circuits will be installed.

2.4 CONNECTORS, SPLICES, AND TERMINALS

A. Manufacturers:
   1. AFC Cable Systems, Inc.
   3. O-Z/Gedney; EGS Electrical Group LLC.
   4. 3M; Electrical Products Division
   5. Tyco Electronics Corp.

B. Description: UL 486A-486B, UL 486C, UL 486D, UL 486E; factory-fabricated connectors, splices, and terminals of size, ampacity rating, material, type, and class for application and service indicated.

2.5 TERMINATIONS

A. Compression set, bolted or screw type lug, or direct to bolted or screw type terminal.

2.6 PLASTIC CABLE TIES

A. Nylon or approved; locking type; metallic ties not permitted.

PART 3 - EXECUTION

3.1 INSTALLATION OF CONDUCTORS AND CABLES

A. Install conductors in a raceway system, unless otherwise specified or indicated.

B. Install conductors only after:
   1. Mechanical work likely to damage conductors has been completed
   2. Raceway installation is complete and supported

C. Pull conductors into raceway at same time.
D. Neatly train and lace conductors inside boxes, equipment, and panelboards.

E. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

F. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer’s recommended maximum pulling tensions and sidewall pressure values.

G. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

H. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible. Protect exposed cables from damage.

I. Identify and color-code conductors and cables according to Section 26 05 53 - Electrical Systems Identification.

J. Limit conduit fill to a maximum of 9 current-carrying conductors.

K. Install stranded conductors where conductors terminate in crimp type lugs. Do not place bare stranded conductors directly under screws.

3.2 CONDUCTOR MATERIAL APPLICATIONS

A. Branch Circuits: Solid or stranded for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Minimum conductor sizes shall be as follows:
   1. No. 12 AWG – Branch circuits of any kind.

C. Branch wiring length limitations:
   1. 208Y/120 V circuits over 100 ft in length: Increase wire size one size for each 100 ft of length. Increase conduit size as required.
   2. 480Y/277 V circuits over 150 ft in length: Increase wire size one size for each 150 ft of length. Increase conduit size as required.

3.3 CONDUCTOR INSULATIONS AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Exposed Branch Circuits, Including in Crawl Spaces: XHHW-2, rated 90°C for dry and wet or damp locations, single conductors in raceway.

B. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: XHHW-2, rated 90°C for dry and wet or damp locations, single conductors in raceway.

C. Wiring in Fixture Channels above grade: Type THHN, rated 90°C for dry and damp locations, single conductors.

D. Branch Circuits Single Conductors in Raceway: 90°C rated conductors sized at 75°C rating for connection to equipment and devices.

3.4 CONNECTORS, SPLICES, AND TERMINALS

A. Connectors:
1. Except where equipment is furnished with bolted or screw type lug, use compression set pressure connectors with insulating covers. Use compression tools and die compatible with connectors being installed.

2. Use bolt or compression-set type with application of insulating tape, pre-stretched or heat-shrinkable insulating tubing for splices and taps of #8 AWG conductors and larger. Install with hydraulic compression tool.

3. Use pre-insulated “twist-on” connectors with integral spring for splices and taps of #10 AWG conductors and smaller.

4. Tighten electrical connectors and terminals according to manufacturer’s published torque-tightening values. If manufacturer’s torque values are not indicated, use those specified in UL 486A-486B.

B. Splices:
   1. Splice wires and cable only in accessible locations such as within junction boxes.
   2. Make splices to carry full capacity of conductors with no perceptible temperature rise.
   3. Make below-grade splices in handholes watertight with pre-stretched or heat-shrinkable insulating tubing, or resin-filled insulator.
   4. Use electrical tape to build up insulation level equivalent to cable insulation and cover with not less than two half-lapped layers of plastic electrical tape, for joints, taps, and splices of #1 AWG conductors and larger.
   5. Plastic snap-on splice insulators are not allowed.
   6. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Terminals:
   1. Insulate ends of spare conductors with electrical tape and identify spare circuit number where appropriate.
   2. Eye type crimped terminal for removable screw type terminal. Forked torque terminal when screw terminal cannot be removed.
   3. Train wires to eliminate fanning of stands, crimp with proper tool and die.
   4. Torque screw termination per manufacturer’s recommended values.

3.5 CABLE TIES

A. Neatly bundle conductors and cables together for support. Size cable ties sufficiently to accommodate the multiple cables being supported.

3.6 FIELD QUALITY CONTROL

A. Test 600 volt conductors and cables for continuity and resistance to ground.

B. Interpret test results in writing and submit to Engineer.

C. Replace conductors and cables that are found defective, at no expense to Owner.

END OF SECTION 26 05 19
PART 1 - GENERAL

1.1 RELATED WORK
A. Section 26 05 43 - Ducts and Raceways for Electrical Systems

1.2 REFERENCE
A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION
A. Section includes methods and materials for grounding systems and equipment, as required by State Codes, NFPA 70, applicable portions of other NFPA codes, as indicated herein.

1.4 REFERENCE STANDARDS
A. ANSI J-STD-607-A – Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
B. ASTM B 3 – Specification for Soft or Annealed Copper Wire
C. ASTM B 8 – Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard or Soft
D. ASTM B 33 – Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes
E. IEEE C2 – National Electrical Safety Code (ANSI)
F. NETA MTS – Maintenance Testing Specifications
G. NFPA 70 – National Electrical Code
H. NFPA 70B – Recommended Practice for Electrical Equipment Maintenance
I. UL 467 – Grounding and Bonding Equipment

1.5 SUBMITTALS
A. Product Data: For each type of product indicated.

1.6 QUALITY ASSURANCE
A. Regulatory Requirements:
   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70.
   2. Comply with UL 467 for grounding and bonding materials and equipment.

1.7 DELIVERY, STORAGE, AND HANDLING
A. Store products in clean, dry space. Protect from dirt, fumes, water, corrosive substances, and construction debris.
1.8 WARRANTY

A. Refer to Division 01 and Section 26 00 00 – General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 1 yr written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction, insulation color: green.

B. Bare Copper Conductors:
   3. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
   4. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8" wide and 1/16" thick.

C. Bare Grounding Conductor and Conductor Protector for Wood Poles:
   1. No. 4 AWG minimum, soft-drawn copper.
   2. Conductor Protector: Half-round PVC or wood molding. If wood, use pressure-treated fir or cypress or cedar.

2.2 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
   1. Pipe Connectors: Clamp type, sized for pipe.

C. Compression Connectors: Irreversible type.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel 3/4” in diameter by 10 ft in length.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger, unless otherwise indicated.

B. Underground Grounding Conductors: Install bare copper conductor. No. 2/0 AWG minimum. Sized as indicated on drawings.
1. Bury at least 24" below grade.

C. Conductor Terminations and Connections:
   1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors
   2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated
   3. Connections to Ground Rods at Test Wells: Bolted connectors
   4. Connections to Structural Steel: Welded connectors

3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Grounding Handholes: Install a driven ground rod through handhole floor, close to wall, and set rod depth so 4" will extend above finished floor. If necessary, install ground rod before handhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into handhole through a waterproof PVC sleeve in handhole wall.

3.3 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with feeders and branch circuits. Install for each branch circuit.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
   1. Feeders and branch circuits
   2. Lighting circuits
   3. Receptacle circuits
   4. Flexible raceway runs
   5. Armored and metal-clad cable runs

C. Duplex receptacles of any amperage: Install separate jumper between grounding terminal on device and metallic box.

D. Size of equipment grounding conductors for branch circuits: As indicated in NEC-70, except minimum size shall be No. 12 AWG.

E. Size of branch panel feeder originating at switchboards/switchgear: As indicated in NEC-70, except in no instance smaller than No. 8 AWG.

F. Install equipment grounding conductor from secondary side of each transformer to grounding electrode system as required for separately derived system.

G. Install grounding conductor to luminaires hanging from conduit swivel hangers.

H. Metal and Wood Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors to pole base. Grounding Conductor: Same size as phase conductors, but not smaller than No. 10 AWG.
   1. Install at each pole or standard a concealed driven 1/2" x 8'-0" ground rod, ground clamp and No. 3 stranded copper conductor concealed and attached to pole and base.
3.4 SEQUENCING, SCHEDULING

A. Permanently attach equipment grounds prior to energizing equipment.

3.5 INSTALLATION

A. Connections: Exposed and visible for inspection at all times.

B. Identify all grounding conductors by system and panel at building.

C. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

D. Ground Rods: Drive rods until tops are 2” below finished floor or final grade, unless otherwise indicated.
   1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.

E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
   1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
   2. Use exothermic-welded connectors for outdoor locations where indicated. For disconnect-type connection, use a bolted clamp.

F. Make grounding connections on surface that has been cleaned of paint, dirt, oil, etc., so that connections are bare metal to bare metal contact.

G. Make grounding connections tight with UL listed grounding devices, fittings, bushings, etc.

H. Equipment Grounding Conductor: Verify termination in panelboard at green wire ground bus.

I. Multiple Conductors on Single Lug: Not permitted. Terminate each grounding conductor on its own terminal lug.

J. Flexible Metallic Conduit, Non-Metallic Rigid Conduit, or Liquid Tight Flexible Conduit: Install green wire grounding conductor with phase conductors in conduit.

3.6 FIELD QUALITY CONTROL

A. After installing grounding system but before permanent electrical circuits have been energized, test for continuity back to source at panelboard.

B. Interpret test results in writing and submit to Engineer.

C. Inspect completed system by commissioning authority, prior to backfilling.

END OF SECTION 26 05 26
PART 1 - GENERAL

1.1 RELATED WORK
A. Section 03 30 00 - Cast-In-Place Concrete
B. Section 26 05 26 - Grounding and Bonding for Electrical Systems
C. Section 26 05 33 - Raceway and Boxes for Electrical Systems
D. Section 26 05 43.13 - Excavation and Backfill
E. Section 26 05 43.19 - Handholes and Hardware
F. Section 26 05 53 - Electrical Systems Identification

1.2 REFERENCE
A. Work under this section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION
A. Section includes conduits, ducts, and duct accessories for direct buried for underground distribution for electrical power and communications.
B. The terms duct and duct bank, as used in this Section, are defined as follows:
   1. Duct: A single underground conduit, direct buried.
   2. Duct Bank: Two or more ducts run together.

1.4 REFERENCE STANDARDS
B. ANSI C80.1 – Rigid Steel Conduit-Zinc Coated (GRC)
D. NEMA TC2 – Electrical Polyvinylchloride (PVC) Conduit
E. NEMA TC3 – PVC Fittings for Use with Rigid PVC Conduit and Tubing
F. NEMA TC6&8 – PVC Plastic Utilities Duct for Underground Installation
G. NEMA TC9 – Fittings for PVC Plastic Utility Duct for Underground Installation
H. NFPA 70 – National Electrical Code
I. UL 651 – Schedule 40 and 80 Rigid PVC Conduit
J. UL 651A – Type EB and A Rigid PVC Conduit and HDPE Conduit
K. UL E53373 – Underground Fiber Reinforced Epoxy Conduit (FRE)
1.5 SUBMITTALS

A. Product data for the following:
   1. Duct bank materials, including spacers and miscellaneous components
   2. Ducts and conduits and their accessories, including elbows, end bells, bushings, seals, bends, fittings, plugs, pull tape, and solvent cement
   3. Warning tape

B. Manufacturer’s Installation Instructions:
   1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

C. Closeout Submittals:
   1. Project Record Documents:
      a. Record actual routing of conduits and duct banks.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Comply with NFPA 70
   2. Comply with ANSI C2
   3. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect from dirt, water, construction debris, and traffic.

B. Deliver ducts to project site with end capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

1.8 WARRANTY

A. Refer to Division 01 and Section 26 00 00 – General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 1 yr written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.1 CONDUITS

A. Rigid Steel Conduit (RSC): ANSI C80.1, UL 6, heavy wall, hot dipped, galvanized steel.

B. Rigid Nonmetallic Conduit (RNC): NEMA TC 2 Type EPC-80-PVC, UL 651, with matching fittings by same manufacturer, complying with NEMA TC 3 and UL 651, listed for underground use, direct buried.
C. Size: As indicated on drawings

2.2 NONMETALLIC DUCTS AND DUCT ACCESSORIES

A. Underground Plastic Utilities Duct: NEMA TC 6 & 8, Type EB-20-PVC, ASTM F 512, UL 651A, with matching fittings by the same manufacturer, complying with NEMA TC 9.

B. Underground Plastic Utilities Duct: NEMA TC 6 & 8, ASTM F 512, with matching fittings by the same manufacturer, complying with NEMA TC 9.

C. Duct Accessories:
   1. Duct Spacers: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
   2. Elbows: Material to match conduit for installations associated with short cable pulls; minimum bend radius of 24". Rigid galvanized steel for installations subjected to wear from long cable pulls.
   3. Bushings: Groundable steel bushings of appropriate sizes on all metal conduits; pre-manufactured system for PVC with conduit seals, provisions for roughing into concrete pour and water stops, when entering an existing building or a new or existing handhole or pull box.
   4. Seals: Mechanical interlocking assembly seal of modular synthetic rubber links properly sized to fit the pipe and tightened in place, in accordance with manufacturer’s instructions, when entering an existing building below grade, concrete shall be core drilled for the appropriate size conduit and seal.
   5. Plugs: Closure plugs or caps of same material as conduit at ends of unused sections.
   6. Pull Tape: Nylon pull tape with measurement markings in uniform lengths in each empty duct.

D. Grounding: Steel grounding bushings.

E. Warning Tape: Underground line warning tape specified in Section 26 05 53 - Electrical Systems Identification.

F. Solvent Cement: Recommended by conduit manufacturer.

PART 3 - EXECUTION

3.1 COORDINATION

A. Coordinate layout and installation of ducts with final arrangement of other utilities, site grading, and surface features as determined in the field.

B. Coordinate elevations of ducts and duct bank entrances into handholes or pull boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to handholes, and as approved by Engineer. For handholes construction, refer to Section 26 0543.19 – Handholes and Hardware.

C. Adjust the depth of electrical utilities to avoid existing utilities with no change to contract price.
3.2 EXISTING UTILITIES

A. The existing utilities shown on contract drawings have been plotted from available records. No guarantee is made as to accuracy of locations indicated, and is shown for the benefit of Contractor.

B. Contact all serving utility companies and have them locate their lines prior to commencing work. Telephone “Call Before You Dig” at 1-800-424-5555 forty-eight (48) hours prior to commencing work. Coordinate with Owner all existing utility lines prior to commencing work.

C. Protect shown, visible and located utilities from damage. Promptly repair all active shown, visible and located utilities damaged by construction. This repair shall be made solely at the expense of the Contractor.

D. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with Owner to shut off services if lines are active.

3.3 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
   1. Notify Construction Manager and Owner no fewer than 10 days in advance of proposed interruption of electrical service.
   2. Do not proceed with interruption of electrical service without Construction Manager’s and Owner’s written permission.

3.4 DUCT INSTALLATION

A. Slope: Pitch ducts a minimum slope of 1:300 down toward handholes and away from buildings and equipment. Slope ducts from a high point in runs between two handholes to drain in both directions.

B. Curves and Bends: Use flexibility of material for small changes in direction. Use manufactured long sweep bends with minimum radius of 36”, both horizontally and vertically, at other locations, unless otherwise indicated. All 90-degree sweeps with radius less than 2 feet: Rigid steel conduit.

C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer’s written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane. Do not use conduit that requires the use of couplings for straight runs. Use acceptable PVC terminal adapters when joining PVC conduit to metallic fittings or rigid metal conduit.

D. Duct Entrances to Polymer Concrete Handholes: Use end bells, spaced approximately 10” o.c. for 5-inch ducts, and vary proportionately for other duct sizes.
   1. Begin change from regular spacing to end-bell spacing 10 ft from the end bell without reducing duct line slope and without forming a trap in the line.
   2. Direct Buried Duct Banks: Install an expansion and deflection fitting in each conduit in area of disturbed earth adjacent to manhole or handhole.
   3. Concrete Enclosed Duct Banks: Install watertight expansion fitting in each conduit, with internal bonding jumper to allow for 3/4” movement in any direction.
   4. Grout end bells into structure walls from both sides to provide watertight entrances.

E. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 5 ft outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit
penetrations of building walls as specified in Section 26 05 33 - Raceway and Boxes for Electrical Systems.

F. Expansion Fittings: Provide suitable expansion fittings or other suitable means to compensate for expansion and contraction for raceways crossing expansion joints in structures or concrete slabs between two adjacent structures and between a duct bank and structure. Provide for the high rate of thermal expansion and contraction of PVC conduit by providing PVC expansion joints as recommended by manufacturer and as required. Refer to structural drawings for location of expansion joints in structures.

G. Sealing: Provide temporary closure at termination of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand minimum of 15 psig hydrostatic pressure. Provide watertight entrance sealing device where an underground conduit enters a structure through a concrete roof or membrane waterproofed wall or floor.

H. Fire Stops: Provide fire stop openings around electrical penetrations to maintain fire-resistance rating, where underground raceways penetrate fire-rated walls or floors.

I. Pulling Cord: Install 100-lbf-test nylon cord in ducts, including spares. Identify with tags at each end and at any intermediate pull point the origin and destination of each spare duct. Provide a removable permanent cap over each end of each spare duct.

J. Concrete Encased Ducts: Support ducts on duct spacers.
   1. Spacer Installation: Space spacers close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 ft of duct. Secure spacers to earth and to ducts to prevent floating during concreting. Stagger spacers approximately 6” between tiers. Tie entire assembly together using tie wires and reinforcing steel. Install base and intermediate spacers at every coupling point of each duct line for a separation horizontally and vertically per NEC.
   2. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
      a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer’s written recommendations, or use other specific measures to prevent expansion-contraction damage.
      b. Terminate each pour in a vertical plane if more than one pour is necessary, and install 3/4” reinforcing rod dowels extending 18” into concrete on both sides of joint near corners of envelope. Obtain Architect’s approval for the number and location of dowels.
   3. Pouring Concrete: Space concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct bank application.
   4. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing bars and ties without forming conductive or magnetic loops around ducts or duct groups. Size reinforcing bars and wire ties as indicated on drawings. Provide rebars with minimum of 2” of concrete on sides, top and bottom. Reinforcing bars shown in sections are required throughout.
   5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms of materials and in a manner acceptable to Architect.
6. Minimum Space between Ducts: 3” between ducts and exterior envelope wall, 2” between ducts for like services, and 4” between power and signal ducts.

7. Depth: Install top of duct bank at least 30” below finished grade in areas not subject to deliberate traffic, and at least 30” below finished grade in deliberate traffic paths for vehicles, unless otherwise indicated.

8. Maintain a grade of at least 4” per 100 ft, either from one manhole or pull box to the next, or from a high point between them, depending on surface contour.

9. Warning Tape: Bury warning tape approximately 12” above all concrete-encased ducts and duct banks. Align tape parallel to and within 3” of the centerline of duct bank. Provide an additional warning tape for each 12” increment of duct bank width over a nominal 18”. Space additional tapes 12” apart, horizontally.

10. Place duct banks on an undisturbed soil base if possible. Where concrete encased duct bank is installed over an extensive area of disturbed earth such that within the periphery of a building, provide a separate concrete base under the duct bank to ensure stability of raceways during installation. Allow this base to set before duct bank is installed.

K. Direct Buried Duct Banks:
1. Support ducts on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.

2. Space spacers close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 ft of duct. Secure spacers to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6” between tiers.

3. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Section 26 05 43.13 - Excavation and Backfill.

4. Install backfill as specified in Section 26 05 43.13 - Excavation and Backfill.

5. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to 4” over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction as specified in Section 26 0543.13 - Excavation and Backfill.

6. Install ducts with a minimum of 3” between ducts for like services and 6” between power and signal ducts.

7. Depth: Install top of duct bank at least 24” below finished grade, unless otherwise indicated.

L. Stub-Ups:
1. Use manufactured PVC duct elbows for stub-ups at poles and equipment.

2. Use manufactured rigid steel conduit elbows for stub-ups at land bridge for light shelf power.
   a. Couple steel conduits to ducts with adapters designed for this purpose, and encase couplings with 3” of concrete. Concrete encasement applies to concrete encased ducts.
   b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete pads, extend steel conduit horizontally a minimum of 5 ft from edge of equipment pad or foundation. Encase in concrete for concrete encased ducts. Install insulated grounding bushings on terminations at equipment.

M. Arrangement and Routing:
1. Arrange multiple duct runs substantially in accordance with details shown on drawings. Locate underground ducts where indicated on drawings and grade to the elevations shown on civil drawings.

2. Make minor changes in location or cross-section as necessary to avoid obstructions or conflicts. Where duct runs cannot be installed substantially as shown because of conditions not discoverable prior to digging of trenches, refer the condition to the Construction Manager for written instructions before further work is done.

3. Maintain a 12-inch minimum vertical separation between ducts and other systems at crossings where other utility piping systems are encountered or being installed along a raceway route. Maintain a 12-inch minimum separation between ducts and other systems in parallel runs. Do not place ducts over valves or couplings in other piping systems. Refer conflicts with these requirements to the Construction Manager for written instructions before further work is done.

4. Provide markers at grade to indicate direction of underground conduits provided under this contract. Provide markers consisting of double-ended arrows, straight for straight runs and bent at locations where runs change direction. Provide markers at all bends and at intervals not exceeding 100 ft in straight runs. Use markers made of sheet bronze not less than 1/4" thick embedded in and secured to the top of concrete posts. User markers not less than 10" long and 3/4" wide and marked ELECTRIC CABLES in letters 1/4" high incised into the bronze to a depth of 3/32".

5. Enter manholes and structures with ducts at right angles.

3.5 UNDERGROUND DUCT APPLICATION

A. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-40-PVC, in direct buried duct bank, unless otherwise indicated.

B. Underground Ducts for Telephone, Communications, or Data Circuits: RNC, NEMA Type EPC-40-PVC, in direct buried duct bank, unless otherwise indicated.


3.6 EARTHWORK

A. Excavation and Backfill: Comply with Section 26 0543.13 - Excavation and Backfill, do not use heavy-duty, hydraulic-operated compaction equipment.

3.7 CONCRETE

A. Concrete: 3000 psi, 28-day strength, complying with Division 03 – Concrete, where concrete encased.

3.8 GROUNDING

A. Ground underground ducts according to Section 26 0526 - Grounding and Bonding for Electrical Systems.

3.9 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts.
2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80% fill of duct. If obstructions are indicated, remove obstructions and retest.

B. Preparation for pulling in conductors:
   1. Do not install crushed or deformed raceways. Avoid traps in raceways where possible. Take care to prevent the lodging of, concrete, dirt, or trash in raceways, boxes, fittings, and equipment during the course of construction. Make raceways entirely free of obstructions or replace them. Ream all raceways, remove burrs, and clean raceway interior before introducing conductors or pull wires.
   2. Immediately after installation, plug or cap all raceway ends with watertight and dust-tight seals until the time for pulling in conductors.

C. Do not backfill underground direct buried and concrete encased ducts until the Inspection Authority has inspected them. Notify Engineer 24 hrs in advance of duct concrete pour, or backfill of direct buried ducts.

3.10 CLEANING
   A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

END OF SECTION 26 05 43
PART 1 - GENERAL

1.1 RELATED WORK
A. Section 31 20 00 - Earth Moving
B. Section 26 05 43 - Underground Ducts and Raceways for Electrical Systems

1.2 REFERENCE
A. Work under this section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION
A. Section lists methods and materials for trench excavation and backfill for electrical and communications conduits in duct banks. Refer to Section 26 05 43 – Underground Ducts and Raceways for Electrical Systems.

1.4 DEFINITIONS
A. Backfill: Soil material or controlled low-strength material used to fill an excavation.
B. Excavation: Removal of material encountered above sub-grade elevations and to lines and dimensions indicated.
C. Duct: A single underground conduit encased in concrete or direct buried.
D. Duct Bank: Two or more ducts run together.
E. Fill: Soil materials used to raise existing grades.
F. Sub-grade: Surface or elevation remaining after completing excavation, or top surface of fill or backfill immediately below subbase, drainage fill, or topsoil materials.
G. Utilities: On-site underground ducts and duct banks as well as underground services within buildings.

1.5 SUBMITTALS
A. Submit list of materials to be used for backfill.

1.6 QUALITY ASSURANCE
A. Pre-excavation Conference: Conduct conference at project site to comply with requirements in Division 01 Section “Project Coordination.”

PART 2 - PRODUCTS

2.1 FILL MATERIAL
A. Type 1 Fill:
1. Material from excavation separated from materials, which do not compact by tamping and rolling. No stones larger than 3” and no building, organic, or corrosive or frozen materials and no lumps larger than 6”.

B. Type 2 Fill:
   1. Sand or gravel materials with none larger than 2” and of that portion passing the #4 sieve less than 5% to pass #200 sieve.

C. Type 3 Fill:
   1. Gravel of rounded to sub-angular shape, screened, which will pass 3/4” sieve and retained on #4 sieve.

D. Type 4 Fill:
   1. Pit run rock or gravel with maximum stone size of 1”.

E. Type 5 Fill:
   1. Pea gravel, screened, which will pass 3/8” sieve and retained on #4 sieve.

2.2 CRUSHED ROCK
A. Crushed Rock: 1-1/4” minus, unless smaller is required for bedding material.

2.3 SAND
A. Sand: Clean and washed building sand.

2.4 TOPSOIL
A. Topsoil: Equal in quality to that removed.

2.5 SOD
A. New Sod: Mature, densely rooted grass free of weeds and objectionable grasses.

2.6 PLANTS
A. Plants: Obtained from a commercial nursery and be similar to those replaced.

PART 3 - EXECUTION

3.1 PREPARATION
A. Establish grade lines and locations of roadways and sidewalks and garage structure. Provide necessary stakes and batter boards.

B. Verify elevations of existing utilities prior to excavation for new ducts.

C. Verify locations of handholes with civil drawings

D. Coordinate excavation and backfill with Section 31 20 00 – Earth Moving.

3.2 EXCAVATION
A. Provide excavation for underground work, including ducts, handholes, and pull boxes. Lay duct in open trench.
B. Include clearing, tree removal, grubbing, pavement removal, substructure removal such as walls, footings, and piers, and all incidental work such as tunneling, sheet piling, shoring, underpinning, pumping, bailing, and transportation. Coordinate excavation extending beyond construction limits with Construction Manager and Owner.

C. Do not provide blasting on this project.

D. Dispose of excess excavation material on site in location designated by Construction Manager.

E. Over excavate 3" and fill with 3" of sand, where trench bottom is rock, or rocky, or contains debris larger than 1", or material with sharp edges.

F. Perform all crossings of concrete or asphalt after surface material has been saw cut to required width and removed.

G. Conform to City of Seattle requirements for excavation and handhole installation in addition to contract document requirements where excavations are for installing City of Seattle street lighting.

3.3 ROCK EXCAVATION

A. Use mechanical methods to remove rock in trenches for underground ducts.

B. Refer to Geotechnical Report available from Architect/Engineer for data on rock.

C. Include rock excavation in the Bid, unless otherwise indicated.

3.4 INSTALLATION

A. Keep underground ducts to proper line and grade and sealed to prevent entrance of animals or foreign matter.

B. Provide bracing and sheet piling as necessary to support trenches. Comply with Local Regulations, applicable provisions of OSHA Regulations on trenching, or with provisions of "Manual of Accident Prevention in Construction" published by Associated General Contractors of America.

C. Do not lay duct in water.

D. Keep trench free from water until duct joint material has hardened and concrete encasement is in place.

E. Do not increase the contract cost due to presence of ground water in soil or necessity of sheet piling or bracing trenches. Adjust contract cost when sheet piling is left in place, on written order of Owner.

F. Do not remove sheet piling until trench is substantially backfilled. Cut off sheet piling left in place not less than 2 ft below new, finished grade.

G. Place underground ducts on 3" compacted bedding of sand. Shape bedding for clearance for joints and fittings, tamped in place and graded evenly to ensure uniform bearing for the full length of duct. Do not support duct by blocking, planking or mounding of bedding material.

H. Install lines passing under foundations with minimum of 3" clearance to concrete and ensure there is no disturbance of bearing soil.
3.5 BACKFILL

A. Backfill around ducts by hand to depth of 12" above top of duct with Type 3 or 5 fill in 6" layers. Compact backfill thoroughly with compactor of suitable weight or with approved mechanical tamper. Do not use flooding or jetting with water.

B. Place backfill from 12" above duct to elevation of subgrade in layers not exceeding 8" in depth with Type 3, 4 or 5 fill.

C. Backfill from 12" above duct to sub-grade with Type 2, 3, or 4 fill, when excavating through areas which are to become walks, roads, driveways or parking areas of concrete, bituminous or exposed gravel surfacing or such areas are existing to remain. Backfill in 12" layers and compact with mechanical means to density 95% modified proctor.

D. Conform excavation, duct laying, backfilling, grading and surfacing, as herein specified, when excavation occurs on public property or areas beyond the property line. Comply with additional requirements for public utility or other authorities. Check with each utility and incorporate cost of any additional requirements in base bid.

E. Backfill around vaults and handholes to be free of debris larger than 13/4" in all directions to 1 ft from vault.

F. Provide 6" of pea gravel or sand bedding for vaults and handholes larger than 3'-0" x 3'-0". For handholes smaller than 3'-0 x 3'-0", provide 3" pea gravel or sand.

G. Other backfill shall be free of debris larger than 6" in diameter.

H. Place backfill material so as to obtain a minimum degree of compaction of 95% of maximum density at optimum moisture content. Moisten backfill material as required to obtain proper compaction.

I. Broken pavement, concrete, sod, roots, and debris shall not be used for backfill.

3.6 DEWATERING

A. Provide, operate, and maintain all pumps or other dewatering equipment required for control of water in trenches and excavations for electrical and communications site work during the entire construction period.

3.7 SHORING

A. Provide as required by trenching and excavating to secure site work. Comply with applicable safety regulations.

3.8 FINISHING

A. On completion of trenching and backfilling operations, restore grades to original elevation or to new sub-grade elevation.

B. Replace surfaces to existing conditions when trenching is through existing areas or beyond construction limits.

C. Use 6" of topsoil and sod to match existing elevations in landscaped areas or as otherwise approved by Landscape Architect.
3.9 SURFACE FINISHING

A. Refinish every disturbed surface to its original condition.

B. Replace planted materials not surviving 90 days after contract acceptance at Contractor’s own expense.

C. Return after 1 year and re-fill, compact and refinish settled areas to grade.

3.10 CARE OF PLANTS AND TREES

A. Remove and safely store plants and trees with trunks smaller than 6” diameter prior to commencing site work. Avoid trees larger than 6” diameter when so indicated on drawings. Replace plants and trees upon completion of site work.

END OF SECTION 26 05 43.13
PART 1 - GENERAL

1.1 RELATED WORK
A. Section 03 30 00 – Cast-in-Place Concrete
B. Section 26 05 26 – Grounding and Bonding for Electrical Systems
C. Section 26 05 43 – Underground Ducts and Raceways for Electrical Systems
D. Section 26 05 43.13 – Excavation and Backfill

1.2 REFERENCE
A. Work under this section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION
A. Section includes underground utility structures: Handholes, pull boxes, and accessories for power and communication cable systems.

1.4 REFERENCED STANDARDS
A. AASHTO HB 17 – Standard Specifications for Highway Bridges
B. ANSI C2 – National Electrical Safety Code
C. ASTM A 48/A 48M – Specification for Gray Iron Castings
D. ASTM C 270 – Specification for Mortar for Unit Masonry
E. ASTM C 387 – Specification for Packaged, Dry, Combined Materials for Mortar and Concrete
F. ASTM C 858 – Specification for Underground Precast Concrete Utility Structures
G. ASTM C 891 – Standard Practice for Installation of Underground Precast Concrete Utility Structures
H. ASTM C 1037 – Practice for Inspection of Underground Precast Concrete Utility Structures
J. ISO 9000 – Quality Management
K. ISO 10012 – Measurement Management Systems
L. NFPA 70 – National Electrical Code
M. SCTE 77 – Specification for Underground Enclosure Integrity

1.5 SUBMITTALS
A. Product Data:
   1. Accessories for underground utility structures.
B. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Include plans, elevations, sections, details, attachments to other work, and accessories, including the following:
   1. Duct entry provisions, including locations and duct sizes
   2. Reinforcement details
   3. Frame and cover design and handhole frame support rings
   4. Grounding details

C. Shop Drawings for Factory-Fabricated Handholes and Pull Boxes Other Than Precast Concrete: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:
   1. Duct entry provisions, including locations and duct sizes
   2. Cover design
   3. Grounding details
   4. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons

D. Product Certificates: For concrete and steel used in precast concrete handholes, as required by ASTM C 858.

E. Qualification Data: For professional engineer and testing agency.

F. Source quality-control test reports.

G. Field quality-control test reports.
   1. Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.

H. Manufacturer’s Installation Instructions:
   1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

I. Closeout Submittals:
   1. Project Record Documents:
      a. Record actual location of underground utility structures.
   2. Operation and Maintenance Data:
      a. Include manufacturer’s recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.
      b. Include spare parts data listing, source, and current prices of replacement parts and supplies.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated

B. Comply with ANSI C2

C. Comply with NFPA 70

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store underground utility structures at project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.
B. Life and support precast concrete units only at designated lifting or supporting points.

1.8 WARRANTY

A. Refer to Division 01 and Section 26 00 00 – General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 1 yr written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.1 PRECAST CONCRETE HANDHOLES AND PULL BOXES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. PenCell
   2. Hubbell
   3. Oldcastle Precast Group
   5. The product indicated on drawings

B. Comply with ASTM C 858 for design and manufacturing processes.

C. Structural Load Ratings: As specified in Part 3 “Underground Enclosure Application.”

D. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or pull box.
   1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
   2. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
   3. Frame and Cover: Weatherproof steel frame, with hinged steel access door assembly with tamper-resistant, captive, cover-securing bolts.
      a. Cover Hinges: Concealed, with hold-open ratchet assembly
      b. Cover Handle: Recessed
   4. Frame and Cover: Weatherproof aluminum frame with hinged aluminum access door assembly with tamper-resistant, captive, cover-securing bolts.
      a. Cover Hinges: Concealed, with hold-open ratchet assembly
      b. Cover Handle: Recessed
   5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
   6. Cover Legend: Molded lettering, “ELECTRIC.”
   7. Configuration: Units shall be designed for flush burial and have open bottom, unless otherwise indicated.
   8. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
      a. Extension shall provide increased depth of 12”.
      b. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.
9. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12” vertically and horizontally to accommodate alignment variations.
   a. Windows: Located no less than 6” from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
   b. Window opening: Cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie-in to concrete envelopes of ductbanks.
   c. Window openings: Framed with at least two additional NO. 4 steel reinforcing bars in concrete around each opening.

10. Duct Entrances in Handhole Walls:
   a. Type and size: Fittings matched to duct or conduit to be terminated.
   b. Fittings: Aligned with elevations of approaching ducts and located near interior corners of handholes to facilitate racking of cable.

11. Handholes 12” wide by 24” long and larger: Inserts for cable racks and pulling-in irons installed before concrete is poured.

2.2 HANDHOLES AND PULL BOXES OTHER THAN PRECAST CONCRETE

A. Description: Comply with SCTE 77.
   2. Configuration: Designed for flush burial and have open bottom, unless otherwise indicated.
   3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
   4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
   5. Cover Legend: Molded lettering, “ELECTRIC.”
   6. Direct Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.

B. Polymer Concrete Handholes and Pull Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Armorcast Products Company
      b. Carson Industries LLC.
      c. CDR Systems Corporation
      d. NewBasis

2.3 SOURCE QUALITY CONTROL

A. Test and inspect precast concrete utility structures according to ASTM C 1037.

B. Nonconcrete Handhole and Pull Box Prototype Test: Test prototypes of handholes and pull boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

   1. Tests of materials shall be performed by an independent testing agency.
2. Strength of tests of complete pull boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.

3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 UNDERGROUND ENCLOSURE APPLICATION

A. Handholes and Pull Boxes for 600 V and Less:
   2. Handholes and Pull Boxes in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete, SCTE 77, Tier 15 structural load rating.
   3. Handholes and Pull Boxes in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Polymer concrete units, SCTE 77, Tier 8 structural load rating.
   4. Handholes and Pull Boxes Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf vertical loading.

3.2 INSTALLATION OF CONCRETE HANDHOLES AND PULL BOXES

A. Precast Concrete Handhole Installation
   1. Comply with ASTM C 891, unless otherwise indicated.
   2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
   3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
   4. Concrete: 5000 psi, 28-day strength, complying with Division 03 – Concrete.

B. Elevations:
   1. Handhole Covers: In paved areas and traffic-ways set surface flush with finished grade. Set covers of other handholes 1” above finished grade.
   2. Where indicated, cast handhole cover frame integrally with handhole structure.

C. Drainage: Install drains in bottom of handholes via drain lines where indicated. Coordinate with drainage provisions indicated.

3.3 INSTALLATION OF HANDHOLES AND PULL BOXES OTHER THAN PRECAST CONCRETE

A. Install handholes and pull boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use pull box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2” sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas and traffic-ways, set so cover surface will be flush with finished grade. Set covers of other handholes 1” above finished grade.
D. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

E. Field-cut openings for ducts and conduits according to enclosure manufacturer’s written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetration after fittings are sealed.

F. For enclosures installed in asphalt paving and subject to occasional, non-deliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.
   1. Concrete: 3000 psi, 28-day strength, complying with Section 03 3000 - Cast-in-Place Concrete, with a troweled finish.
   2. Dimensions: 10” wide by 12” deep.

3.4 GROUNDING

A. Ground utility structures according to Section 26 05 26 - Grounding and Bonding for Electrical Systems.

B. Provide 1 ground rod in each power system handhole and pull box and 2 ground rods in each communication system manhole. Provide ground ring conductor, minimum 3/0 bare copper, secured around perimeter of the handhole or pull box interior at 12” above floor, and exothermically connected to the ground rod. Comply with Section 26 05 26 - Grounding and Bonding for Electrical Systems.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:
   1. Demonstrate capability and compliance with requirements on completion of installation of underground utility structures.
   2. Test handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 26 05 26 - Grounding and Bonding for Electrical Systems.

B. Correct deficiencies and retest as specified above to demonstrate compliance.

C. Interpret test results in writing and submit to Engineer.

3.6 CLEANING

A. Clean internal surfaces of handholes, including sump and remove foreign material, after completing the installation of all devices, equipment, cables and terminations.

B. Remove water from handholes. If handholes continue to fill up with water, Contractor shall pump them regularly until the source of water has been detected and corrected.

END OF SECTION 26 05 43.19
PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 05 16 – Owner Furnished Equipment
B. Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables
C. Section 26 05 33 – Raceways and Boxes for Electrical Systems
D. Section 26 05 43 – Underground Ducts and Raceways for Electrical Systems

1.2 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 - General Requirements.

1.3 DESCRIPTION

A. Section includes the following:
   1. Identification for raceway.
   2. Identification for conductors and communication and control cable.
B. Refer to the respective Division 26 Sections, and Sections in other Divisions that specify electrical components, for additional electrical identification requirements.

1.4 REFERENCE STANDARDS

A. ANSI A13.1 – Scheme for the Identification of Piping Systems
B. ANSI C2 – National Electrical Safety Code
C. ANSI Z535.4 – National Standards for Product Safety Signs and Labels
E. NFPA 70 – National Electrical Code

1.5 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

1.6 QUALITY ASSURANCE

B. Comply with NFPA 70.
1.7 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

PART 2 - PRODUCTS

2.1 RACEWAY CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Manufacturers: Brady USA, Ideal, Marking Services, Inc. (MSI), Seton, or approved equal.

C. Color for Printed Legend:
   1. Power Circuits: Black letters on an orange field.
   2. Legend: Indicate system or service and voltage, if applicable.

D. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

E. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action when placed in position.

F. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2” long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action when placed in position.

G. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2” wide; compounded for outdoor use.

2.2 CONDUCTOR AND COMMUNICATION- AND CONTROL-CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend.

B. Manufacturers: Brady USA, Ideal, Marking Services, Inc. (MRI), Seton, or approved equal.

C. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2” wide.

D. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

E. Aluminum Wraparound Marker Labels: Cut from 0.014” thick aluminum sheet, with stamped, embossed, or scribed legend, and fitted with tabs and matching slots for permanently securing around wire or cable jacket or around groups of conductors.
F. Metal Tags: Brass or aluminum, 2" x 2" x 0.05", with stamped legend, punched for use with self-locking nylon tie fastener.

G. Write-On Tags: Polyester tag, 0.010" thick, with corrosion-resistant grommet and polyester or nylon tie for attachment to conductor or cable.
   1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

H. Plasticized Card-Stock Tags: Vinyl cloth with preprinted and field-printed legends. Orange background, unless otherwise indicated, with eyelet for fastener.

2.3 UNDERGROUND-LINE WARNING TAPE

A. Manufacturers: Brady USA, Ideal, Marking Services, Inc. (MRI), Seton, or approved equal.

B. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.
   1. Not less than 6" wide by 4 mils thick.
   2. Compounded for permanent direct-burial service.
   3. Embedded continuous metallic strip or core.
   4. Printed legend shall indicate type of underground line.

2.4 EQUIPMENT IDENTIFICATION NAMEPLATES

A. Engraved, Three-layer, Laminated Acrylic or Melamine Nameplate: Punched or drilled for screw mounting. White letters on a black background, except emergency power equipment nameplates are to have white letters on a red background. Minimum letter height shall be 3/8" unless noted otherwise.

B. Stenciled Legend: In non-fading, waterproof, black ink or oil-based, alkyd enamel paint. Minimum letter height shall be 1".

2.5 MISCELLANEOUS IDENTIFICATION PRODUCTS

   1. Minimum Width: 3/16"
   2. Tensile Strength: 50 lb minimum
   3. Temperature Range: -40 to +185°F
   4. Color: Black, except where used for color-coding

B. Paint: Paint materials and application requirements are specified in Division 09 – Finishes painting Sections.

C. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

A. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits: Identify with orange snap-around labels.
   1. Identify 4" round, 4" square and 4-11/16" junction boxes concealed above ceiling or exposed with neat lettering on cover with permanent black marking pen. Identify source, circuit number, phase, and control circuit number.
B. Power-Circuit Conductor Identification: For conductors in handholes, use color-coding conductor tape. Identify source and circuit number of each set of conductors or other appropriate number or letter to expedite future tracing and troubleshooting. For single conductor cables, identify phase in addition to the above. Phase identification shall be consistent throughout the system.

C. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in the same junction or pull box, use color-coding conductor tape write-on tags. Identify each ungrounded conductor according to source and circuit number.

D. Conductors to Be Extended in the Future and Spare Conductors: Attach write-on tags to conductors and list source and circuit number.

   1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
   2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
   3. Coordinate identification with project drawings, manufacturer’s wiring diagrams, and Operation and Maintenance Manual.

F. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.

G. Equipment Identification Nameplates: On each unit of equipment, install unique designation nameplate that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply nameplates to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
   1. Nameplate Instructions:
      a. Indoor Equipment: Engraved, laminated acrylic or melamine nameplate. Unless otherwise indicated, provide a single line of text with 1/2” high letters (1/4” where space is limited) on 1-1/2” high nameplate; where 2 lines of text are required, use nameplates sized 2” high.
      b. Outdoor Equipment: Engraved, laminated acrylic or melamine nameplates sized similar to indoor equipment nameplates.
      c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
   2. Install nameplates for equipment including, but not limited to, the following:
      a. Panelboards, electrical cabinets, and enclosures
      b. Disconnect switches
      c. Enclosed circuit breakers
      d. Contactors
      e. Remote-controlled switches, dimmer modules, and control devices
   3. Nameplates shall identify equipment or load controlled and/or function and shall be same as indicated on contract documents. Voltages shall be shown on panelboard nameplates.

3.2 INSTALLATION

A. Verify identity of each item before installing identification products.
B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Install non-adhesive signs and plastic nameplates parallel to equipment lines; attach with screws and auxiliary hardware appropriate to the location and substrate. Secure to inside surface of door or panelboard that is recessed in finished locations.

F. System Identification Color Banding for Raceways and Cables: Each color band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50 ft maximum intervals in straight runs, and at 25 ft maximum intervals in congested areas.

G. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded feeder and branch-circuit conductors.
   1. Color shall be factory applied.
   2. Colors for 208/120 V Circuits:
      a. Phase A (left bus in panelboard): Black
      b. Phase B (center bus in panelboard): Red
      c. Phase C (right bus in panelboard): Blue
      d. Neutral: White
      e. Equipment Ground: Green
   3. Colors for 480/277 V Circuits:
      a. Phase A (left bus in panelboard): Brown
      b. Phase B (center bus in panelboard): Orange
      c. Phase C (right bus in panelboard): Yellow
      d. Neutral: Gray
      e. Equipment Ground: Green
   4. Field-applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6" from terminal points and in boxes where splices or taps are made. Apply last two runs of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

H. Aluminum Wraparound Marker Nameplates and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

I. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8" below finished grade.

J. Painted Identification: Prepare surface and apply paint according to Division 09 – Finishes painting Sections.

END OF SECTION 26 05 53
PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Architectural Dimming Control System

1.2 RELATED SECTIONS
A. Section 26 00 00 – General Electrical Requirements
B. Section 26 51 00 – Interior Lighting

1.3 REFERENCE STANDARDS
A. UL 1472   Solid-State Dimming Controls
B. UL 1950   Safety of Information Technology Equipment
C. ANSI C62.41-1991  Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits
D. IEC 801-2  Electrostatic Discharge Testing Standard
E. ISO 9001   Quality Management Systems
F. NEMA WD1 (R2005) - General Color Requirements for Wiring Devices.

1.4 SYSTEM DESCRIPTION
A. Provide complete architectural lighting dimming system as shown on drawings, details and schedule(s).
B. The system shall be designed for the control of architectural lighting and shall consist of factory pre-wired processing rack enclosure containing DMX control electronics.
C. System shall be provided with necessary accessories for complete installation.
D. Entire system shall be UL listed.

1.5 QUALITY ASSURANCE
A. Manufacturer: Minimum 10 years experience in manufacture of architectural lighting controls.
B. Manufacturer's Quality System: Registered to ISO 9001:2000 Quality Standards, including in-house engineering for product design activities.
C. Lighting control system components: Listed by UL specifically for the required loads. Provide evidence of compliance upon request.

1.6 SUBMITTALS
A. Submit under provisions of Section 01 33 00.
B. Specification Conformance Document: Indicate whether the submitted equipment:
1. Meets specification exactly as stated.
2. Meets specification via an alternate means and indicate the specific methodology used.

C. Shop Drawings include:
   1. Schematic of system.
   2. Full scale drawings showing system components.
   3. Control schedules indicating load type their respective control zones.
   4. Full system riser diagrams showing detail of each control, which zones are associated with that control, and interconnect wiring between controls and any special considerations.
   5. Catalog cut sheets with performance specifications demonstrating compliance with specified requirements. Submittal of project manual cut sheets is not acceptable.

1.7 PROJECT CONDITIONS
A. Do not install equipment until following conditions can be maintained in spaces to receive equipment:
   1. Ambient temperature: 0° to 40° C (32° to 104° F).
   2. Relative humidity: Maximum 90 percent, non-condensing.
   3. Lighting control system must be protected from dust during installation.

1.8 WARRANTY
A. Provide manufacturer’s warranty covering two-year parts and labor and eight year limited parts warranty to repair and replace defective equipments.
B. Manufacturer shall:
   1. Maintain a standard stock of all spare parts for installed system for a minimum of ten (10) years from the date of system turn over to owner.
   2. Provide factory direct technical support hotline 24 hours per day, 7 days per week.
   3. Provide on-site service support within 72 hours if required.

PART 2 - PRODUCTS
2.1 The control system basis of design is ETC Unison Mosaic Tessera Controls.

2.2 MANUFACTURERS
A. Acceptable manufacturers
   1. ETC Unison Mosaic Architectural Controls
   2. Pre-approved equivalent manufacturer per Division 01
B. Substitutions: Under provisions of Division 01.
C. It is the responsibility of the Contractor to ensure that architectural lighting control system submitted meet or exceed the functional design intent and design quality standards in this Specification.

2.3 GENERAL
A. Provide system software, hardware, and equipment that is designed, tested, manufactured, and warranted by a single manufacturer.
B. Architectural Lighting Controls shall have a minimum ten-year operational life while operating continually at any temperature in an ambient temperature range of 0° C to 40° C and 90 percent non-condensing relative humidity.

C. Designed and tested to withstand electrostatic discharges up to 15,000 V without impairment per IEC 801-2.

2.4 CONTROL HARDWARE

A. General
1. The Controller shall be a microprocessor-based system specifically designed for control of lighting and other related systems in an architectural or entertainment application. A personal computer running emulation software shall not be acceptable.
2. The Controller shall be provided with a 5 year manufacturer warranty.

B. Mechanical
1. The controller shall have a fully integrated capacitive touchscreen driven by the application running on the microprocessor. A web browser displaying remotely served content shall not be acceptable.
   a. The capacitive touch screen shall be 4.3" with a resolution of 480x272 pixels with 24-bit color depth
2. The touchscreen application shall be dedicated to displaying a user interface for the controller. No other processes shall run on the touchscreen.
3. The Controller shall have a recessed switch for resetting the unit without removal of power.
4. No physical buttons shall be visible or exposed when the Controller is correctly installed.
5. There shall be visual indicators on the Controller showing status of the controller and its interfaces.
6. The controller shall be entirely solid-state with no moving parts, fans or hard disc drives
7. The controller shall operate in a temperature range from 0°C to 50°C (32°F to 122°F)

C. Electrical
1. The Controller shall have the following standard connectors:
   a. RJ45 socket for 10/100Base-TX Ethernet
2. The Controller shall utilize Power over Ethernet (IEEE 802.3af PoE powered device).
3. The Controller shall be ETL/ cETL listed and CE compliant

D. Functional
1. The appearance and content of the user interface shall be customizable by the user
2. The user interface shall support portrait or landscape orientation.
3. The Controller shall store show data in non-volatile solid-state memory. This memory shall be removable for purposes of backup or disaster-recovery.
4. Show data may be downloaded from a remote personal computer over an Ethernet connection.
5. The Operating Software of the Controller shall be stored in a dedicated non-removable non-volatile solid-state memory. It shall be possible to update the Operating Software by download from a remote personal computer over an Ethernet connection.
6. The Controller shall commence show playback automatically on receiving power without additional external inputs.
7. The Controller shall have an internal real-time clock that continues to operate when external power is absent. It shall be capable of adjusting for Daylight Saving Time automatically and can be updated over the Internet using the Network Time Protocol (NTP).
   a. The Controller shall be able to calculate sunrise and sunset times based on longitude and latitude information, and use these as triggers for events.

8. The Controller shall have a capacity of 512 channels of network DMX protocols including streaming ACN (ANSI E 1.31), Philips KiNet, Pathway XDMX and Art-Net II protocols.
   a. The controller shall be able to output multiple Ethernet DMX protocols simultaneously, up to the output control channel limit

9. The Controller shall operate a web server on its Ethernet interface. This shall allow status information, control and configuration options to be accessed remotely.
   a. The appearance and content of the web interface may be customized by the user.

10. The Controller shall allow lighting to be programmed as separate zones, with independent triggering and manual intensity control.

11. The Controller shall support multiple timelines, crossfades and effects running concurrently.

12. The Controller shall support playback of video media with individual pixels mapped to lighting fixtures in an array.

13. The Controller shall support an ambient light sensor to automatically adjust the touchscreen backlight level.

14. The controller shall support a proximity sensor to automatically wake up the screen.

15. The Controller shall support a learning IR receiver.

16. The Controller shall be capable of providing show feedback via the user interface.

17. The Controller shall support multiple remote modules connected via Ethernet for support of additional show control interfaces, such as contact closures, analog inputs, relay outputs, serial audio input, linear time code, MIDI and DALI.

18. The Controller shall support multiple remote button stations connected via Ethernet for use as triggers and user feedback.

19. The Controller shall support multiple streams of linear time code and audio data within a single networked system.

20. The Controller shall have an internal security feature that will restart the unit in the event of program failure.

21. Multiple Controllers shall automatically synchronize and share triggers when programmed as part of a single show and linked via Ethernet during playback.

22. The Controller shall support conditional logic and execute user-defined Lua scripts to support advanced show control operations.

E. Software
1. The Controller shall be supported by programming software running on either a PC or Mac platform. Programming features shall include:
   a. Comprehensive architectural and automated fixture library
   b. Drag and drop placement of fixtures on plan
   c. Drag and drop patching of fixtures to output addresses
   d. Import of any media for mapping to fixture arrays
   e. Timeline-based programming and playback
   f. Extensive range of editable effect presets
   g. Drag and drop placement of effect presets and media on timeline
   h. Variety of triggering options for firing system-wide events
i. Each trigger event may be configured to initiate one or more lighting or show control action
j. Each trigger event may be configured to test one or more conditions before executing its actions
k. Simulation of individual timelines, and entire project with triggers
l. Live output from software for programming verification purposes
m. Controller and network management tools
n. Export CSV reports for all aspects of programming
o. Tools for remote management of content and show programming

2. The Controller shall be supported by user interface creation software running on PC or Mac platform. User interface configuration features shall include:
   a. Create multiple pages of user interface controls
   b. Library of page control layouts with buttons, sliders and color pickers
   c. Change the appearance of pages and controls by applying themes
d. Use themes from the theme library, or create custom themes
e. Choose a background image for each page
f. Assign local functionality to controls, e.g. change page or screen brightness.
g. Add navigation controls to pages and configure page transitions.

2.5 CONFIGURATION AND CONTROL SOFTWARE

A. System Configuration
   1. The Architectural Control System Configuration software shall be the Unison Paradigm LightDesigner as manufactured by Electronic Theatre Controls, Inc., or approved equal.

   2. Definitions
      a. A System is the configuration of one or more Paradigm Processors
      b. A Fixture is a controllable entity with one or more Attributes
c. An Attribute is a parameter of control such as Intensity, Pan or Gobo select
d. A Group is a selection of Fixtures that can be stored and recalled
e. A Space is defined area where other System objects reside. A Space defines the scope of Control for other objects.
f. Room Combine is functionality enabling the scope of control to vary in a pre-defined way based on the current status of a moveable Wall or Walls
g. A Control is a single point of input to the System (e.g. Button, Fader, Serial Port)
h. An Indicator is a single point of feedback from the System (e.g. LED, Label on LCD)
i. A Station has an arrangement of Controls and Indicators
j. A Page stores the assignment of function to Controls and Indicators of a particular Station and their properties (e.g. lockout threshold)
k. Actions are items of functionality that can occur within a running Paradigm system in response to events (e.g. button presses, timed events)
l. Preset is a container of Attribute settings (levels) and timings that can stored and recalled
m. A Sequence is a series of connected steps referencing Presets along with additional timing information
n. Effects are Attribute settings that result in continually varying levels following a specified curve and using additional timing parameters (e.g. period, offset)
o. Palette is a container of Attribute settings (levels) that can be referenced from Presets, allowing a change in the Palette to globally modify referenced Presets.

p. Macros are user-defined operations built up as a sequence of Actions that can be recalled

q. Binding is the process of associating a logical instance of a device within the configuration with a physical device discovered at runtime

3. Environment
   a. Shall be possible to work with multiple System configurations simultaneously
   b. There shall be clipboard functionality (cut, copy, paste) for entire objects (e.g. Presets, Stations), settings (e.g. Attribute levels) and text
   c. There shall be undo and redo functionality where persistent changes are made to the System configuration (but not application settings or playback state)
   d. There shall be a auto-backup feature
   e. The application interface shall be based around (i) a tree-view; (ii) a workspace area; (iii) a properties inspector; (iv) item selector.
   f. It shall be possible to represent data about the workspace area graphically (plan) or in tabular form
   g. Plan views shall support zoom
   h. Plan views shall support a layout grid with user-defined spacing and color with associated snap-to-grid functionality
   i. The properties inspector shall be used to view and modify the properties of one or multiple objects
   j. There shall be 2 modes of operation that expose progressively more in-depth functionality (Normal, Advanced)
   k. It shall be possible to enter User-configurable names in any language supported by their operating system (e.g. encoded as UTF8)
   l. User-configurable names shall be limited to 64 display characters each
   m. There shall be provision for help functionality to be accessed from within the application

4. System Configuration
   a. It shall be possible to create Spaces
   b. It shall be possible to add Fixtures by selecting a Fixture Template from the provided library and create custom Fixtures
   c. It shall be possible to add Stations by selecting a Station Definition from the provided library and create custom Stations
   d. It shall be possible to create a System based on data imported from a defined documentation format (e.g. CSV, XML)
   e. It shall be possible to export System configuration data to a defined documentation format (e.g. CSV, XML)
   f. There shall be a wizard to assist with the initial setup of a System including Project data entry, Space creation, network configuration, and zone creation.
   g. There shall be a straightforward process for the assignment of Fixtures and Stations to particular Processors
   h. There shall be a 2-dimensional plan view that displays the layout of Spaces
   i. A Space shall be displayed as a user-configurable polygon with straight edges
   j. The plan shall display Fixtures and Stations located within Spaces
   k. The plan shall display Walls between Spaces and their current state (open, closed)
l. Items displayed on the plan may be arranged using standard graphical interaction methods (e.g. drag-and-drop)
m. It shall be possible to import images JPEG, BMP and GIF formats as a background image to the plan view
n. It shall be possible to create Walls that accomplish Room Combine between Spaces

5. Fixture Configuration
   a. There shall be functionality to patch Fixtures to DMX and Streaming ACN
   b. There shall be support for Fixtures with split patches (e.g. VL5)
   c. There shall be support for multiply-patching a Fixture
   d. It shall be possible to swap pan and tilt axes for a moving-light Fixture
   e. It shall be possible to specify a minimum and maximum value for an Attribute
   f. It shall be possible to specify a minimum fade time for an Attribute
   g. It shall be possible to invert the range of values for an Attribute
   h. It shall be possible to specify a default value for an Attribute
   i. It shall be possible to specify a dimmer curve for an intensity Attribute

6. Design and Simulation
   a. There shall be a tabular view of Fixture Attributes within Spaces
   b. There shall be control of Zones (as a type of Fixture)
   c. There shall be control of LED arrays (as a type of Fixture)
   d. There shall be control of moving lights (as a type of Fixture)
   e. There shall be independent control of every Attribute of a Fixture
   f. Appropriate graphical controls shall be provided for non-intensity Attributes (e.g. color picker)
   g. It shall be possible to create Groups as a selection shortcut
   h. The plan shall show the current status of Room Combine
   i. The plan shall show simulation feedback for Fixtures in a graphical form
   j. Feedback values for Attributes shall be displayed in terms of real-world units where an appropriate real-world unit and mapping is available (e.g. pan in degrees)
   k. Control events may be simulated by clicking on a representation of the Station in at least the plan view
   l. The simulation may be linked to the actual online System to synchronize playback and inject control events (live control)

7. Presets
   a. There shall be provision to record a Preset based on current Attribute settings
   b. There shall be a display of Presets that affect Fixtures in the Space being worked with and their activation status
   c. A Preset may store a reference to a Palette as an Attribute setting
   d. Presets may be displayed and modified in tabular form (spreadsheet)
   e. Timing in Presets may be set on an individual Attribute basis
   f. Timing settings shall include a fade time, a delay time and a fade profile
   g. All Presets may include split timing
   h. Presets may be applied in an Latest Takes Precedence (LTP) or Highest Takes Precedence (HTP) manner
   i. It shall be possible for all Presets to include Effects
j. Each Effect shall have a Curve and parameters (to include size, period, offset and repeat count)
k. There shall be support for a flicker effect
l. There shall be a provision to create Sequences from Presets
m. It shall be possible for a Sequence to be displayed and modified as a timeline display
n. It shall be possible for any step of a Sequence to trigger a defined Action
o. The end state of a Sequence shall be user configurable (e.g. release, loop, hold at end)

8. Actions
a. There shall be a standard Action for toggling the Intensity Attribute of a Fixture or Group (Fixture Toggle)
b. There shall be standard Actions for recalling Presets (Preset Recall)
c. There shall be a standard Action for recording a Preset (Preset Record)
d. There shall be standard Actions for controlling Sequences (Timeline Control)
e. There shall be standard Actions for changing Wall state (Wall Toggle)
f. There shall be a standard Action for raising or lowering the intensity setting of a Fixture or Group
g. There shall be a standard Action for raising or lowering the intensity setting of a Preset
h. There shall be a standard Action that activates Faders within its scope (Manual)
i. There shall be a standard Action that activates Faders on a target station and locks out other Stations within its scope (Take Control)
j. There shall be a standard Action for setting lock out variables for a Station, within a Space or System-wide (Lock Out)
k. There shall be a standard Action for enabling and disabling Overrides
l. There shall be a standard Action for recalling a Macro (Call Macro, Macro Toggle)
m. There shall be a standard Action for turning Off a particular Fixture, Group or Fixtures within a Space (Off)
n. There shall be a standard Action for controlling Fixture or Group Intensity levels from a Fader
o. There shall be a standard Action for controlling Preset Intensity levels from a Fader
p. There shall be a standard Action for mastering Fixture or Group Intensity levels from a Fader
q. There shall be a standard Action for modifying Preset fade times from a Fader
r. There shall be a standard Action for modifying Preset rate from a Fader
s. There shall be an equivalent standard Indicator behavior for every standard Action
t. Qualified users may create custom Actions

9. Macros
a. Users can create, store and recall Macros that are sequences of Actions (standard or custom)
b. Macros may define separate sequences to occur when turned on and off (toggle)
c. Macros may incorporate conditional statements based on current status of the System (e.g. comparisons such as x > y)
d. Conditional statements may be combinations of several simpler statements using logical operators (AND, OR)

10. Script
a. There shall be a mechanism for defining custom functionality using a scripting language
b. The behaviors of Controls and Indicators may be customized through the use of Script
c. Script may be used to define custom functionality (Actions) within the System
d. Script shall allow new functionality to be defined in a manner that is reusable in different Systems
e. Script shall support logical and arithmetic operations
f. Script shall support direct access to System data using names
g. Script shall support creating, reading and writing to persistent System-wide variables (registered variables)
h. Script shall support timer functionality including the capability to cancel a running timer
i. Script shall support logging functionality
j. Standard functionality may be implemented as Scripts that will not be user modifiable
k. A Custom Script may be copied from a suitable Standard Script to provide a starting point
l. Script shall support reading data directly from connected interfaces (e.g. LON NVs, ACN properties, DMX inputs)
m. Script shall support writing data directly to connected interfaces (e.g. LON NVs, ACN properties, DMX outputs, Serial ports)
n. Script shall allow parsing of data (e.g. reading 8 contact inputs as individual bits from a byte of data)

11. Reports
   a. It shall be possible to generate tabular reports and customize their layout and appearance
   b. It shall be possible to print reports
   c. It shall be possible to export reports to file (e.g. CSV)
   d. There shall be reports for Presets
   e. There shall be reports for Fixtures
   f. There shall be reports for Stations
   g. There shall be reports for Processors
   h. There shall be reports for Macros

12. Resources
   a. The installed package shall include a set of LCD Design Themes
   b. Effect Curves, Fade Profiles and Dimmer Curves shall use a common format and allow custom variants to be generated by the user
   c. Additional Fixture Templates may be defined by the user (custom Fixtures)
   d. Additional Station Definitions may be defined by the user (custom Stations)

13. Pharos
   a. It shall be possible to add Pharos systems to the configuration for triggering and status monitoring
   b. There shall be standard Actions and Indicator behaviors for Pharos integration via Ethernet

B. Touchscreen Station Configuration
1. The Architectural Control System Touchscreen Configuration software shall be the Unison Paradigm ControlDesigner as manufactured by Electronic Theatre Controls, Inc., or approved equal.

2. The Unison Paradigm ControlDesigner software program shall be an application software package that facilitates off-line Unison Paradigm Touchscreen station configuration.
   a. Software setup shall include Configuration and Design Wizards, to create a graphical representation of a control environment.
   b. The software program shall be downloadable from the manufacturer’s website free of charge.

3. Functions
   a. Provides functionality to create and modify Pages for display on a specific type of LCD Station
   b. There shall be a wizard to assist with the creation of Pages
   c. A single configuration for an LCD Station shall be defined as a set of one or more Pages
   d. Each Page shall have a background that may incorporate multiple images or animations
   e. Pop-ups can be shown/hidden over any Page in a Configuration and more than one Popup can be shown at once
   f. Pages may have multiple design elements that may be Controls, Indicators or both
   g. Design elements shall have a user-defined size, position and z-order that cannot be changed from within the System
   h. Each design element shall have between 1 and 256 states, each of which can have a distinct appearance
   i. The appearance of a state can be taken from a Theme or imported image file
   j. There shall be support for import of at least JPG, PNG and GIF image formats
   k. Transparency shall be supported
   l. Animated images shall be supported
   m. Transitions between states of design elements can be animated
   n. Page transitions can be animated
   o. Design elements shall have a visibility group and threshold
   p. Design elements that are Controls shall have a lockout group and threshold
   q. All text shall have a user-definable font family, size, color and alignment
   r. There shall be at least the following types of design elements
      1) Label
      2) Level Indicator
      3) Button
      4) Fader (straight and curved)
      5) Clock (analogue and digital)
      6) Numeric Keypad
      7) Tab widget
   s. Themes shall define a collection of consistent appearances and sounds for design elements
   t. It shall be possible to change the Theme used for a particular Station without modifying the underlying design elements
   u. There shall be tools to assist with the creation of new Themes
v. Shall allow sounds to be associated with a particular Page
w. Shall allow sounds to be associated with state transitions of particular design elements
x. Sounds may be used to provide Touchscreen interaction feedback
y. A Page can be designated as the Stations inactivity Page
z. A Page can have a lockout group and threshold
aa. A Tab can have a visibility group and threshold
bb. There shall be a visualization interface for Page creation and editing
c. Standard graphical interaction methods (drag-and-drop) shall be used to arrange design elements on Pages
d. There shall be a layout grid with user-defined spacing and color with associated snap-to-grid functionality
e. It shall be possible to reuse the graphical layout of a configuration independent of any assigned functionality
ff. The LCD Design functionality shall be part of a separate application that can be used alongside Light Designer
g. Pop-ups can be any fixed size up to the Page size
hh. Pop-ups will have a fixed position on screen (but may move when being shown/hidden)

C. Minimum Computer Requirements
   1. The software shall require the Windows XP SP2 (Home or Pro) operating system running on a x86-Windows-compatible computer (2 GHz Pentium 4 or better) with a minimum of 1 GB of hard drive space and 1 GB RAM, OpenGL graphics acceleration, a monitor capable of displaying at least 1024 x 768 screen resolution, a CD-ROM optical drive, Ethernet port, USB port or SD card slot, keyboard and mouse.

2.6 SOURCE QUALITY CONTROL
   A. Perform full-function testing on all completed assemblies at end of line. Statistical sampling is not acceptable.
   B. Diagnostics and Service – Tiered control scheme for dealing with component failure that minimizes loss of control for occupant.
      1. Bus failure: Lights go to emergency level for safety.
      2. Failure of one sensor type: Ballast still controllable via other sensors.

PART 3 - EXECUTION

3.1 INSTALLATION
   A. Install system as shown on manufacturers approved shop drawings.
   B. Equipment shall be installed utilizing manufacturer’s installation instructions and in accordance with these specifications.
   C. Control wiring shall be low voltage, Class II wiring, electrically isolated from power wiring by Class II transformer.
   D. System wiring shall be in conduit.
E. Wall Control Stations:
   1. Install wall control stations plumb and in quantities and type as noted on plans.
   2. Field confirm precise placement of all wall station devices with architect prior to back box rough in.

F. Provide any additional hardware or ancillary equipment required for a complete and functional system according to control system design intent.

3.2 TESTING

A. Upon completion of installation and prior to feeding loads through dimmers, Contractor shall completely test all line voltage power and low voltage control wiring for continuity and accuracy of connections. Bypass shall remain in place until all loads have been fully tested and found to be free of miswires, short circuits, or other wiring defects.

B. System shall be checked out by manufacturer's factory-trained representative. Checkout will be performed upon notification by Contractor that system installation is complete.

3.3 COMMISSIONING

A. System commissioning and startup shall be done by factory-certified field service engineers during site visits to ensure proper system installation and operation under the following parameters:
   1. Qualifications for factory-certified field service engineer:
      a. Minimum experience of 2 years training in the electrical/electronic field.
      b. Certified by the equipment manufacturer on the system installed.
   2. Make a site visit upon completion of installation of Architectural Lighting Control Systems to:
      a. Verify connection of power feeds and load circuits.
      b. Verify connection and location of controls.
      c. Energize processor panel and download system data program.
      d. Verify proper connection of panel links (low voltage/data) and address panel.
      e. Download system panel data to dimming/switching panels
      f. Check dimming panel load types and currents and remove by-pass jumpers.
      g. Verify system operation control by control, circuit by circuit.
      h. Verify proper operation of manufacturers interfacing equipment.
      i. Verify proper operation of manufacturers supplied Touchscreen and installed programs.
      j. Verify proper functionality and set up of all ancillary input devices and equipment.
      k. Verify Graphical software control programming.
      l. Obtain sign-off on system functions
      m. Program color changing LED fixtures per landscape architect/lighting designer.

B. Following installation completion and basic system setup, contractor shall provide a qualified, fully trained, system programmer to field program system functionality at the direction of architect, lighting consultant, or electrical engineer. Programming will include:
   1. Setting preset lighting levels for all areas.
   2. Setting time of day Time Clock events.
   3. Setting Astronomic Time Clock events.
4. All other items required for full system functionality per design intent.

C. Contractor shall provide a qualified, fully trained, system programmer to field program system functionality.

3.4 TRAINING

A. Contractor shall provide owner with three (3) complete copies of a set of Operations and Maintenance manuals.

B. Each manual shall contain overview system information as well as specific information pertaining to the system installed.

C. Each manual shall contain at a minimum:
   1. Detailed as built shop drawings for the system as installed.
   2. Control schedules for the system as installed.
   3. Control Station Schedules for the system installed.
   4. Manufacturer's Cut Sheets for all equipment installed.
   5. Manufacturer's complete installation instructions.
   7. System maintenance requirements and maintenance schedules.
   8. Manufacturer’s Contact.
   9. Manufacturer’s Warranty.

D. Manufacturer's factory service representative shall instruct Owner for a minimum of eight (8) hours on system capabilities, operation, and maintenance at owner’s schedule.

END OF SECTION 26 09 33.19
PART 1 - GENERAL

1.1 RELATED WORK
A. Section 26 00 00 - General Electrical Requirements
B. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables
C. Section 26 05 26 - Grounding and Bonding for Electrical Systems
D. Section 26 05 33 - Raceway and Boxes for Electrical Systems
E. Section 26 09 33 19 - Architectural Dimming System

1.2 REFERENCE
A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION OF WORK
A. Provide luminaires as shown on Contract Drawing and Specifications.
B. Luminaires shall be provided complete with necessary accessories for proper installation.
C. Catalog numbers shown in luminaire schedule are basic luminaire types. Additional features, accessories and options specified or scheduled shall be included.
D. Provide lamps for luminaires as recommended by luminaire manufacturer and as scheduled.
E. Specifications and drawings convey the features, and functions of luminaires only and do not show every item or detail necessary for the work.
F. Work includes final aiming and focusing of luminaires under direction of the Landscape Architect/Engineer/Lighting Designer.

1.4 REFERENCE STANDARDS
A. NECA/IESNA 500 - Standard for Installing Indoor Commercial Lighting Systems (ANSI)
B. NECA/IESNA 501 - Standard for Installing Exterior Lighting Systems (ANSI)
C. NECD/IESNA 502 - Standard for Installing Industrial Lighting Systems (ANSI)
D. UL 496 – Lampholders
E. UL 542 – Fluorescent Lamp Starters
F. UL 676 – Underwater Luminaires and Submersible Junction Boxes
G. UL 773 - Plug-in Photocontrols for use with area lighting
H. UL 924 - Emergency Lighting and Power Equipment
I. UL 935 - Fluorescent Lamp Ballasts
J. UL 1029 - High Intensity Discharge Lamp Ballast
K. UL 1598 – Luminaires
L. UL 1838 – Low Voltage Landscape Lighting Systems
M. UL 2108 – Low Voltage Lighting Systems
N. UL 2388 – Flexible Lighting Products
O. UL 8750 – LED Light Sources for use in Lighting Products
P. ANSI C78.377 – Chromaticity
Q. IESNA LM-79 – Photometry Testing
R. IESNA LM-80 – Lumen Maintenance Testing

1.5 QUALITY ASSURANCE

A. Luminaire and accessory components shall be constructed of materials appropriate for their use.
B. Luminaires, ballasts, lamps and other components shall meet the requirements of all applicable State and Municipal energy codes.
C. Provide luminaires listed and labeled for their indicated use and installation conditions.
D. Contractor shall coordinate installation of lighting systems with all trades.
   1. Manufacturers listed in the luminaire schedule shall be assumed capable of supplying listed luminaires. Any such exceptions shall immediately be brought to the attention of Architect and Lighting Consultant. Multiple Name Specification:
      a. When multiple manufacturers are listed, Electrical Contractor shall choose which of the listed products are to be provided.
      b. Products of the same type shall be of same manufacturer.
   2. Single Name Specification:
      a. When only one product is suitable for the application and/or no other known acceptable products exist, only one manufacturer/product is listed in the Luminaire Schedule. For such instances, Electrical Contractor shall provide the listed product with no exceptions.
      b. Specifier has secured accurate pricing for all single name products prior to bidding and has shared this information with Architect/Owner's Representative. Contractor shall supply contractor net unit pricing for all single name products specified. Unit price shall be for equipment only and not include installation or miscellaneous electrical costs.
E. Substitution requests:
   1. Will be evaluated prior to Bid.
   2. Shall follow procedures set forth in this Section and in Section 01 25 00 - Substitution Procedures.
   3. Shall be made not less than 14 days prior to bid date.
   4. Shall include the following information:
      a. Specified and proposed manufacturer's product data sheet, noting options and features.
      b. Provide dimensioned drawing of luminaire.
c. Provide photometric data in form of an electronic IES file for use in a recognized computer lighting program.

5. Equipment delivery lead time shall not be held as a valid reason for requesting luminaire substitution unless luminaire lead time from specified manufacturer is in excess of 14 weeks. It shall be the sole responsibility of the Electrical Contractor to determine necessary equipment lead times, deliver submittals for review in a timely fashion, and place orders accordingly to ensure timely delivery.

6. When requesting a substitution, Electrical Contractor shall provide unit and extended pricing for specified luminaire, unit and extended pricing for proposed alternate, and unit and extended delta savings to owner to be realized by accepting proposed alternate. If requested, provide unit pricing for each luminaire type specified to provide a baseline comparison for substitution request.

7. Electrical Contractor shall guarantee pricing on all luminaire types for which a substitution request has been granted. This price guarantee shall be per unit and shall be maintained through the end of construction, regardless of quantity purchased.

1.6 WARRANTY

A. Ballasts: Provide manufacturer’s warranty for a period of not less than five years. Warranty shall include parts and labor to replace defective ballasts.

B. Exit Signs Utilizing LED Lamp Technology: Provide manufacturer’s warranty for a period of not less than five years including parts and labor for full replacement of defective product.

C. LED Luminaire: Provide manufacturer’s warranty for a period of not less than three years for repair or replacement of defective electrical parts, including light source and power supplies.

1.7 SUBMITTALS

A. As soon as possible after award of Contract, submit complete list of lighting products to be furnished, with manufacturer and catalog designations, including currently quoted lead times for product delivery. Should Electrical Contractor anticipate delivery schedule of any specified product may adversely impact construction schedule, he shall bring it to the attention of the Owner at this time.

B. In addition to complying with requirements of Section 26 00 00 - General Electrical Requirements, submittals shall include the following:

1. Manufacturer's product data
2. Installation instructions
3. Maintenance data
4. Parts list for each luminaire accessories
5. Photometric Data: photometric data for luminaire, including optical performance as follows:
   a. Coefficients of utilization
   b. Luminance table
   c. Candela distribution data
   d. Zonal lumens
   e. Area and roadway luminaires shall include Isocandela Charts and IES Roadway Distribution Classification.
6. Ballast schedule indicating manufacturer, type, and catalog number for each luminaire
7. Ballast cut sheet for each ballast used, referencing luminaire type(s)
8. Lamp schedule indicating manufacturer, type, and catalog number for each luminaire
9. Lamp cut sheet for each lamp used, referencing luminaire type(s)
10. Documentation of lamp and ballast compatibility
11. Product color/finish
   a. Where specific finish or color is not specified and options exist, submit color or finish
      samples to Architect/Engineer for selection.

C. Shop Drawings for equipment provided under this Section shall include the following:
1. Detailed drawings of linear luminaires including dimensions, support spacing, suspension type,
   power feed type and locations, lamp combinations, ballast locations, luminaire joint locations
   and end plates.
2. Detailed drawings for nonstandard luminaires indicating dimensions, weights, method of field
   assembly, components, features, and accessories. Details shall be scaled at not less than half
   full size.
3. Photometric Data: Where indicated on luminaire schedule and Contract Drawings, supply
   complete photometric data for luminaire, including optical performance rendered by
   independent testing laboratory developed according to methods of the Illuminating Engineering
   Society of North America as follows:
   a. Coefficients of utilization
   b. Luminance table with data presented numerically, showing maximum luminaire luminance
      at shielding angles. Readings should be taken both crosswise and lengthwise in case of
      fluorescent luminaire or luminaire with an asymmetric distribution.
   c. Candela distribution data, presented graphically and numerically, in 5° increments (5°, 10°,
      15°, etc.) Data developed for up and down quadrants normal, parallel, and at 11-1/2°, 45°,
      67-1/2° to lamps if light output is asymmetric.
   d. Zonal lumens stated numerically in 10° increments (5°, 15°, etc.) as above.
   e. Area and roadway luminaires shall also include isocandela charts and IES roadway
      distribution classification.

D. Catalogue Cuts lacking sufficient detail will not be accepted.

E. No variation from the general arrangement and details indicated on drawings shall be made on
   shop drawings unless required by actual conditions. All variations shall be marked on drawings
   submitted for approval.

1.8 SAMPLES
A. Upon return of submittals, and prior to release for manufacturing, Contractor shall furnish one
   sample of each luminaire for which sample requirement is noted in fixture schedule.

B. Shipping: Samples shall be complete with specified lamp(s), cord and plug, ready for hanging,
   energizing, and examining, and shall be shipped, prepaid by Contractor, to
   Architect/Engineer/Lighting Designer, or as otherwise advised.

C. Samples will not be returned, nor included in quantities listed for project.

D. Sample must be actual working unit.

E. All custom fixtures require a submission of material finish samples, component approval, and a
   complete operating prototype fixture. Prototype to be submitted prior to commencement of final
   fixture fabrication and shall include specified lamps. Modifications may be required as a result of
   the prototype review. These modification and others that do not materially affect the cost of the
   fixture shall be incorporated at no additional cost to the owner.
F. A working sample shall be provided for each type equipped with an LED light source. Sample shall be fully functional and precisely as specified including light output, correlated color temperature, and beam pattern.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Luminaires:
   1. As shown on Luminaire Schedule

B. Magnetic Fluorescent Ballasts:
   1. Advance, GE, Robertson, Universal Lighting Technologies

C. Electronic Fluorescent Ballasts:
   1. Advance, GE, Motorola, Osram Sylvania, Robertson

D. Electronic Dimming Fluorescent Ballasts:
   1. Advance, Lutron, Motorola, Osram Sylvania

E. Emergency Fluorescent Ballasts:
   1. Bodine, Dual-Lite, Exide

F. Magnetic HID Ballasts:
   1. GE, Valmont Electric, Universal Lighting Technologies

G. Electronic HID Ballasts:
   1. Aromat
   2. Other manufacturers shall require preapproval.

H. Low Voltage Transformers:
   1. Q-Tran
   2. Other manufacturers shall require preapproval.

I. Lamps:
   1. General Electric, Osram Sylvania, Philips Lighting, Ushio

J. LEDs:
   1. Lumileds, Cree, Nichia, Philips
   2. Other manufacturers shall require preapproval.

K. LED Driver:
   1. Osram, Advance, Eldoled, Lutron, Lightech, Qtran, Lightwild, Philips
   2. Other manufacturers shall require preapproval.

2.2 FABRICATION AND MANUFACTURER

A. Luminaires:
   1. Construction
      a. Luminaires shall bear label indicating circuit voltage. Labels shall not be visible from normal viewing angles.
b. Luminaires shall be constructed with joints made by means of welded, brazed, screwed, or bolted construction methods.
c. Housings shall be so constructed that all electrical components are accessible and replaceable without removing luminaires from their mountings.
d. Surface temperatures of luminaires with ballasts shall not exceed 90°C in 30°C ambient.
e. Miter cuts shall be accurate, joints shall be flush and without burrs.

2. Lenses, Reflectors and Diffusers
   a. All lenses or louvers shall be removable, but held so that normal motion will not cause them to drop out.
   b. All glass used in incandescent luminaires shall have thermal resistance characteristics equal to "Pyrex" glass.
   c. Optical lenses shall be free from spherical and chromatic aberrations.
   d. Acrylic lenses shall be 100% virgin acrylic material.
   e. Fluorescent troffer lenses shall be 0.125" thick, unless otherwise noted.
   f. Alzak reflectors and louvers shall be low iridescent equivalent to Coil Anodizers. All alzak parabolic cones shall be guaranteed against discoloration for a minimum of ten years.

3. Optics and Adjustments
   a. Lamp sockets shall be suitable for the indicated lamps and shall be set such that lamps are positioned in optically correct relation to all luminaire components.
   b. Spread Lens Luminaire: Luminaires with spread lens shall contain lens orientation locking devices to insure that lens orientation is not disturbed during future lamp replacement or cleaning.
   c. Oval Beam Luminaire: Luminaires with oval shape beam pattern lamps shall contain lamp orientation locking devices to insure that beam orientation is not disturbed during lamp replacement or cleaning.
   d. Adjustable Angle Luminaire: Luminaires with adjustment beam angle shall contain reliable angle locking devices.

4. Finishes
   a. Provide luminaires with finish as shown in the luminaire schedule. Verify final finish requirements before releasing luminaires for fabrication.
   b. Painted luminaires shall be painted after fabrication or "post painted".
   c. Ferrous parts and supports shall be rust proofed after fabrication.

5. Wiring
   a. Luminaires shall be completely wired at the factory.
   b. Internal wiring shall contain no splices.
   c. Connections shall be made with insulated "wire nut" type mechanical connectors.
   d. Wire for connections to lamp sockets and lamp auxiliaries shall be minimum #16 ga luminaire wire.
   e. Luminaires shall be provided with flexible conduit, pigtails, and equipment for external connections.
   f. Incandescent luminaires shall be wired with heat resistant wire.
   g. Provide dual-level switching for luminaires as indicated on luminaire schedule and where shown on Contract Drawings. Typically first switch designation controls outboard lamps, and second switch designation controls inboard lamp(s), unless noted otherwise.
   h. Provide lamps for all luminaires.

6. LED Fixtures:
LED fixtures shall be:
1. IESNA LM-79-08 tested using absolute photometry criteria
2. Rated at ≥ 70% lumen maintenance at 25,000 hours of operation
3. Rapid cycle stress tested
4. Integral lamp shall have a minimum operating temperature of -20°C
5. Have a maximum operating temperature at LED junction to not exceed 80-90°C.
6. RoHS compliant and mercury free
7. LED operating frequency of ± 120 Hz
8. Must meet the appropriate FCC requirements for FCC 47 CFR 15 (consumer use) and/or FCC 47 CFR Part 18 (industrial use)
9. Class A sound rated
10. Supplied with power supply that complies with IEEE C. 62.41-1991
11. Operated at 120 or 277 volts, +/- 10%

b. Manufacturer of LED fixtures shall use an advanced production LED binning process to maintain color consistency.

c. All LED fixtures (100% of each lot) shall undergo a minimum 8-hour burn-in test during manufacturing.

d. Manufacturer shall provide optical performance, polar diagrams, and relevant luminance and illuminance photometric data based on test results from an independent testing lab.

e. The LED fixture shall be operated at constant and carefully regulated current levels. LEDs shall not be overdriven beyond their specified nominal voltage and current.

f. High-power LED fixture shall be thermally protected using one or more of the following thermal management techniques: metal core board, gap pad, and/or internal monitoring firmware.

g. LED fixture housing shall be designed to transfer heat from the LED board to the outside environment.

h. All hardwired connections to LED fixtures shall be reverse polarity protected and provide high-voltage protection in the event connections are reversed or shorted during the installation process.

i. Power/data supply outputs shall have current-limiting protection.

j. Power/data supply shall provide miss-wiring protection.

k. Power/data supply shall have power factor correction.

l. LED system shall have a selectable means of external control via a data network.

m. The LED system shall be controlled by a single, centralized controller.

n. Manufacturer shall have at least 5 years of experience designing, selling, and supporting intelligent LED systems.

7. Outdoor Lighting Systems:

a. Luminaire schedule shows style of outdoor luminaires, pole heights, and basic IESNA distribution patterns.

b. Provide poles as shown on luminaire schedule.
   1. Poles shall have hand-holes.
   2. Fusing for each luminaire head shall be located in hand-hole near base of pole.
   3. Pole base anchor bolts shall be galvanized.

C. Exterior Luminaires:
   1. Shall operate at a minimum ambient temperature of 0°F.
2. Fully gasketed, with UL wet location label
3. Provide approved wire mesh screens for ventilation openings.
4. Anodized aluminum reflectors shall have minimum of 0.02 mm anodizing thickness.

8. All castings and extrusions shall be given minimum one coat of baked-on clear lacquer, unless painted finish is specified.
9. Aluminum surfaces shall receive a duromodic or polyester powder paint finish.
10. Cast-in Luminaire housings installed directly in concrete shall be fabricated of hot dip galvanized steel or cast aluminum or composite.
   a. Where cast aluminum housings are used, give two coats of asphaltum paint prior to installation.
   b. Provide 3 mm thick x 51 mm diameter solid neoprene grommets at each point light luminaire surfaces are mounted to concrete structure.

2.3 BALLASTS

A. Ballasts shall be equipped with line fuses.
   1. Fuses shall be type and size recommended by luminaire manufacturer.

B. Ballasts shall be suitable for operating the indicated lamps.

C. Ballasts for use in cold or freezer rooms, parking structures, loading docks, and outdoors shall be low temperature type.
   1. Ballast shall have lowest temperature rating available in standard manufacture for its type.

D. Ballasts shall be located in luminaire they serve, unless otherwise noted.

E. Electronic Fluorescent Ballasts:
   1. Compact fluorescent lamps, above 13 Watts, use only electronic programmed rapid start ballasts.
   2. Linear fluorescent lamps, T8 and T5 type, shall use programmed rapid start electronic ballasts.
   3. Multi-lamp programmed rapid start ballasts shall be of the series sequence type.
   4. Ballasts shall be:
      a. ETL Certified, CBM and UL Listed, and meet or exceed NEMA and ANSI Standards.
      b. Class P thermally protected
      c. Class A sound rated
      d. Operate lamps as scheduled
      e. Maintain constant light output over entire operating voltage range.
      f. Operate lamps at frequency of 40 kHz or higher with less than 2% flicker.
      g. Meet or exceed EMI and RFI limits set by FCC (Part 18).
      h. Maintain the following performance:
         1). Lamp Current Crest Factor $\leq 1.6$
         2). Total Harmonic Distortion $\leq 20\%$
         3). Third Harmonic Distortion $\leq 10\%$
         4). Power factor $\geq 0.90$
      i. Equipped with a cut-off circuit that senses over-voltage condition to lamp for end-of-life protection.
      j. Ballast case temperature shall not exceed 25°C temperature rise over 40°C ambient.
k. Be equipped with a cut-off circuit that senses an over-voltage condition to lamp for end-of-life protection for all lamps smaller than one inch in diameter (all T2, T4 and T5 lamps).

F. Magnetic High Intensity Discharge (HID) Ballasts:
1. Provide as indicated on Luminaire Schedule, per manufacturer's recommendations and mounting conditions.
2. Ballasts shall be high power factor premium constant wattage type with a minimum power factor of 90%
3. Be for 60 Hz operation.
4. Have thermal protection integral with ballast.
5. Be fused.
6. Be rated at lowest possible sound level for type provided.
7. Meet or exceed NEMA and ANSI Standards.
8. Metal Halide Ballasts shall be Pulse start type when available for said wattage.
9. High-Pressure Sodium (HPS) Ballasts shall be equipped with solid-state igniter/starter having an average life in pulsing mode of 10,000 hours at an igniter/starter case temperature of 90°F.
10. Provide all necessary hardware for remote mounted ballasts.
11. Contractor shall verify that ballasts are appropriate for use with lamp type, voltage, distance between lamp and ballast, and remote mounting conditions.

G. Electronic High Intensity Discharge (HID) Ballasts:
1. Provide as indicated on Luminaire Schedule, per manufacturer's recommendations and mounting conditions.
2. Contractor shall verify that ballasts are appropriate for use with lamp type, voltage, distance between lamp and ballast, and remote mounting conditions.
3. Provide electronic ballasts for Ceramic Metal Halide lamps with the following features:
   a. Integrated electronic ballast, igniter and capacitor
   b. Operating Voltage: Match system voltage, or universal voltage
   c. Power Factor ≥95%
   d. Total Harmonic Distortion ≤15%
   e. Lamp Current Crest Factor ≤1.3
   f. Sound Rating: Class "A"
   g. Equipped with "Turn Off" safety function to prevent excessive ballast pulsing under conditions of failed lamp, no lamp, or other sustained abnormal conditions
   h. Not more than +/- 0.5 percent variation in output power with a +/- 10% variation in input line voltage
   i. Comply with FCC Part 18C for non-consumer limits for EMI and RFI. Ballast shall be UL Listed.

H. LED drivers and power supplies shall be
1. Color changing LED drivers shall be Compatible with DMX
2. Supplied with over-temperature protection circuitry.
3. NEMA enclosure.
4. Equipped with knockouts to accommodate standard conduit sizes
5. UL Class 2 power supply.
6. Power Factor to meet .9 or better
7. Dimmable LED drivers must be compatible with dimming system(s) provide and control fixtures per fixture schedule and controls documentation.

8. ETL certified, CBM and UL Listed, high power factor, and meet or exceed NEMA and ANSI Standards.

9. Rated at lowest available sound level

10. Equipped with resetting thermal sensitive device.

11. For operation at 60 Hz and voltage as scheduled.

12. Meet or exceed all ANSI or NEMA standards

I. LED Data Enablers shall be
   1. Compatible with DMX.
   2. NEMA enclosure.
   3. Equipped with knockouts to accommodate standard conduit sizes.
   5. RoHS compliant.

2.4 TRANSFORMERS

A. Transformers shall be:
   1. Sized to compensate for voltage drop over indicated distances
   2. Locally fused

B. Transformers shall have line voltage switch within reach.

C. Provide adequate ventilation to meet code and manufacturers requirements.

2.5 TANDEM WIRED LUMINAIRE PAIRS

A. Luminaires may be tandem wired in a master/slave configuration to minimize the use of single lamp ballasts or to minimize circuit connection points.

B. Tandem wiring shall consist of a UL Listed wiring system fabricated by the luminaire manufacturer to interconnect ballast wiring from the "master" luminaire to the unballasted "slave" luminaire.

C. Wiring shall be:
   1. 12 AWG ga minimum
   2. Enclosed in 3/8" diameter flexible metallic conduit.

D. Tandem wiring shall not be used for luminaires spaced greater than 10 ft apart (on center).

E. Support conduit with nylon tie wraps or metal clips.

2.6 LAMPS

A. Provide lamps as noted on Luminaire Schedule.

B. Provide lamps of same type from same manufacturer.

C. Where a specific lamp manufacturer has been indicated in the Luminaire Schedule, lamps shall be supplied from named manufacturer only.

D. Linear fluorescent lamps shall be:
1. Rapid start
2. Triphosphor
3. Minimum CRI of 80
4. Color temperature as noted on Luminaire Schedule

E. Compact fluorescent lamps shall be:
   1. Triphosphor
   2. Four pin
   3. Minimum CRI of 80
   4. Color temperature as noted on Luminaire Schedule

F. Metal halide lamps 100 watts or lower, shall be:
   1. Ceramic metal halide
   2. Minimum CRI of 80
   3. Color temperature as noted on Luminaire Schedule
   4. Color temperature shall not vary more than 200 Kelvin over rated lamp life.

G. Metal Halide lamps 150 watts or higher, shall be:
   1. Metal halide lamps
   2. Minimum CRI of 70
   3. Color temperature as noted on Luminaire Schedule
   4. Provide pulse-arc lamps when available.

H. Metal Halide Lamps shall have extinguishing mechanisms to terminate operation in event outer globe of lamp is broken, punctured, or missing.

I. White LED lamps shall be:
   1. IESNA LM-80-08 tested
   2. Have a life expectancy of 70% output at 50,000 hours
   3. Meet ANSI C78.377-2008 consistent with 7 step chromaticity quadrangles and DUV tolerances. The change of chromaticity over the minimum lumen maintenance test period shall be within 0.007 on the CIE 1976 (u',v') diagram.
   4. Minimum CRI of 75
   5. Binned to meet color consistency, as described above
   6. Must have lam base listed by ANSI C81.61-2007
   7. Warranted for 3 years for material repair or replacement
   8. Packaged to clearly state any known incompatibility with photo controls, occupancy sensors, or dimming devices

J. RGB LEDs shall be:
   1. Compatible with DMX controls

K. Provide all other lamp types and special purpose lamps as noted on Luminaire Schedule.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Marking:
   1. Voltage identification: Luminaires designed for voltages other than 110-125 volt circuits shall be clearly marked with rated voltage.
   2. Lamp/ballast coordination: Luminaires equipped with ballast for operation of rapid start lamps shall be plainly marked "Use Rapid Start Lamps Only". Similarly, luminaires equipped with ballasts or other components requiring use of specific types of lamps shall be plainly marked. 
   3. Markings must be clear and shall be located to be readily visible to service personnel but invisible from normal viewing angles when lamps are in place.

B. Installation of Luminaires:
   1. Lamps, glassware, reflectors and refractors shall be clean and free of chips, cracks and scratches.
   2. Install decorative luminaires, reflector cones, baffles, aperture plates, lenses, trims, and decorative elements of recessed luminaires after completion of ceiling tile, plastering, painting, and general cleanup is completed. Where luminaire location or construction does not permit sequential installation, all reflectors, lenses, flanges and other visible surfaces shall be carefully protected.
   3. Locations
      a. Install luminaires at locations and heights as indicated.
      b. Do not scale electrical drawings for locations of luminaires.
      c. Mount all luminaires so as to maintain full range of motion.
   4. Conduit and Wiring
      a. Wire for connections to lamp sockets and auxiliaries shall be suitable for temperature, current, and voltage conditions.
   5. Cast-in Luminaires:
      a. Where installed in tree grates, furnish burial light lens and louver to tree grate manufacturer for coordination of opening.
      b. Provide adequate drainage system per manufacturer's recommendations.

C. Installation of Outdoor Pole Bases
   1. General Contractor shall provide bases for luminaires.
   2. Electrical Contractor shall:
      a. Rough-in conduits
      b. Furnish information to General Contractor for spacing, base dimensions, heights, orientation of bases, etc.
   3. Where square or rectangular poles or luminaire heads are used, Contractor shall verify orientation with Architect.

D. Pole Installation:
   1. Install luminaires, poles, hardware, etc., for complete system.
   2. Use web fabric slings (not chain or cable) to raise and set poles.

E. Lamps:
   1. Provide new lamps delivered in original manufacturer's cartons.
2. Fluorescent and metal halide lamps shall be energized continuously for not less than 100 hours for proper seasoning.

F. Grounding:
   1. Ground luminaires and metal poles according to Division 26 Section "Grounding and Bonding for Electrical Systems".
   2. Poles:
      a. Install 10 ft driven ground rod at each pole.
   3. Nonmetallic Poles:
      a. Ground metallic components of lighting unit and foundations. Connect luminaires to grounding system with No. 10 AWG conductor.

3.2 SUBSTANTIAL COMPLETION

A. Quality Control:
   1. At Date of Substantial Completion, replace lamps which are not operating properly.
   2. Replace any lamps used as worklights during construction phase.
   3. Protection wrapping on louvered (parabolic) luminaires shall be removed before installation of furniture, but after finish work is complete.
   4. Deliver spare lamps to Owner's representative.

B. Tests:
   1. Give advance notice of dates and times for field tests.
   2. Provide instruments to make and record test results.
   3. Verify normal operation of each luminaire after luminaires have been installed and circuits have been energized.
   4. Replace or repair malfunctioning luminaires and components, then retest. Repeat procedure until all units operate properly.
   5. Report results of tests.

C. Adjusting and Cleaning:
   1. Clean luminaires of handling marks, dust and dirt.
   2. Cleaning and touch-up work shall be performed in accordance with luminaire manufacturer's recommendations.
   3. Damaged luminaires or components shall be replaced with new.
   5. Verify orientation of directional luminaires prior to installation.
      a. This includes wall washers, cove lighting, floodlights, exterior area lights and adjustable accent luminaires. Contractor shall provide electrician's services to aim, adjust, and focus luminaires, as required, at the direction of Architect/Engineer. These electricians shall be available at times designated by the Architect/Engineer and shall be provided at no extra charge to the Owner over base bid. Contractor shall provide equipment for luminaries' focus including ladders and mechanical lifting systems.
   6. Program preset dimming system lighting levels.
   7. Exterior poles, bollards, bases and other exterior luminaires shall be painted to match factory color where finish has been damaged.
   8. No light leaks shall be permitted at the ceiling line from any visible part or joint.

D. Training
1. Contractor shall provide qualified personnel onsite to provide a minimum of three days of training to Owner's representatives.

2. This training shall cover:
   a. Luminaire use and maintenance
   b. Architectural lighting system use and maintenance
   c. Group relamping cycles

END OF SECTION 26 51 00
Be memorable. Special effects are no longer just for the stage. Everyday life has become the staging ground for entertainment experiences. It is not enough to engineer a space or structure functionally. The art and wonder of interactive lighting, automation, audio and visual spectacle, kinetic-art displays, water effects, and more are captivating people’s attention — differentiating a venue, creating a landmark, making a truly memorable event.

But how? Unison® Mosaic. You need a control solution that can merge disparate elements — show control, LEDs, moving lights, media effects, and more into one visionary work — seamlessly closing the distance between architectural and entertainment technology.

ETC’s Unison Mosaic Show Control System assembles the pieces you need, giving you the freedom to focus on creativity not technology. Mosaic provides state-of-the-art software and hardware tools. Easy to learn and use, Mosaic Designer Software™ provides the canvas for your artistic design, from conception through programming and execution. Mosaic Show Controllers® (MSCs) are the ultra-compact hardware solution, running your shows reliably, with peace-of-mind precision. And the MSCs’ wide range of inputs and outputs include industry-standard network protocols to facilitate system integration as needed.

For retail, museum, and themed spaces, art installations and special events — any unique environment — Mosaic control is the solution.

Refer to Luminaire Schedule for manufacturer’s catalog ordering code, required lamping, finishes, modifications and/or required accessories.
UNISON® MOSAIC™ DESIGNER SOFTWARE™

Freedom to focus on creativity not technology. Unison Mosaic Designer Software provides the framework for creating your unique work of art. Everything you need is here: from importing project plans for system layout, to positioning lighting fixtures and other devices in the plan, to editing triggers and timelines, picking specific colors, programming special effects, mapping pixels to an array, playing back video clips, visualizing the results, and uploading your show.

Before, your only option was to program your show on a lighting control console and capture it on a playback device. That is a limited way to control lighting and other effects — it can only reproduce its output as programmed, with no opportunity for interaction.

With Mosaic — you don’t need a console. You already have one — inside the Designer Software. You directly create a real show in real time using your Mac or PC. Even after uploading the show, you have all the features you’d need to influence and modify your design to be interactive with the outside world.
UNISON® MOSAIC™
DESIGNER SOFTWARE™

Each of your projects is unique — seemingly ‘one off.’ Wouldn’t you like to turn to one software solution, time and time again, for all your projects — without needing a computer science degree? Unison Mosaic Designer Software melds the capabilities of a lighting control console, the flexibility of a media server, and the precision of a PLC to empower you to achieve your artistic visions — on time and on budget.

Mosaic Designer Software guides you through your projects with a trove of tools at each step.

**DesignView** allows you to import images to form the basis of your lighting design so that fixtures and other elements reflect your project team’s architectural plans.

**FixtureManager**’s deep library of multi-attribute fixtures gives you drag-and-drop access to your LEDs, moving lights, and other devices — including those from different manufacturers. Designer even has a dedicated interface for pan/tilt and beam control of moving lights.

Create an infinite mosaic of show looks with Designer’s **TimeSlice.** Program each element of your design using visual, timeline-based blocks. Use **ColorPick,** Designer’s powerful color selector to change intensity and hue, which are then displayed on the timeline itself. **EasyFX** brings out the artistry of your design with a comprehensive range of customizable special effects. Moving lights have their own dedicated programming interface to avoid complicating the primary intensity and color controls. And you can place fixture and design elements on the same timeline for seamless coordination across the entire show.

**Chart new territory.** Designer’s **PixelMap** goes way beyond traditional lighting effects allowing you to define a group of fixtures as a virtual screen and then playback static or video images on it. Use this as true video playback across an LED array or to generate dynamic and fluid color effects across large numbers of LEDs and other fixtures. The Mosaic Show Control system replaces separate lighting control and video pixel-mapping systems that would be required otherwise.

**TriggerManager** links your presentation to the outside world by allowing specific TimeSlices to be linked to either external inputs or real-time events (including ‘sunrise’ and ‘sunset’). You can also place conditions on triggers so that an event will only occur if a series of requirements are met. **ControlView** transforms your design elements into a simulation environment for viewing your project before installation — including the ability to test triggers and show-programming. With **LiveControl,** if Mosaic Controllers are connected during simulation you can output the show directly to the fixtures themselves. The Mosaic **RealEngine** ensures an accurate representation of your show — whether in software simulation or when played live via the hardware.

Refer to Luminaire Schedule for manufacturer’s catalog ordering code, required lamping, finishes, modifications and/or required accessories.
ETC®  Unison® Mosaic® Tessera Panel Controller

GENERAL INFORMATION

The Unison Mosaic Tessera Panel Controllers (MTPCs) are the permanent part of your installation. The Mosaic Tessera Controller provides a touchscreen user-interface with up to 512 channels of DMX-Over-Ethernet (and other Ethernet based protocols) to control color-mixing fixtures, conventional dimmable fixtures and automated lights.

The built-in real-time clock triggers precise timed events, including 'sunrise' and 'sunset' astronomical cues. Each MTPC supports onboard triggering over Ethernet and user input at the touchscreen. Additional channels and triggering interfaces are supported by optional MSC controllers and Remote Devices attached over an Ethernet network.

APPLICATIONS

- LED Lighting Control
- Pixel mapping
- Show Control and Lighting Integration

FEATURES

- Integrated Show Control and User Interface
- Programmed and Configured using Mosaic Designer Software
- Configurable user-interface using Mosaic Touch Editor Software
- RealEngine – ensures an accurate representation of your show – whether in software simulation or when played live to connected controllers
- LiveControl – Live output of your Mosaic show file to connected Mosaic Controllers and fixtures during simulation
- DesignerAccess – Internal Web server with active pages providing status, configuration information, remote monitoring, and remote show uploads
- QuickChange – Show data is stored on a removable flash memory card, which can be transferred to another MTPC if required

GENERAL

- ETL/cETL Listed
- CE Compliant

ORDERING INFORMATION

Unison Mosaic Show Controllers

<table>
<thead>
<tr>
<th>MODEL</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTPC</td>
<td>Unison Mosaic Tessera Panel Controller</td>
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Compatible Unison Mosaic Show Controllers

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<tr>
<th>MODEL</th>
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<tbody>
<tr>
<td>MSC1</td>
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<td>MSC2</td>
<td>Unison Mosaic 1024 Channel Show Controller</td>
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<tr>
<td>MSC4</td>
<td>Unison Mosaic 2048 Channel Show Controller</td>
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<tr>
<td>MSCX</td>
<td>Unison Mosaic High Capacity Show Controller</td>
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Unison Mosaic Remote Devices and Accessories

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<tr>
<td>MROI-A</td>
<td>Mosaic Remote Audio/Timecode Device</td>
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<tr>
<td>MROI-D</td>
<td>Mosaic Remote DALI</td>
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<tr>
<td>MROI80</td>
<td>Mosaic Remote I/O Device with 8 Inputs</td>
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<tr>
<td>MROI44</td>
<td>Mosaic Remote I/O Device with 4 In and 4 Out</td>
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<tr>
<td>MROI08</td>
<td>Mosaic Remote I/O Device with 8 Outputs</td>
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<tr>
<td>MSC-NET</td>
<td>5-port Ethernet Switch w/ PoE</td>
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Unison Mosaic Button Stations

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<tr>
<th>MODEL</th>
<th>DESCRIPTION</th>
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<tbody>
<tr>
<td>M108-__</td>
<td>1-gang, 8-Button Station</td>
</tr>
</tbody>
</table>

Enter station color code in __ space provided:
-6 = Natural bezel with black overlay
-7 = Acrylic bezel with customizable overlay

Refer to Luminaire Schedule for manufacturer’s catalog ordering code, required lamping, finishes, modifications and/or required accessories.
Unison® Mosaic® Tessera Panel Controller

Unison Control Series

SPECIFICATIONS

GENERAL
- Touchscreen controller with user customizable interface
- 4.3” capacitive touch display
- 480 x 272 resolution, 24-bit color
- 512 channel Ethernet based control output
- Support for sACN, KNet, Pathport, or Art-Net output
- Integrated real and astronomical time clock
- Triggering and show control integration using Remote Devices and MSC controllers connected over an Ethernet network
- Integrated web server for remote management
- Programmed and configured using Unison Mosaic Designer Software
- User Interface configured using Mosaic Touch Editor Software
- Simple integration with other Mosaic devices for large systems including MSC X and Audio Video Controller (AVC)
- Solid State, high reliability components

FUNCTIONAL
- Scalable up to 40 Mosaic Show Controllers or Mosaic Tessera Panel controllers using standard Ethernet networking
- Project data stored in non-volatile, solid-state memory
- Resumes output automatically upon receiving power
- Supports conditional logic and scripting for powerful integration
- Software and configuration upload using Ethernet
- Integrated web server provides with active monitoring and remote triggering using Ethernet
- Remote management and upload of configuration using RemoteManager software application

MECHANICAL
- Flush or surface mount using provided backbox
- No visible means of attachment
- Metal faceplate with magnetic overlay
- Integrated learning IR receiver compatible with 3rd party remotes
- Integrated light, proximity and temperature sensors support system-wide feedback
- Removable SD memory card for configuration and data storage
- All connections use standard pluggable connectors

ELECTRICAL
- PoE power input (IEEE 802.3af), 4 watt consumption
- 10/100Base-TX Ethernet using RJ45 connection
- ETL and cETL Listed, CE compliant

THERMAL
- Ambient temperature: 0-50°C / 32-122°F

PHYSICAL

Unison Mosaic Show Controller Dimensions*

<table>
<thead>
<tr>
<th>MODEL</th>
<th>HEIGHT</th>
<th>WIDTH</th>
<th>DEPTH</th>
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<td>MTPC</td>
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Unison Mosaic Show Controller Weights*

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*Weights and dimensions typical
Refer to Luminaire Schedule for manufacturer’s catalog ordering code, required lamping, finishes, modifications and/or required accessories.
Refer to Luminaire Schedule for manufacturer's catalog ordering code, required lamping, finishes, modifications and/or required accessories.
Refer to Luminaire Schedule for manufacturer's catalog ordering code, required lamping, finishes, modifications and/or required accessories.
UW Montlake Triangle
10879-01
Conformed Set

Type: XH1
03-20-2012

Refer to Luminaire Schedule for manufacturer’s catalog ordering code, required lamping, finishes, modifications and/or required accessories.

All of the top and intermediate elements turn with the assistance of an inner mechanism through 360° on their vertical axes to provide the required adjustment.
Refer to Luminaire Schedule for manufacturer’s catalog ordering code, required lamping, finishes, modifications and/or required accessories.
CITY ELEMENTS 230: Illuminating Column

City Elements 230 offers design professionals the flexibility of a multi-purpose lighting system in a single architectural structure. The modularity of the light column system allows each column to be customized for area lighting, accenting, waymarking, or pathway illumination or a combination of several different functions. Modules are fully rotatable and adjustable internally for highlighting and aiming. Heights range from low-level bollards to columns up to thirty feet tall. Base elements are available in flanged or flangeless models. Optional modules are also available to accommodate security cameras or convenience outlets with in-use covers for remote power. Luminaire housings and extruded aluminum shaft with flush handhole are finished in finely textured paint. All hardware is stainless steel. Consult on-line Configurator at www.hessamerica.com for detailed technical specifications and information on CE200 and CE180 for smaller diameter columns. CSA Certified for Wet Locations.

<table>
<thead>
<tr>
<th>Top Elements</th>
<th>Optics / Symmetric</th>
<th>Lamp</th>
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<tbody>
<tr>
<td>CE230-ARR900</td>
<td>Symmetric / Asymmetric</td>
<td>150 MH / 70 MH / 39 MH / 140 COS / 90 COS / 60 COS / LED</td>
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<tr>
<td>CE230-ARR900</td>
<td>Asymmetric</td>
<td>150 MH / 70 MH / 39 MH / 140 COS / 90 COS / 60 COS / LED</td>
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<tr>
<td>CE230-ARR900</td>
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<td>BS300-13.5</td>
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<tr>
<th>Base Elements</th>
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<tr>
<td>CR01-Si</td>
<td>Internal flange with soil insert</td>
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<tr>
<td>CR02-AB</td>
<td>External flange with anchor bolts and base cover</td>
</tr>
<tr>
<td>CR02-Si</td>
<td>External flange with soil insert</td>
</tr>
</tbody>
</table>

Refer to Luminaire Schedule for manufacturer's catalog ordering code, required lamping, finishes, modifications and/or required accessories.
Refer to Luminaire Schedule for manufacturer’s catalog ordering code, required lamping, finishes, modifications and/or required accessories.
ILUMIPOD™ 18 IP
OPTIC 30 RGB & OPTIC 15 RGB
OPTIC 30 RGB GRAY: 11018004
OPTIC 15 RGB GRAY: 11018001

1. 316 Stainless Steel Screws for Corrosive Environments
2. Integrated Cooling Enhancement™
3. 18 1 Watt LEDs With RGB Technology
4. UV Resistant Gray Powder Coat
5. Heavy Duty Installation Stand
6. IP67 Rated
7. 100-240V, 50/60Hz Auto Ranging Integral Driver
8. DMX Control with 1, 3, 4 or 7 Channels
9. Humidity Controlling Gore Valve

Refer to Luminaire Schedule for manufacturer’s catalog ordering code, required lamping, finishes, modifications and/or required accessories.
Refer to Luminaire Schedule for manufacturer’s catalog ordering code, required lamping, finishes, modifications and/or required accessories.
Refer to Luminaire Schedule for manufacturer’s catalog ordering code, required lamping, finishes, modifications and/or required accessories.

The maximum recommended length of an entire DMX run is 1000’. Longer runs can be achieved using a DMX repeater. The maximum number of devices on a DMX network is 32. Install a DMX terminator at the end of the DMX run. Each Ilumipod 18 IP draws a maximum of 30W.

This fixture requires the Ilumicode remote addresser to change the starting address, change the personality, change the dimming curve, or to set the fixture to operate on a static program. This fixture can project a static scene in the absence of a DMX controller.
Modern architecture often integrates curvilinear, rectilinear, classical, and neoclassical styles into a single structure. The eclectic shape of The Archetype readily adapts to and universally complements contemporary architectural design. Lighting performance, materials, robust construction, and the latest technology combine to make The Archetype the state-of-the-art luminaire for outdoor cutoff lighting. The AR (Large Archetype) is available in HID lamp modes up to 400 watts and Induction Fluorescent lamp modes in 85 and 165 watts. The SAR (Small Archetype) has been scaled to complement the larger model at lower mounting heights. Available up to 175 watts in HID and 55 watts in Induction Fluorescent, the smaller model is ideal for pathways and courtyards where fixtures are nearer human scale. When used together, the large and small Archetype provide a logical transition from parking lot to building entrance by decreasing luminaire scale and maintaining a consistent design.

archetype (är’kē tıp’)
1: an original pattern or model of which other things are copies.
2: first molded as a pattern, exemplary.
Design Logic

Architectural Relevance
Architecture controls the design of an architectural luminaire. Today’s architecture is eclectic, combining square, round and neoclassic shapes into a single structure. The Archetype® is designed to reflect eclectic form and outwardly express function. This variety and purpose has been beautifully sculptured into a unified luminaire design that makes a strong statement of both aesthetics and engineering.

The Archetype’s slanted nose, undercut ballast compartment and oval arm combine to balance its directional nature and form.

Round poles provide the optimum complementary shape to the Archetype.

The Archetype’s directional form is further influenced by its optics. A downward and outward light throw is expressed by corresponding fixture shape.

The Archetype’s eclectic form is evident in these three views. From the side, its function is clearly stated. The bottom view is rectilinear while the section is a simple half cylinder. All elements combine to create a unified sculptural form that will integrate with virtually any architectural environment.

Front View

Side View

Bottom View

Refer to Luminaire Schedule for manufacturer’s catalog ordering code, required lamping, finishes, modifications and/or required accessories.
Specifications

70 to 150 watt
Medium Base
Maximum Fixture weight (150HPS) = 25 lb

Housing: One-piece die-cast, low copper (<0.6% Cu) aluminum alloy with integral cooling ribs over the optical chamber and electrical compartment. Solid barrier wall separates optical and electrical compartments. Double-thick wall with gussets on the support-arm mounting end. The fixture's housing forms a half cylinder with 58° front face plane providing a recess to allow a flush single-latch detail. All hardware is stainless steel or electro-zinc plated steel.

Lens Frame: One-piece die-cast, low copper (<0.6% Cu) aluminum alloy lens frame with 1” minimum depth around the gasket flange. Integral hinges with stainless steel pins provide no-tool mounting and removal from housing. Single die-cast aluminum am-latch provides positive locking and sealing of the optical chamber by a one piece extruded and vulcanized silicone gasket. Clear ¾” thick tempered glass lens retained by eight steel clips with full silicone gasketing around the perimeter.

Reflector Module: Specular Alzak® optical segments are rigidly mounted within a die-cast aluminum enclosure that attaches to the housing as a one-piece module. Reflector module is field rotatable in 90° increments. PMH and HPS sockets are porcelain 4KV pulse rated medium base. All reflector modules are factory prewired with quick-disconnect plug and include silicone seal at the penetration of the internal barrier wall in the luminaire housing.

Electrical Module: All electrical components are UL and CSA recognized, mounted on a single plate and factory prewired with quick-disconnect plugs. Electrical module attaches to housing with no-tool hinges and latches, accessible by opening the lens frame only. All ballasts are high power factor rated -20°F starting.

Support Arm: One-piece extruded aluminum with internal bolt guides and fully radiussed top and bottom. Luminaire-to-pole attachment is by internal draw bolts, and includes a pole reinforcing plate with wire strain relief. Arm is circular cut for specified round pole.

Optional Wall Mounting: Fixture mounts to 3” or 4” junction boxes by a cast aluminum adapter plate with fixture mounting bolts.

Finish: Super TGIC thermoset polyester powder coat paint, 2.5 mil nominal thickness, applied over a titanated zirconium conversion coating. 2500 hour salt spray test endurance rating. Standard colors are Black, Dark Bronze, Light Gray, Stealth Gray®, Platinum Silver, or White. Custom colors are available.

CAUTION: Fixtures must be grounded in accordance with local codes or the National Electrical Code. Failure to do so may result in serious personal injury.

Listings and Ratings

<table>
<thead>
<tr>
<th>UL cUL 1598®</th>
<th>CE</th>
<th>IP66 Rated</th>
<th>2SC Ambient</th>
</tr>
</thead>
</table>

*Suitable for wet locations.

KIM LIGHTING RESERVES THE RIGHT TO CHANGE SPECIFICATIONS WITHOUT NOTICE.

Refer to Luminaire Schedule for manufacturer’s catalog ordering code, required lamping, finishes, modifications and/or required accessories.
Standard Features

Mounting
3SY configuration is available for round poles only.

Plan View:

Wall Mount

EPA: 0.7 1.4 1.2 1.9 1.9 2.5
Cat. No.: 1SA 2SB 2SL 3ST 3SY 4SC 1W

Fixture
Cat. No. designates fixture and light distribution.
See the Kim Site/Roadway Optical Systems Catalog for detailed information on reflector design and application.

Light Distribution:
Type I Type II Type III Type IV Type V
Forward Throw Square Full Cutoff Full Cutoff Full Cutoff Full Cutoff

Cat. No.: SAR1 SAR2 SAR3 SAR4 SAR5

Electrical Module
HPS = High Pressure Sodium
PMH = Pulse Start Metal Halide

Cat. Nos. for Electrical Modules available:

Lamp Type: ED-17, Clear
Socket Type: Medium Base
ANSI Ballast Type: S-62, S-54, S-55

Probe Start Metal Halide
Lamp Type: ED-17, Clear
Socket Type: Medium Base
ANSI Ballast Type: M-98, M-90, M-102

(Visit www.aboutlightingcontrols.org or the Library of Congress website for more details).

Finish
Super TGIC powder coat paint over a titanated zirconium conversion coating.

Color: Black Dark Bronze Light Gray Stealth Gray® Platinum Silver White Custom Color®
Cat. No.: BL DB LG SG PS WH CC

*Custom colors subject to additional charges, minimum quantities and extended lead times. Consult representative. Custom color description:

Refer to Luminaire Schedule for manufacturer’s catalog ordering code, required lamping, finishes, modifications and/or required accessories.
Optional Features

Wall Mounting
Cat. No. □ 1W □ No Option
Select from Mounting on page 2.

Fixture mounts to 3” or 4” junction boxes by a cast aluminum adapter plate with fixture mounting bolts. 

**NOTE:** Junction box in wall must provide adequate fixture support. See NEC sections 370-13, 17 and 410-14, 16. Quick-disconnect plug and wiring are provided to allow field connections prior to fixture mounting.

Photocell Control
Cat. No. (See right) □ No Option

Fixture supplied with an internal photocell with the sensor on the fixture end facing the pole. For multiple-fixture pole mountings, one fixture has a photocell to operate the others. Not available if wall mounted (1W).

- **Cat. No.**
  - A-30 120V
  - A-31 208V
  - A-32 240V
  - A-33 277V
  - A-35 347V
  - A-34 480V

- **Line Volts:**
  - 120V
  - 208V
  - 240V
  - 277V
  - 347V
  - 480V

Mounting Configuration:
- **S** – Fixture with Photocell Sensor
- **S** – slave unit(s)

No fixture wattage limit.

Convex Glass Lens
Cat. No. □ CGL □ No Option

The 3/8” thick clear convex tempered glass lens replaces the standard flat glass lens. Provides increased lens presence and provides a subtle improvement in uniformity where pole spacing is extreme. Increases effectiveness of houseside shielding.

Polycarbonate Lens
Cat. No. □ LS □ No Option

Fixture supplied with a one piece vacuum formed, clear, UV stabilized convex polycarbonate, fully gasketed, replacing the standard tempered glass lens.

**CAUTION:** Use only when vandalism is anticipated to be high. Useful life is limited by UV discoloration from sunlight and metal halide lamps.

Quartz Standby
Cat. No. □ QS □ No Option

Integral electronic device energizes a T-4 mini-can socket during initial lamp start-up or after a power interruption. De-energizes prior to HID lamp reaching full brightness. T-4 halogen lamp by others; 100 watt maximum.
**Optional Features**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
<th>Cat. No.</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Houseside Shield</strong></td>
<td><em>(Types II, III, and IV only)</em> Fixtures with the standard flat glass lens are available with stamped aluminum louvers that pass streetside light and block houseside light, and a blackened panel added to the reflector to reduce houseside reflections. Fixtures with the optional convex glass lens are available with a formed aluminum shield that passes streetside light and blocks houseside light, and a black anodized panel added to the reflector to reduce houseside reflections. Use with clear lamps only, as coated lamps reduce effectiveness.</td>
<td>HS</td>
<td>Recommended for use with clear lamps only. Effectiveness is reduced for coated lamps. Not for use with Type V light distributions.</td>
</tr>
<tr>
<td><strong>Neighbor Friendly Shield</strong></td>
<td><em>(Type IV only)</em> Stamped internal shield and blocking panels are used to direct and redirect lighting into a forward throw distribution. The amount of light directed and redirected toward the back of the liminaire is dramatically reduced to create extremely low glare behind the pole. Only available on the Type IV reflectors.</td>
<td>NFS</td>
<td>For use with all fixtures with convex glass lens. Not for use with Type V light distributions.</td>
</tr>
<tr>
<td><strong>Tamper-Resistant Latch</strong></td>
<td>Standard die-cast latch is provided with a captive 10-32 stainless steel flat socket-head screw to prevent unauthorized opening. <strong>NOTE:</strong> Required only for vandal protection in locations where fixtures can be reached by unauthorized persons.</td>
<td>TL</td>
<td></td>
</tr>
<tr>
<td><strong>Horizontal Slipfitter Mount</strong></td>
<td>Replaces standard mounting arm with a slipfitter which allows fixture to be mounted to a horizontal pole davit-arm with 2&quot; pipe-size mounting end (2 3/4&quot; O.D.). Cast aluminum slipfitter with set screw anti-rotation lock. Bolts to housing from inside the electrical compartment using mounting holes for the standard support arm. Davit-arm must be field drilled at a set screw location to insure against fixture rotation. Finished to match fixture and arm.</td>
<td>HSF</td>
<td>Davit-arm with 2” pipe-size fixture mount (by others)</td>
</tr>
<tr>
<td><strong>Special Options for Street Lighting</strong></td>
<td><strong>Air Filter (AF):</strong> Allows for ventilation through the optical chamber, filtering all air particles above 500 microns. Assembly mounted on solid wall between optical compartment and latch cavity.</td>
<td>AF</td>
<td></td>
</tr>
</tbody>
</table>
Optional Features

**Vertical Slipfitter Mounts**
Cat. No. includes Mounting

(See right) □ No Option

- Allows fixture with standard support arm to be mounted to poles having a 2” pipe-size tenon (2½” O.D. x 4½” min. length). All mounting configurations can be used (1SA, 2SB, 2SL, 3ST, 3SY, 4SC). 4” square or round die-cast aluminum with flush cap, secured by four ⅜” stainless steel set point allen screws, finished to match fixture and arm.

**NOTE:** 3SY only available on round slipfitter.

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Mounting Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>VSF-1SA</td>
<td>1SA - single arm mount</td>
</tr>
<tr>
<td>VSF-2SB</td>
<td>2SB - 2 at 180°</td>
</tr>
<tr>
<td>VSF-2SL</td>
<td>2SL - 2 at 90°</td>
</tr>
<tr>
<td>VSF-3ST</td>
<td>3ST - 3 at 90°</td>
</tr>
<tr>
<td>VSF-3SY</td>
<td>3SY - 3 at 120°</td>
</tr>
<tr>
<td>VSF-4SC</td>
<td>4SC - 4 at 90°</td>
</tr>
</tbody>
</table>

© 2011 KIM LIGHTING INC. • P.O. BOX 60080, CITY OF INDUSTRY, CA 91716-0080 • TEL: 626/968-5666 • FAX: 626/369-2695 5600511091
Refer to Luminaire Schedule for manufacturer’s catalog ordering code, required lamping, finishes, modifications and/or required accessories.
Mounting detail for rail mounted fixture shown for reference only. See landscape rail details for mounting.

Refer to Luminaire Schedule for manufacturer’s catalog ordering code, required lamping, finishes, modifications and/or required accessories.
The Archetype® LED

The eclectic shape of The Archetype LED readily adapts to and universally complements contemporary architectural design. Lighting performance, materials, innovative construction, and the latest solid state lighting technology combine to make The Archetype LED the state-of-the-art outdoor lighting luminaire for a broad range of applications. The Archetype LED comes in two sizes and is available for pole and wall mount configurations.

This is LED site lighting perfection. This is Kim Lighting.
Refer to Luminaire Schedule for manufacturer’s catalog ordering code, required lamping, finishes, modifications and/or required accessories.
The Archetype LED luminaires employ dual heat management methods to mitigate the heat produced by the LED diode. This heat management is achieved through both conduction and convection, ensuring that heat is dissipated into the surrounding environment.

**Automatic Thermal Self-Monitoring and Adjustment**

Each EmitterDeck incorporates two temperature sensors located at the hottest locations of the backside of the deck. These sensors send temperature readings every 30 seconds to the LifeShield Protection System. In extreme conditions, LifeShield detects overheating and automatically reduces the current to the system to preserve diode life. Lumen output is restored to full capacity once the temperature is stabilized to acceptable levels. The LifeShield Protection System provides consistent performance with minimal output reduction in extreme and fluctuating environmental conditions. See page 9 for further details.

Refer to Luminaire Schedule for manufacturer's catalog ordering code, required lamping, finishes, modifications and/or required accessories.
**Specifications**

**SAR-LED**
60 Light Emitting Diodes
Total System Watts = 73W
Maximum Weight = 30 lbs.

**Housing:** One-piece die-cast, low copper (<0.6% Cu) aluminum alloy with integral cooling ribs over the optical chamber and electrical compartment. Solid barrier wall separates optical and electrical compartments. Double-thick wall with gaskets on the support-arm mounting end. Housing forms a half cylinder with 55° front face plane providing a recess to allow a flush single-latch detail. All hardware is stainless steel or electro-zinc plated steel.

**Lens Frame:** One-piece die-cast, low copper (<0.6% Cu) aluminum alloy lens frame with 1” minimum depth around the gasket flange. Integral hinges with stainless steel pins provide no-tool mounting and removal from housing. Single die-cast aluminum cam-latch provides positive locking and sealing of the optical chamber by a one-piece extruded and vulcanized silicone gasket. Clear 5/8” thick tempered glass lens retained by eight steel clips with full silicone gasketing around the perimeter.

**Electronic Module:** All electrical components are UL and CSA recognized, mounted on a single plate and factory prewired with quick-disconnect plugs. Module includes a driver, thermal control device and surge protector. Electrical module attaches to housing with no-tool hinges and latches, accessible by opening the lens frame only. Driver is rated for -40°F starting and has a 0-10V dimming interface for multi-level illumination options.

**Optical Module:** Precision, replaceable MicroEmitters are positioned to achieve directional control toward desired task. The entire EmitterDeck fastens to the housing as a one-piece module.

**Support Arm:** One-piece extruded aluminum with internal bolt guides and fully radiussed top and bottom. Luminaire-to-pole attachment is by internal draw bolts, and includes a pole reinforcing plate with wire strain relief. Arm is circular cut for specified round pole.

**Optional Wall Mounting:** Fixture mounted to poured concrete walls only. A modified support arm is provided with side access to allow field splices within the arm. A wall embedment bracket is provided to accept draw bolts, and a trim plate covers the wall-embedded junction box. All wall mount components are finished to match the fixture.

**Finish:** Super TGIC thermoset polyester powder coat paint, 2.5 mil nominal thickness, applied over a titanated zirconium conversion coating; 2500 hour salt spray test endurance rating. Standard colors are Black, Dark Bronze, Light Gray, Stealth Gray® Platinum Silver, or White. Custom colors are available.

**Warranty:** Kim Lighting warrants The Archetype LED products ("Products") sold by Kim Lighting to be free from defects in material and workmanship for (i) a period of five (5) years for metal parts, (ii) a period of ten (10) years for exterior housing paint finish, (iii) a period of six (6) years for LED Light Engines (MicroEmitters) and, (iv) a period of five (5) years for LED power components (LED Driver, LifeShield™ device, Surge Protector), from the date of sale of such goods to the buyer as specified in Kim Lighting shipment documents for each product.

**CAUTION:** Fixtures must be grounded in accordance with national, state and/or local electrical codes. Failure to do so may result in serious personal injury.

**Listings and Ratings**

<table>
<thead>
<tr>
<th></th>
<th>ETL to UL 1598® Standards</th>
<th>CE</th>
<th>25 C Ambient</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>*Suitable for wet locations. Kim Lighting reserves the right to change specifications without notice.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Refer to Luminaire Schedule for manufacturer’s catalog ordering code, required lamping, finishes, modifications and/or required accessories.*

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**Patent Pending**

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**SAR**

**The Archetype® - Small, Electronic-LED**  
revised 6/9/11 • kim_sarled_spec.pdf

---

**Standard Features**

<table>
<thead>
<tr>
<th>Mounting</th>
<th>3SY configuration is available for round poles only.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plan View:</td>
<td>Wall Mount</td>
</tr>
<tr>
<td>Distribution:</td>
<td>Type II</td>
</tr>
<tr>
<td>Fixure Cat. No.</td>
<td>designates fixture and optic.</td>
</tr>
<tr>
<td>Housing Size:</td>
<td>SAR</td>
</tr>
<tr>
<td>Flat Lens</td>
<td></td>
</tr>
</tbody>
</table>

**Electrical Module**

<table>
<thead>
<tr>
<th>Cat. Nos. for Electrical Modules available:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>60 LxK</td>
<td>x</td>
</tr>
</tbody>
</table>

**Source:** 60 = 60 LED's  
**Color Temperature:**
- 3K = 3500K  
- 5K = 5100K  
- 2K = 580nm - Amber

**Voltage:**
- 120 = 120V  
- 208 = 208V  
- 240 = 240V  
- 277 = 277V  
- 347 = 347V  
- 480 = 480V

4300K and 6500K are also available on an “Engineered-to-Order” (ETO) basis.  
*Due to current unavailability of 347V and 480V drivers, specification of these voltages may feature an integral step-down transformer.

---

**Finish**

Super TGIC powder coat paint over a titanated zirconium conversion coating.

**Color:**  
- Black  
- Dark Bronze  
- Light Gray  
- Stealth Gray®  
- Platinum Silver  
- White  
- Custom Color®

**Cat. No.:**
- BL  
- DB  
- LG  
- SG  
- PS  
- WH  
- CC

*Custom colors subject to additional charges, minimum quantities and extended lead times. Consult representative. Custom color description:

---

Refer to Luminaire Schedule for manufacturer’s catalog ordering code, required lamping, finishes, modifications and/or required accessories.
Optional Features

Wall Mounting
Cat. No. □ 1W □ No Option
Select from Mounting on page 2.

Fixture mounts to 3” or 4” junction boxes by a cast aluminum adapter plate with fixture mounting bolts.

NOTE: Junction box in wall must provide adequate fixture support. See NEC sections 370-13, 17 and 410-14. 16. Quick-disconnect plug and wiring are provided to allow field connections prior to fixture mounting.

Wall mount using adapter plate 3” or 4” J-box in wall (by others)

Photocell Control
Cat. No. (See right) □ No Option

Fixture supplied with an internal photocell with the sensor on the fixture end facing the pole. For multiple-fixture pole mountings, one fixture has a photocell to operate the others. Not available if wall mounted (1W).

Mounting Configuration:
S – Fixture with Photocell Sensor
S – slave unit(s)
No fixture wattage limit.

Dimming Controls

The Archetype LED driver is a 0-10V dimming interface, allowing 0-100% illumination output when synchronized with a control and dimming system, provided by others. Kim Lighting is working with several control system manufacturers to develop a variety of proven turnkey solutions to meet any application’s need. Kim Lighting will advise availability of complete control packages, and even two-way monitoring systems, once they have been tested and exceed Kim’s high quality standards.

Convex Glass Lens
Cat. No. □ CGL □ No Option

The ⅛” thick clear convex tempered glass lens replaces the standard flat glass lens. Provides increased lens presence and provides a subtle improvement in uniformity where pole spacing is extreme. Increases effectiveness of houseside shielding.

CAUTION: Use only when vandalism is anticipated to be high.

Tamper-Resistant Latch
Cat. No. □ TL □ No Option

Standard die-cast latch is provided with a captive 10-32 stainless steel flat socket-head screw to prevent unauthorized opening.

NOTE: Required only for vandal protection in locations where fixtures can be reached by unauthorized persons.
Refer to Luminaire Schedule for manufacturer’s catalog ordering code, required lamping, finishes, modifications and/or required accessories.
Lumen Performance Charts

NOTES:

1. Lumen loss stabilization is a result of Kim Lighting's MicroEmitter™ luminaires exclusive LifeShield™ Protection System and Dual Heat Management.

2. The LifeShield™ Protection System will lower the current to the LEDs significantly if the luminaire is exposed to direct heat (sun) or excessive abnormal conditions.

3. Luminaire Lumen Loss assumptions are based on LM-80 results and an actual outdoor product testing based upon 5100K CCT, 350mA drive current, 25°C/77°F tab ambient and cathode temperature at 85°C/185°F. Assumptions past 6,000 hours are interpolated.

4. Cathode temperature baseline is at 85°C/185°F. If cathode temperature increases during ambient changes and abnormal environment conditions, % of rated lumens will slightly decrease.

5. Outdoor ambient temperatures are assumed SITU average by geographic region.

6. As Solid State Lighting technology and thermal management systems continually advance, lumen loss projections are subject to improvement.

Outdoor Temperature at 10°C/50°F. Temperature is based on continual average, annual assumptions.

Outdoor Temperature at 40°C/104°F. Temperature is based on continual average, annual assumptions.

Stabilizes Output Due to Exclusive LifeShield Protection System

Refer to Luminaire Schedule for manufacturer's catalog ordering code, required lamping, finishes, modifications and/or required accessories.
Refer to Luminaire Schedule for manufacturer’s catalog ordering code, required lamping, finishes, modifications and/or required accessories.
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Refer to Luminaire Schedule for manufacturer's catalog ordering code, required lamping, finishes, modifications and/or required accessories.
**UW Montlake Triangle**
**10879-01**
**Conformed Set**

**Type: XS3**

**03-20-2012**

---

**LIGHTWILD**

**RECTANGULAR TILE 4.0**

**SPECIFICATION SHEET**

(NOMINAL SIZE: 2x24 in or 55x600 mm DIAMETER)

**DIMENSIONS**

(DOWNLOAD CAD-BASED DIMENSIONAL DRAWINGS AND PHOTOMETRIC DATA AT WWW.LIGHTWILD.COM)

<table>
<thead>
<tr>
<th>TILE</th>
<th>LW - TILE - FLOOR - RECT - 2x24 -</th>
</tr>
</thead>
<tbody>
<tr>
<td>LED COLOR</td>
<td>WW = WARM WHITE ³</td>
</tr>
<tr>
<td></td>
<td>CW = COOL WHITE ³</td>
</tr>
<tr>
<td></td>
<td>RGB = COLOR CONTROLLABLE</td>
</tr>
</tbody>
</table>

| SUPPORT BOX | LW - TILE - FLOOR - RECT - 2x24 - BOX |

**FEATURES**

- **POWER REQUIREMENT:** 24VDC
- **POWER CONSUMPTION:** 8.7 W PER TILE
- **LISTINGS:** UL (2108, 1838)
- **ENVIROMENTS:** USE IN DRY, DAMP, OR WET LOCATIONS ³
- **LENS:** TEMPERED, LOW-IRON FROSTED GLASS
- **LEDs:** SURFACE MOUNT
- **SLIP RESISTANCE CO-EFFICIENT OF FRICTION:** 0.75 DRY, 0.71 WET
- **LOAD RATING:** UP TO 1000 PSI WITH TOTAL LOAD NOT TO EXCEED 3000 LBS (1360 KGS) PER TILE. ³
- **HOUSING:** STAINLESS STEEL
- **TEMPERATURE RANGE:** -13° TO 122° F (-25° TO 70° C)
- **LUMEN MAINTENANCE (L70):** LED LIFETIMES ARE AFFECTED BY AMBIENT OPERATING TEMPERATURES AND OTHER FACTORS. CONSULT LIGHTWILD FOR DETAILS.
- **IP RATING:** IP65
- **CCT ³:** WW=3000K, CW=4000K.
- **CABLE CONNECTION:** TILE SHIPS WITH AN 18 GAUGE 2- OR 4-CONDUCTOR CABLE WHIP WITH PLAIN ENDS. A LIGHTWILD SUPPLIED TERMINAL BOX CONNECTS WHIP TO BRANCH CABLE. TERMINAL BOX RESIDES IN SUPPORT BOX UNDER TILE IN FINAL INSTALLATION.
- **CONTROL:** CORROSION RESISTANT STAINLESS STEEL

**CONTROL**

**SERIES A CONTROL UNITS**
- POWER ON/OFF CONTROL

**SERIES B CONTROL UNITS**
- POWER + DIMMING BY LIGHTWILD
  - POWER + DIMMING BY OTHERS (0-10V OR DMX)
  - DMX SHOW CONTROL BY OTHERS (LIGHTWILD CONTROL UNIT IS DMX READY)

**SERIES C CONTROL UNITS**
- INCLUDES ONE LIGHTWILD DMX DIRECTOR FOR SHOW CONTROL
  - SHOW SELECTION OPTIONS:
    - LIGHTWILD SHOW SELECTOR WALL CONTROLLER
    - THIRD PARTY SHOW SELECTOR VIA CONTACT CLOSURE INTERFACE

**SERIES D CONTROL UNITS**
- BUILT TO ORDER AND REQUIRES CONSULTATION WITH LIGHTWILD
  - INDIVIDUALLY CONTROL LIGHTWILD FIXTURES
  - CONTROL A LARGE NUMBER OF GROUPS OF LIGHTWILD FIXTURES

SEE ALSO CONTROL UNIT DATA SHEETS

---

**LIGHTWILD TILES & SUPPORT BOX**

**SPECIFICATION SHEET**

(NOMINAL SIZE: 2x24 in or 55x600 mm DIAMETER)

**ACTUAL DIMENSIONS:** SEE DIAGRAMS

**TYPE**

**CONSTRUCTION**

- TILES ARE SEALED FIXTURES WITH NO REPLACEMENT BULB OPTIONS, MEANING THE ENTIRE FIXTURE MUST BE REPLACED IF THERE IS A FIXTURE FAILURE. FOLLOWING LIGHTWILD’S INSTALLATION RECOMMENDATIONS PROVIDES A REASONABLE MEANS FOR REMOVING LIGHTWILD TILES IF NECESSARY.

**WARNING:** RISK OF ELECTRIC SHOCK. INSTALL ALL LUMINAIRES 10 FEET (3.05 M) OR MORE FROM A POOL, SPA, OR FOUNTAIN. TILES ARE IP65 RATED. PROPER DRAINAGE REQUIRED. DO NOT ALLOW WATER TO COLLECT OR STAND AROUND INSTALLED TILES. TILES ARE NOT FOR USE IN SUBMERSIBLE APPLICATIONS.

**FOOT TRAFFIC AND LIGHT UTILITY VEHICLES (MAINTENANCE CARTS, GOLF CARTS, ETC.) ONLY. NOT RATED FOR CARS AND VEHICULAR TRAFFIC.**

**THE MANUFACTURING PROCESS USED FOR LIGHTWILD TILES CAN OCCASIONALLY PRODUCE SLIGHT VARIATIONS IN DIMENSIONS QUOTED ON PRODUCT DATA SHEETS, THE LIGHTWILD WEB SITE, AND OTHER PRODUCT DOCUMENTATION. IN FINAL INSTALLATIONS, TILES SHOULD BE SLIGHTLY RECESSED FROM SURROUNDING SURFACES TO PREVENT POSSIBLE DAMAGE TO THE EDGES OF THE GLASS CAUSED BY LOADS FROM LIGHT UTILITY VEHICLES OR DIRECT IMPACT FROM SNOW PLUNES OR SHOVELS AS WELL AS TO REDUCE TRIPPING HAZARDS. INSTALLATION PROCEDURES SHOULD INCLUDE A MEANS TO LEVEL TILES VERTICALLY OR ADJUST HORIZONTALLY IF NECESSARY TO ACHIEVE DESIRED RESULTS.**

**SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.**

SEE LIGHTWILD TERMS AND CONDITIONS AT WWW.LIGHTWILD.COM FOR PRODUCT WARRANTY INFORMATION.

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Refer to Luminaire Schedule for manufacturer’s catalog ordering code, required lamping, finishes, modifications and/or required accessories.
Luminaire Schedule for manufacturer’s catalog ordering code, required lamping, finishes, modifications and/or required accessories.
Refer to Luminaire Schedule for manufacturer's catalog ordering code, required lamping, finishes, modifications and/or required accessories.
Prepare installation location. Provide for adequate drainage below fixture location to prevent the support box from filling with water.

Secure the support box in place. The support box should be positioned so that the installed LightWild Tile is 1/16 to 1/8 inch below the finished surface. The provided wooden blockout lid on the support box represents the thickness of the finished fixture height.

Run conduit and cable to the support box.

Secure the wooden blockout lid to the support box using duct tape (supplied by others).

Install concrete, cement, pavers or other flooring materials. The finished floor should exceed the blockout lid by 1/16 to 1/8 inch such that the LightWild Tile is slightly recessed in the final installation.

Once floor material is in place, remove and discard the wooden blockout lid.

Feed cables into the junction box. Note: Leave enough lead cable on LED tile to allow removal for service.

Clamp the cables to the junction box.

Strip wires.

Connect cables.

Tuck cables into the junction box.

Fill junction box with dielectric grease.

Install junction box cover.

Porous base material.

Tile support box.

Provide drainage pipe to subsurface if Tile is installed on a non-porous base material.

Refer to Luminaire Schedule for manufacturer’s catalog ordering code, required lamping, finishes, modifications and/or required accessories.
### Installation Notes

An installed Tile should be slightly recessed in the finished surface level to prevent trip hazards and to protect the Tile edge. The surface of the wooden blockout lid on a LightWild support box can help approximate the surface level of the Tile.

Build the base under and around the support box. This can help drainage from inside the support box and also secure the support box during concrete placement.

**WARNING: RISK OF ELECTRIC SHOCK.** Install all luminaires 10 feet (3.05 meters) from a pool, spa, or fountain.

The unit secondary wiring shall be protected by routing in close proximity to the luminaire or fitting or next to a building structure such as a house or deck. The wiring shall not be buried except for a maximum 6 inches (15.2 cm) in order to connect the main secondary wire. The wire shall have the length cut off so that it is connected to a connector within 6 inches (15.2 cm) from a building structure, a luminaire, or fitting.

Proper drainage in potentially wet areas is required. Do not allow water or liquids to stand or collect around installed Tiles.

Apply a concrete release agent (form release) to the outside surface of the wooden blockout cover to ease removal after placement of concrete.

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Proper drainage in potentially wet areas is required. Do not allow water or liquids to stand or collect around installed Tiles.

Apply a concrete release agent (form release) to the outside surface of the wooden blockout cover to ease removal after placement of concrete.

During final placement of the Tile, apply a metal-to-metal adhesive where the Tile sets on the support box for maximum security.

LightWild Tiles are built to withstand common weather elements, pedestrian traffic, and occasional traffic from utility vehicles such as maintenance carts. Tiles are not rated for full size vehicular traffic. Common sense care should be used around the Tiles. For instance, if the edge of a Tile is struck with a snowplow or shovel, damage is likely to occur. Damage is also likely if excessive salt, snow removal agents, or other chemicals are used on the Tiles.

Tiles are sealed fixtures with no replacement bulb options, meaning the entire fixture must be replaced if there is a fixture failure. Following LightWild’s installation recommendations provides a reasonable means for removing LightWild Tiles if necessary.

The manufacturing process used for LightWild Tiles can occasionally produce very slight variations in dimensions and other Tile features such as lens or LED colors quoted in this manual. Please contact your LightWild representative or the LightWild Projects Team (projects@lightwild.com or 913-851-3000) if you have any questions about the LightWild Tiles, support boxes, or power and control units delivered to your project site.

See additional installation information at www.lightwild.com

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### MAXIMUM CABLE LENGTHS FOR SINGLE RUNS

<table>
<thead>
<tr>
<th>Watts</th>
<th>Amps</th>
<th>#18AWG</th>
<th>#16AWG</th>
<th>#14AWG</th>
<th>#12AWG</th>
<th>#10AWG</th>
<th>#8AWG</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-12</td>
<td>0.5-0.75</td>
<td>150 ft.</td>
<td>240 ft.</td>
<td>300 ft.</td>
<td>300 ft.</td>
<td>300 ft.</td>
<td>300 ft.</td>
</tr>
<tr>
<td>12-24</td>
<td>0.75-1.0</td>
<td>120 ft.</td>
<td>190 ft.</td>
<td>300 ft.</td>
<td>300 ft.</td>
<td>300 ft.</td>
<td>300 ft.</td>
</tr>
<tr>
<td>24-36</td>
<td>1.0-1.5</td>
<td>80 ft.</td>
<td>120 ft.</td>
<td>200 ft.</td>
<td>300 ft.</td>
<td>300 ft.</td>
<td>300 ft.</td>
</tr>
<tr>
<td>36-48</td>
<td>1.5-2.0</td>
<td>55 ft.</td>
<td>95 ft.</td>
<td>150 ft.</td>
<td>300 ft.</td>
<td>300 ft.</td>
<td>300 ft.</td>
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<tr>
<td>48-60</td>
<td>2.0-2.5</td>
<td>n/a</td>
<td>45 ft.</td>
<td>75 ft.</td>
<td>120 ft.</td>
<td>300 ft.</td>
<td>300 ft.</td>
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<tr>
<td>60-72</td>
<td>2.5-3.0</td>
<td>n/a</td>
<td>40 ft.</td>
<td>60 ft.</td>
<td>100 ft.</td>
<td>160 ft.</td>
<td>300 ft.</td>
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<tr>
<td>72-84</td>
<td>3.0-3.5</td>
<td>n/a</td>
<td>35 ft.</td>
<td>55 ft.</td>
<td>85 ft.</td>
<td>130 ft.</td>
<td>300 ft.</td>
</tr>
<tr>
<td>84-96</td>
<td>3.5-4.0</td>
<td>n/a</td>
<td>45 ft.</td>
<td>75 ft.</td>
<td>120 ft.</td>
<td>190 ft.</td>
<td>300 ft.</td>
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<tr>
<td>96-108</td>
<td>4.0-4.5</td>
<td>n/a</td>
<td>40 ft.</td>
<td>65 ft.</td>
<td>100 ft.</td>
<td>170 ft.</td>
<td>270 ft.</td>
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<tr>
<td>108-120</td>
<td>4.5-5.0</td>
<td>n/a</td>
<td>35 ft.</td>
<td>60 ft.</td>
<td>95 ft.</td>
<td>150 ft.</td>
<td>240 ft.</td>
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<tr>
<td>120-132</td>
<td>5.0-5.5</td>
<td>n/a</td>
<td>35 ft.</td>
<td>55 ft.</td>
<td>85 ft.</td>
<td>140 ft.</td>
<td>220 ft.</td>
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<tr>
<td>132-144</td>
<td>5.5-6.0</td>
<td>n/a</td>
<td>30 ft.</td>
<td>50 ft.</td>
<td>80 ft.</td>
<td>120 ft.</td>
<td>200 ft.</td>
</tr>
<tr>
<td>144-160</td>
<td>6.0-6.7</td>
<td>n/a</td>
<td>45 ft.</td>
<td>70 ft.</td>
<td>110 ft.</td>
<td>180 ft.</td>
<td>270 ft.</td>
</tr>
</tbody>
</table>

* 90 watts is the maximum wattage per run for Class 2 installations.
**SOLID STATE LIGHTING**

**EXTERIOR ARCHITECTURAL LINEAR LIGHTING**

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**MEDLEY® X**

**EXTERIOR ARCHITECTURAL LINEAR SOLID STATE LIGHTING**

**WHITE LIGHT & COLOR CHANGING**

<table>
<thead>
<tr>
<th>Optics</th>
<th>Mounting</th>
<th>Fixture Length</th>
<th>Finish</th>
<th>Options &amp; Accessories</th>
</tr>
</thead>
<tbody>
<tr>
<td>CES = Close End Single Fixture</td>
<td>12 = 12&quot; 100 = 100°</td>
<td>12 = 12&quot;</td>
<td>TW = Textured White</td>
<td>LV = Louver</td>
</tr>
<tr>
<td>SMS = Surface Single Fixture</td>
<td>20 = 20&quot; 100 = 100°</td>
<td>24 = 24&quot;</td>
<td>TBL = Textured Black</td>
<td>ACV = Attached Power Supply/LINE Voltage Raceway 120VAC-277VAC ** (Available w/ 24&quot;-96&quot; fixtures only)</td>
</tr>
<tr>
<td>EAS-X = Extended Arm Single Fixture</td>
<td>48 = 48&quot;</td>
<td>48 = 48&quot;</td>
<td>TBR = Textured Bronze</td>
<td>IDIM = Attached 0-10V Dimming Power Supply 120VAC-277VAC ** (Available w/ 36&quot;-96&quot; fixtures only)</td>
</tr>
<tr>
<td>PNS-X = Pendant Single Fixture</td>
<td>60 = 60°</td>
<td>60 = 60°</td>
<td>TN = Textured Natural</td>
<td>** ACV &amp; IDIM options are available with:</td>
</tr>
<tr>
<td>* X = Specify Pendant or Arm Length</td>
<td>84 = 84&quot;</td>
<td>84 = 84&quot;</td>
<td>TS = Textured Sandstone</td>
<td>· White Light only</td>
</tr>
<tr>
<td></td>
<td>96 = 96&quot;</td>
<td>96 = 96&quot;</td>
<td>SF = Specify Finish</td>
<td>· SMS mount only</td>
</tr>
<tr>
<td>SF = Specify</td>
<td>Contact factory for &quot;SF&quot; and &quot;CC&quot; options.</td>
<td></td>
<td>CC = Custom Color</td>
<td>· Requires Insight Line Voltage Cable.</td>
</tr>
<tr>
<td>CC = Custom Color</td>
<td></td>
<td></td>
<td></td>
<td>See page 4 for details</td>
</tr>
</tbody>
</table>

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**SPECSIFICATIONS**

- Housing: products are manufactured from aluminum extrusions with cast aluminum end caps enclosed with a piece, extruded acrylic lens. Standard fixtures are available in 12" to 96° lengths in 12" sections. White Light fixtures are available in 6° increments as a modification upon request.

- Finish: All painted surfaces are pretreated and powder coated to a 3 mil thickness. Standard colors are textured. Custom colors available upon request.

- Mounting: All fixtures are field adjustable, with moveable mounting brackets. See mounting information. Field installable louvers.

- Lens: One piece extruded removable acrylic lens.

- Color Temperature/Binning: Color temperature conforming to ANSI C78 377A.

- Ordering Example: MX/15/50K/EAS-12’/48/W

---

**TYPE:**

**JOB NAME:**

**APPROVAL:**

---

Refer to Luminaire Schedule for manufacturer's catalog ordering code, required lamping, finishes, modifications and/or required accessories.
Refer to Luminaire Schedule for manufacturer's catalog ordering code, required lamping, finishes, modifications and/or required accessories.
Refer to Luminaire Schedule for manufacturer’s catalog ordering code, required lamping, finishes, modifications and/or required accessories.
### DIGITAL CONTROLS

#### SMART CONTROL 2 - LIGHTING PLAYBACK CONTROL, DMX2

**Catalog No:** SC2

- Touch Screen DMX512 stand alone controller
- Live setting of the intensity and color of a scene
- Programmable through the supplied USB cable and control software
- Wall Mount
- Pre-loaded with 8 scenes
- Writable memory of up to 192 steps

#### SMART EYE - STAND-ALONE CONTROLLER

**Catalog No:** SE (Smart Eye)

- Economical stand alone controller
- Programmable with Insight Designer software and compatible with any Windows OS (32 or 64 bit)
- Program scenes, adjust fade and hold times, set triggers
- Use in stand alone mode or live mode with the use of a PC to change programs in real time
- 12V power adaptor with 120V plug and one XLR output for DMX included

#### SMART PAD - TOUCH SCREEN CONTROLLER

**Catalog No:** SP (Smart Pad)

- The Smart Pad is a 1024 channel touch screen wall mount controller that is computer programmable up to two DMX universes
- Alter color, speed and intensity with the push of a button
- Use in stand alone or live mode with the use of a PC to change programs in real time
- Programmers use the Insight Designer software to program scenes, adjust fade and hold times, set triggers and write this information directly to the memory of the controller with PC and a supplied USB cable
- Write programs directly to Smart Pad with PC and supplied USB cable

#### PHAROS LPC - LIGHTING PLAYBACK CONTROL

**Catalog No:** LPC-X

- Pharos LPC is all in one control solution for entertainment and LED lighting installations
- The LPC-X Series is available in up to 200 universes and the ability to integrate with almost any 3rd party control
- The networked control system allows for seamless setup and maintenance
- Users can monitor, trigger and reprogram units remotely and securely over the Internet using a web browser or Pharos installation manager
- Integrate into energy management systems
- RDM and Dali compatible

#### PHAROS BUTTON PANEL

**Catalog No:** PBP

- Wall mount, 8 scenes, push button
- PoE powered
- Simple interface to the Pharos control system allowing for simple network integration

Ref to Luminaire Schedule for manufacturer’s catalog ordering code, required lamping, finishes, modifications and/or required accessories.
### Product Family Optic Mounting

<table>
<thead>
<tr>
<th>Product</th>
<th>Family</th>
<th>Optic</th>
<th>Mounting</th>
<th># of LEDs (× 10)</th>
<th>LED Series</th>
<th>Voltage</th>
<th>Color Options</th>
<th>Drive Current</th>
<th>Factory-Installed Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>STR Lwy</td>
<td>3M</td>
<td>HT</td>
<td>D</td>
<td>10</td>
<td>Universal</td>
<td>120-277V</td>
<td>Silver&lt;sup&gt;3&lt;/sup&gt;</td>
<td>700</td>
<td>4300K Color Temperature&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>UL</td>
<td></td>
<td></td>
<td>70mA</td>
<td>0-10V Dimming&lt;sup&gt;5,6,7&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Black&lt;sup&gt;3&lt;/sup&gt;</td>
<td>525</td>
<td>F Fuse&lt;sup&gt;8,9&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Bronze&lt;sup&gt;3&lt;/sup&gt;</td>
<td>525mA</td>
<td>HL HI/Low (175/350/525, dual circuit input)&lt;sup&gt;10,11&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Platinum&lt;sup&gt;3&lt;/sup&gt;</td>
<td>350</td>
<td>N No Quick Disconnect Harness or Leveling Bubble&lt;sup&gt;12&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>White&lt;sup&gt;3&lt;/sup&gt;</td>
<td>350mA</td>
<td>PD Power Door&lt;sup&gt;13&lt;/sup&gt;</td>
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<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SC Door Safety Tether&lt;sup&gt;14&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>UTL Utility Option&lt;sup&gt;14&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

### Footnotes
1. IESNA Type III Medium distribution
2. Horizontal tenon mount
3. Light engine portion of extrusion is not painted and will remain natural aluminum regardless of color selection
4. Color temperature per fixture; 6000K standard; minimum 70 CRI
5. Control by others
6. Refer to dimming spec sheet for availability and additional information
7. Can’t exceed the specified drive current. Consult factory if exceeding the drive current is necessary.
8. This option not available with all multi-level options. Refer to multi-level spec sheet for more information
9. When code dictates fusing use time delay fuse
10. Refer to multi-level spec sheet for availability and additional information
11. Sensor not included
12. Standard product features unless N option is specified
13. All connections between door and fixture are shipped unconnected from the factory; door release spring included to open door automatically when the latches are released
14. Photocell by others
15. Stainless steel aircraft cable
16. Includes exterior wattage label that reflects watts for the drive current selected. The ability to exceed the selected drive current will be disabled.

### LED PERFORMANCE SPECS

<table>
<thead>
<tr>
<th># of LEDs</th>
<th>Initial Delivered Lumens – Type III Medium @ 6000K</th>
<th>R</th>
<th>G</th>
<th>Initial Delivered Lumens – Type III Medium @ 4300K</th>
<th>B</th>
<th>G</th>
<th>System Watts 120-480V</th>
<th>Total Current @ 120V</th>
<th>Total Current @ 240V</th>
<th>Total Current @ 277V</th>
<th>Total Current @ 480V</th>
<th>L&lt;sub&gt;90&lt;/sub&gt; Hours&lt;sup&gt;1&lt;/sup&gt; @ 25°C (77°F)</th>
<th>50K Hours Lumen Maintenance Factor&lt;sup&gt;1&lt;/sup&gt; @ 50°C (122°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>9,154 (10)</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>8,437 (10)</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>111</td>
<td>0.97</td>
<td>0.52</td>
<td>0.46</td>
<td>0.34</td>
</tr>
<tr>
<td>110</td>
<td>10,010 (11)</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>9,226 (11)</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>122</td>
<td>1.08</td>
<td>0.58</td>
<td>0.51</td>
<td>0.37</td>
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<tr>
<td>120</td>
<td>10,412 (12)</td>
<td>3</td>
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<td>3</td>
<td>9,992 (12)</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>133</td>
<td>1.17</td>
<td>0.62</td>
<td>0.55</td>
<td>0.39</td>
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<tr>
<td>100</td>
<td>12,816 (10)</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>11,612 (10)</td>
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<td>3</td>
<td>3</td>
<td>163</td>
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<td>12,916 (11)</td>
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<td>120</td>
<td>15,179 (12)</td>
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<td>3</td>
<td>3</td>
<td>13,999 (12)</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>195</td>
<td>1.70</td>
<td>0.89</td>
<td>0.76</td>
<td>0.58</td>
</tr>
</tbody>
</table>

**For recommended lumen maintenance factor data see TD-13**

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**NOTE:** All data subject to change without notice.

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Made in the U.S.A. of U.S. and imported parts.

Meets Buy American requirements within the ARRA.

Refer to Luminaire Schedule for manufacturer’s catalog ordering code, required lamping, finishes, modifications and/or required accessories.
General Description
Fixture housing is all aluminum construction. Standard fixture utilizes terminal block for power input suitable for #2–#14 AWG wire and operates at 700mA. Drive current is field switchable. Fixture is designed to mount on 1.25” IP (1.66” [42mm] O.D.) and/or 2” (51mm) IP (2.375” [60mm] O.D.) horizontal tenon (minimum 8” [203mm] in length) and is adjustable +/- 5º to allow for fixture leveling (includes two axis T-level to aid in this process). Fixture carries a limited five year warranty.

Electrical
Modular design accommodates varied lighting output from high power, white, 6000K (+/- 500K per full fixture), minimum 70 CRI, long life LED sources. Optional 4300K (+/- 300K per full fixture) also available. 120–277V 50/60 Hz, Class 1 LED drivers are standard. 347–480V 50/60 Hz option is available. LED drivers have power factor >90% and THD <20% at full load. Quick disconnect harness suitable for mate and break under load provided on power feed to driver for ease of maintenance. Units provided with integral 10kV surge suppression protection standard. Surge protection tested in accordance with IEEE/ANSI C62.41.2.

Finish
Exclusive Colorfast DeltaGuard® finish features an E-Coat epoxy primer with an ultra-durable silver powder topcoat, providing excellent resistance to corrosion, ultraviolet degradation and abrasion. Bronze, black, white and platinum bronze powder topcoats are also available. The finish is covered by our 10 year limited warranty.

Field-Installed Accessories
- Bird Spikes for Light Engine: XA-BRDSPK120
- Bird Spikes Kit for Housing: XA-BRDSPKHSG
- No Photo Available: XA-XIL125IP

Photometrics
[Graph showing luminaire photometric testing performed to IESNA LM-79-08 standards.]

LEDway® EPA & Weight Calculations
Approximate Weight 120–480V
100–120 LED fixture 24.0 lbs. (10.9kg)

EPA
Horizontal Tenon Mount
1 fixture 0.820

EPA
Round External Mount / Square Internal Mount
Horizontal Tenons with Fixture(s)
PT-1H/PD-1H4 Single 1.040
PT-2H(90)/PD-2H(90) 90º Twin 1.379
PT-2H(180)/PD-2H(180) 180º Twin 1.860
PT-3H(90)/PD-3H(90) 90º Triple 2.044
PT-3H(120) 120º Triple 1.824
PT-4H(90)/PD-4H(90) 90º Quad 2.448
1. Add 5 lbs. (2.3kg) for transformer in 347–480V fixtures when multi-level options are selected.

NOTE: All data subject to change without notice.
Refer to Luminaire Schedule for manufacturer’s catalog ordering code, required lamping, finishes, modifications and/or required accessories.

Mounting detail for street lighting shown for reference only.

City of Seattle

Refer to Luminaire Schedule for manufacturer’s catalog ordering code, required lamping, finishes, modifications and/or required accessories.
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. References and standards listed herein are to be the latest edition available, unless specifically stated otherwise.

1.2 SUMMARY

A. These standards and procedures apply to the use of excavated materials and the installation of the earthwork materials.

B. This section includes but is not limited to the following:
   1. Excavation and backfilling for footings
   2. Excavation and backfilling for underground utilities and appurtenances
   3. Preparation of subgrade for footings, walls, walkways and pavements
   4. Structural backfill for foundation and walls
   5. Final grading together with placement and preparation of topsoils for lawns and plantings

C. Related Sections:
   1. Division 01 Section “Submittals Procedures”
   2. 01 56 39 Temporary Tree and Plant Protection
   3. 01 57 13 Temporary Erosion and Sediment Control
   4. 32 12 16 Asphalt Paving
   5. 32 12 43 Porous Flexible Paving
   6. 32 13 00 Rigid Paving
   7. 32 14 43 Porous Unit Paving
   8. 32 90 00 Planting
   9. 32 91 00 Soil Preparation
   10. 32 92 00 Lawns
   11. 33 10 00 Water Utilities
   12. 33 30 00 Sanitary Sewer Utilities
   13. 33 40 60 Storm Drainage Utilities
   14. 33 46 13 Foundation Drainage
   15. Attached Geotechnical Report by Shannon & Wilson (for reference only)

1.3 SUBMITTALS

A. General: Make submittals in accordance with Division 1 Section “Submittal Procedures.”
B. The University requires submittals of the gradation to pre-qualify their use. The Contractor shall also provide, for each, material moisture density curves, which indicate the optimum moisture content.

C. Submit the following samples and sieve analysis for review separately to the project Geotechnical Consultant and Architect at least two weeks prior to use:
   1. Sample and sieve analysis for all imported soil materials
   2. Sample and manufacturer’s information for all Geotextile products

D. Samples of all imported materials for use within public right-of-way or as bedding or backfill for on-site public utilities shall be submitted for review to the City inspector at least two weeks prior to use.

1.4 QUALITY ASSURANCE

A. Soil Testing
   1. The Owner will engage a Geotechnical Consultant to test soil materials proposed for use in the work and for quality control testing during earthwork operations.
   2. Samples of materials shall be submitted as required above.

B. All work to be performed and materials to be used shall be in accordance with the following codes, regulations and standards:
   1. 2011 Standard Specifications and Standard Plans for Road, Bridge and Municipal Construction, as published by the City of Seattle (COS), unless otherwise indicated herein.
      a. The Contractor shall have one copy of the Standard Specifications and Standard Plans at the job site.
      b. The Standard Specifications apply only to performance and materials and how they are to be incorporated into the work. The legal/contractual relationship sections and the measurement and payment sections do not apply to this document.
   3. ASTM Test method D1557 modified for density of soils.

1.5 SPECIFIC REQUIREMENTS

A. Excavation of materials shall consist of removal of materials encountered to subgrade elevation.

B. Unauthorized excavation shall consist of removal of materials below subgrade or outside the dimensions as shown on the plans.

C. Testing and inspection service will be provided by the Owner. The Contractor shall cooperate and provide access and samples when requested by the Owner.

D. All excavated material shall be treated in the following ways:
   1. Removed from campus at no cost to the University.
   2. Approved native material may be used for wall backfill outside 18 inches from the drainage zone or in landscape areas to subgrade during the dry season only.

E. Pea gravel shall not be used for backfill unless specifically indicated on drawings.
F. The site soils are moisture sensitive. See the attached Geotechnical Report section 9.10. Footing subgrades must be protected in inclement weather.
   1. Excavations should be covered or limited to small areas in wet weather.
   2. The ground surface of mass excavations shall be graded to promote runoff to designated locations.

PART 2 - PRODUCTS

2.1 STRUCTURAL FILL
   A. Structural Fill placed outside of the building footprint shall be imported, uniformly graded material, free of organics and debris, and meeting the requirements for Mineral Aggregate Type 17 (bank run gravel) per City of Seattle Standard Specification 9-03.16.

2.2 PIPE BEDDING
   A. Pipe Bedding shall be Controlled Density Fill (CDF) per City of Seattle Standard Specification 9-01.5 where indicated on the Drawings.
   B. Rigid storm and sanitary sewer pipe (ductile iron, concrete and steel casing) shall be bed with Mineral Aggregate Type 9 per City of Seattle Standard Specification 9-03.16.
   C. Flexible pipe shall be bed with Mineral Aggregate Type 22 per City of Seattle Standard Specification 9-03.16.
   D. Ductile Iron water main shall be bed with Mineral Aggregate Type 6 or 7 per City of Seattle Standard Specification 9-03.16.

2.3 BACKFILL FOR WALLS
   A. Backfill for walls shall be imported uniformly graded material free of organics and debris meeting the requirements for Mineral Aggregate Type 17 (bank run gravel) per City of Seattle Standard Specification 9-03.16.

2.4 TRENCH BACKFILL
   A. Trenches not indicated to receive controlled density fill (CDF) backfill shall be backfilled with Structural Fill.

2.5 BACKFILL FOR FOUNDATIONS
   A. Structural Fill placed beneath structural foundations shall be Mineral Aggregate Type 17 (bank run gravel) per City of Seattle Standard Specification 9-03.16.

2.6 CONTROL DENSITY FILL
   A. Control Density Fill (CDF) shall conform with Section 2-10.2(3)A of the COS Standard Specifications.

2.7 TRAIL MIX AGGREGATE
   A. Trail Mix Aggregate shall be Mineral Aggregate Type 1 per City of Seattle Standard Specification 9-03.16.
2.8 GRAVEL BACKFILL FOR DRAINS

A. Gravel Backfill for Drains shall be Mineral Aggregate Type 28 (3/4 inch washed gravel) per City of Seattle Standard Specification 9-03.16.

2.9 PLANTING SOIL PREPARATION

A. Refer to Section 32 91 00 Planting Preparation.

2.10 PEA GRAVEL

A. Pea Gravel shall be Mineral Aggregate Type 9 (3/8 inch washed gravel) per City of Seattle Standard Specification 9-03.16. The amount of deleterious substances remaining in the washed pea gravel shall not exceed values specified in Section 9-03.1(2)B of the City of Seattle Standard Specifications.

2.11 FRENCH DRAIN GRAVEL

A. French Drain Gravel shall consist of clean, 1-inch, naturally occurring rock with the following gradation:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100%</td>
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<tr>
<td>3/4</td>
<td>0-10%</td>
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<tr>
<td>No. 4</td>
<td>0%</td>
</tr>
</tbody>
</table>

2.12 GRASSPAVE2 ROAD BASE

A. Grasspave2 road base shall be Mineral Aggregate Type 2 per City of Seattle Standard Specification 9-03.16.

2.13 CATCH BASIN AND MANHOLE BEDDING

A. Mineral Aggregate Type 9 per City of Seattle Standard Specification 9-03.16, with four sacks of Portland Cement per cubic yard of Aggregate.

2.14 GABION BASE COURSE

A. Gabion base course shall be Mineral Aggregate Type 2 per City of Seattle Standard Specification 9-03.16.

2.15 FLUIDIZED THERMAL BACKFILL

A. Fluidized Thermal Backfill (FTB) shall be Low-Strength FTB per Seattle City Light Material Standard 7150.00.
PART 3 - EXECUTION

3.1 EXCAVATION

A. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of the Owner’s Representative. Unauthorized excavation, as well as remedial work directed by the Owner’s Representative, shall be at no change in contract amount.

1. Under footings, foundation bases, or retaining walls, fill unauthorized excavation by extending the indicated bottom elevation of the footing or base to the excavation bottom. The bottom of the excavation must be at least as wide as the sum of the depth of unauthorized excavation and the footing width.

2. Elsewhere, backfill and compact unauthorized excavations with structural fill as specified herein.

B. Overexcavation: In certain areas where soft spots occur in the subgrade, satisfactory subgrade shall be achieved by overexcavation and replacement with structural fill material or lean mix concrete.

1. Location and extent of soft spot areas to be verified by Owner’s Geotechnical Consultant in the field.

C. Stability of Excavations: Slope the sides of excavations to comply with local codes and ordinances having jurisdiction. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated. Maintain sides and slopes of excavations in a safe condition until completion of backfilling.

D. Shoring and Bracing: Provide shoring and bracing to comply with local codes and authorities having jurisdiction. Provide materials for shoring and bracing, such as sheet piling, uprights, stringers and cross-braces, in good serviceable condition. Maintain shoring and bracing in excavations regardless of the time period excavations will be open. Carry down shoring and bracing as the excavation progresses.

E. Dewatering: Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.

1. Do not allow water to accumulate in excavations. Remove water to prevent softening of foundation bottoms, undercutting footings and soil changes detrimental to stability of subgrades and foundations. Provide and maintain pumps, well points, sumps, suction and discharge lines and other dewatering system components necessary to convey water away from excavations.

2. Establish and maintain temporary drainage ditches and other diversions outside excavation limits for each structure to convey water. Do not use trench excavations as temporary drainage ditches.

F. Material Storage: Stockpile excavated materials as required. Place, grade, shape and cover stockpiles for proper drainage and to prevent accumulation of excess moisture.

1. Locate and retain soil materials away from edge of excavations.

2. Dispose of excess soil material and waste materials legally off-site.

G. Excavation for Buildings and Retaining Walls
1. Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10-foot, and extending a sufficient distance from footings and foundations to permit placing and removal of concrete formwork, installation of services, other construction, and inspection.

2. In excavating for footings and foundations, take care not to disturb the bottom of the excavation. Excavate by hand to final grade just before concrete reinforcement is placed. Trim bottoms to required lines and grades to leave solid base to receive concrete. Compact base to the density required and allow testing of compaction prior to constructing concrete forms.

3. Place footings on native soils, or properly compacted fill material. Where existing soft materials are encountered below footings, overexcavate as required by the Owner's Geotechnical Consultant or until dense native soil is encountered and backfill with lean concrete. The minimum lateral limits of the overexcavation and lean concrete backfill beneath footings shall be defined by a line extending downward and out from the outer edge of the footing at an angle of 1H:1V. Maintain side slopes as required by authorities having jurisdiction.

H. Excavation for Pavements: Cut surface under pavements to comply with cross-sections, elevations and grades as shown within a tolerance of plus or minus 0.10-foot.

I. Excavation for Planting Areas: Conform to cross-sections, elevations and dimensions shown, within a tolerance of plus or minus 0.10-foot.

J. Excavation for Trenches
   1. Excavate trenches to the depth indicated or required. Carry the depth of trenches for piping to establish the indicated flow lines and invert elevations.
   2. Where rock is encountered, carry the excavation 6 inches below the required elevation and backfill with a 6-inch layer of bedding material.
   3. Grade bottoms of trenches as indicated, notching under pipe bells to provide solid bearing for the entire body of the pipe.

K. Cold Weather Protection: Protect excavation bottoms against freezing when atmospheric temperature is less than 35 degrees F.

3.2 SUBGRADE VERIFICATION

A. Following site preparation and excavation for the building, paved surfaces and roadways, the exposed subgrades shall be observed and approved by the Owner's Geotechnical Consultant.

B. Overexcavate any soft, loose or disturbed soils identified by the Geotechnical Consultant and replace with compacted structural fill.

3.3 BACKFILL AND FILL

A. For backfill of all excavations use material sampled and tested by the Owner's Geotechnical Consultant.

B. All fill used for the following shall be structural fill:
   1. Fill beneath footings and foundations.
   2. Backfill against footings, foundations and structural walls, except 18 inches of gravel backfill for walls shall be placed immediately adjacent to structures for drainage, unless otherwise shown on the drawings.
3. Fill beneath building slabs.
4. Fill within 3 feet vertically of the base of pavements.

C. Fill beneath areas to be landscaped shall be nonstructural fill.

D. Backfill excavations as promptly as work permits, but not until completion of the following:
   1. Acceptance by Owner's Representative of construction below finish grade including,
      where applicable, waterproofing, dampproofing, piping, conduits and perimeter insulation.
   2. Inspection, testing, approval and recording locations of underground piping and conduits.
      Coordinate locations with surveyor for as-built survey.
   4. Removal of shoring and bracing and backfilling of voids with satisfactory materials.
   5. Removal of trash and debris.
   6. Permanent or temporary horizontal bracing is in place on horizontally supported walls.

E. Ground Surface Preparation
   1. Remove vegetation, debris, unsatisfactory soil materials, obstructions and deleterious
      materials from ground surface prior to placement of fills. On existing sloped surfaces,
      steeper than 1 vertical to 4 horizontal, cut benches into hillsides of 10 feet minimum width
      and 5 feet maximum height.
   2. When existing ground surface has a density less than that specified under "Compaction"
      for the particular area classification, break up the ground surface, pulverize, moisture-
      condition to within 2 percent of the optimum moisture content, and compact to required
      depth and percentage of maximum density.

F. Placement and Compaction: Allowable thickness of fill lifts will depend on the material type and
   compaction equipment used. In no case place backfill and fill materials in layers more than 8
   inches in loose depth for material compacted by heavy compaction equipment, and more than 4
   inches in loose depth for material compacted by hand-operated tampers. For fill deeper than 3
   feet below the base of pavements, lifts may be 12 inches maximum in loose depth.
   1. Before compaction, moisten or aerate each layer as necessary to provide the optimum
      moisture content.
   2. Compact each layer to required percentage of maximum dry density or relative dry
      density for each area classification.
   3. Do not place backfill or fill material on surfaces muddy, frozen, or containing frost or ice.
   4. Place backfill and fill materials in such a manner as to prevent wedging action of backfill
      against structures.

G. Backfilling with Controlled Density Fill (CDF) shall be performed in accordance with
   requirements of the City of Seattle Street and Sidewalk Pavement Opening and Restoration
   Directors Rule 5-2009. CDF shall be placed in multiple lifts to minimize hydrostatic loading of
   improvements or walls.

H. Backfilling with Fluidized Thermal Backfill (FTB) shall be performed in accordance with
   requirements of the Seattle City Light Material Standard 7150.00.
3.4 COMPACTION

A. General:
   1. Compact all fill and backfill to prevent subsequent settlement.
   2. No compaction will be allowed within the designated tree protection zones.
   3. Control soil compaction during construction providing minimum percentage of density specified for each area.
   4. Water settling or jetting will not be permitted as a means of compaction.
   5. Furnish heavy rollers or compactors except as follows:
      a. Use pneumatic hand tampers for trenches less than 3 feet in width and areas not accessible to heavy equipment,
      b. Compact areas within 5 feet of footing, foundations and wall with hand vibrators.

B. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum dry density determined in accordance with ASTM D 1557 ("Modified Proctor"):
   1. Structures: Compact top 12 inches of subgrade where exposed, and each layer of backfill or fill material to 95 percent of maximum dry density.
   2. Building Slabs and Steps: Compact top 12 inches of subgrade and each layer of backfill or fill material to 95 percent of maximum dry density.
   3. Lawn or Unpaved Areas: Compact top 12 inches of subgrade and each layer of backfill or fill material to 85 percent of maximum dry density.
   4. Walkways: Compact top 12 inches of subgrade and each layer of backfill or fill material to 95 percent of maximum dry density.
   5. Pavements: Compact top 12 inches of subgrade and each layer of backfill or fill material to 95 percent of maximum dry density.
   6. Utility Bedding and Backfill: Compact each layer of bedding and backfill to 95 percent of maximum dry density.
   7. Granular Fill Placed Against Subgrade Walls: Compact to 95 percent of maximum with small hand-operated equipment to avoid overcompaction.

C. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade, or layer of soil material. Prevent free water from appearing on surface during or subsequent to compaction operations.
   1. Remove and replace, or scarify and air dry, soil material too wet to permit compaction to specified density.
   2. Soil material removed because it is too wet to permit compaction may be stockpiled or spread and allowed to dry. Assist drying by discing, harrowing or pulverizing until moisture content is reduced to a satisfactory value.

3.5 GRADING

A. General: Uniformly grade areas of work including adjacent transition areas. Smooth finished surface within specified tolerances, compact with uniform levels or slopes between points where elevations are shown, or between such points and existing grades.
B. Grading Outside Building Lines: Grade areas adjacent to building lines to drain away from structures and to prevent ponding. Finish surfaces shall be free from irregular surface changes.

C. Compacted as specified, and to required elevation. Provide final grades within a tolerance of 1/2-inch when tested with a 10-foot straightedge.

D. Compaction: After grading, compact surfaces to the depth and percentage of maximum density for each area classification.

3.6 EARTHWORK FOR UTILITIES

A. Trench excavation, bedding, and backfill for storm drains, sanitary sewers, water services, hydrants, and detention facilities shall conform with applicable sections of the City of Seattle Standard Specifications.

B. Pipe bedding for storm and sanitary sewers shall be Class B per City of Seattle Standard Plan No. 285.

C. Pipe bedding for water mains shall be installed per City of Seattle Standard Plan 350.

D. All trenches within the traveled portion of public right-of-way and on site, as indicated on the drawings, shall be backfilled with CDF.

3.7 WET WEATHER PROVISIONS

A. Schedule earthwork operations to minimize the potential for erosion, siltation, and disturbance of site soils.

B. Perform earthwork operations in discrete areas as required to minimize the exposure of disturbed soils to wet weather.

C. Compact exposed soil to reduce the infiltration of rain water.

D. Direct surface water away from fills and excavations.

E. Provide temporary pumping equipment to keep excavations and construction free of water.

F. Soils that become too wet for compaction shall be removed and replaced with compacted structural fill.

3.8 DISPOSAL OF EXCESS AND WASTE MATERIALS

A. Transport acceptable excess excavated material to temporary stockpile areas on the Owner's property. Remove any unused excess excavated material from the site, and dispose of legally off the Owners property, prior to final inspection.

B. Remove waste materials, including unacceptable excavated material, trash and debris, and dispose of legally off the Owner's property.

3.9 FIELD QUALITY CONTROL

A. Quality Control Testing During Construction: Allow Owner's Geotechnical Consultant to observe, test and approve subgrades and fill layers before further construction work is performed.
B. Footings for structures and retaining walls shall be observed by the Geotechnical Consultant for bearing capacity verification prior to concrete placement. Compaction tests shall be performed if in the opinion of the Geotechnical Consultant they are necessary.

C. If subgrades or fills which have been placed are below specified density, provide corrective work as specified at no additional expense.

3.10 PROTECTION

A. Protect newly graded areas from traffic and erosion. Keep free of trash and debris.

B. Repair and reestablish grades in settled, eroded, and rutted areas to specified tolerances.

C. Reconditioning Compacted Areas: Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, reshape, compact to required density and provide other corrective work as specified, with retesting, prior to further construction.

END OF SECTION 31 00 00
1. Foreword

1.1 Scope

This material standard covers the requirements for formulation, production, installation, and testing of thermally conductive concrete and controlled low-strength material used in the construction of encased electrical power conduits (duct banks), including:

- Seattle City Light-owned high-strength Fluidized Thermal Backfill (FTB) with fluidizer
- Seattle City Light-owned high-strength FTB without fluidizer (special application)
- Seattle City Light-owned low-strength FTB with fluidizer
- Seattle City Light-owned low-strength FTB without fluidizer (special application)
- Seattle City Light-owned pumpable FTB (special application)
- Proprietary (privately-owned) high-strength FTB
- Proprietary low-strength FTB

FTB is a non-stock commodity at Seattle City Light.

1.2 Material Standard Document Organization

<table>
<thead>
<tr>
<th>Section</th>
<th>Section No.</th>
<th>Page</th>
</tr>
</thead>
<tbody>
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<td>1</td>
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<td>2</td>
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<td>Delivery and Placement</td>
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<td>4</td>
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<tr>
<td>Testing Criteria</td>
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<tr>
<td>References</td>
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</tbody>
</table>

1.3 Application

Fluidized Thermal Backfill™ is used to encase and cover underground power conduits that will contain transmission or distribution cables which may operate at or above normal ampere capacity (ampacity). FTB transfers heat away from power cables, allowing them to conduct more power.

Low-Strength FTB is used like controlled density fill (CDF) to backfill trenches over the high-strength FTB duct banks, and also for encasement where high-strength is not desired. It provides superior thermal properties to other backfills, and is self-compacting – a very desirable property in traffic areas.
1.3 Application, continued

High-Strength FTB is used like concrete for duct bank encasement. It provides maximum protection against dig-ins and undermining during future excavations. As a rule, high-strength FTB is more thermally conductive than low-strength FTB, but it is much more difficult to remove in future excavations.

FTB is normally not required for vault, manhole, or handhole backfill.

FTB should not be left exposed to outdoor air to avoid fissures caused by freezing and thawing. It is especially prone to this damage due to its lack of entrained air.

Admixtures must be pre-approved by SCL. See Section 2.6 for a list of approved admixtures.

SCL-owned mix designs are paid for and owned by SCL, and published for general use by FTB producers. SCL makes periodic adjustments to the designs to ensure the desired thermal performance.

Proprietary mix designs are paid for and owned by outside agencies or companies, typically a ready-mix concrete producer. The mix owner guarantees the thermal and strength performance of their mix, and proprietary mix designs must be re-formulated every 2 years to accommodate natural variations in component materials.

Note: The name Fluidized Thermal Backfill is a registered trademark owned by Geotherm, Inc.

1.4 Industry Standards

ASTM C31/C31M-03a Practice for Making and Curing Concrete Test Specimens in the Field

ASTM C39/C39M-05 Standard Test Method For Comprehensive Strength of Cylindrical Concrete Specimens

ASTM C94/C94M-05 Standard Specification for Sampling Ready-Mixed Concrete

ASTM C136-06 Test Method for Sieve Analysis of Fine and Coarse Aggregates

ASTM C143/C143M-05a Standard Test Method for Slump of Hydraulic-Cement Concrete

ASTM C150-07 Standard Specification for Portland Cement

ASTM C172-04 Standard Practice for Sampling Freshly Mixed Concrete

ASTM C618-05 Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete

ASTM C989-05 Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars

In this Standard, the term “City Spec” refers to: “2005 City of Seattle Standard Specifications for Road, Bridge, and Municipal Construction”. The SCL Civil Inspector for the project shall perform the duties prescribed for the Engineer in this reference.

See also section 7, References

2. Mix Design

2.1 General

2.1A FTB mix designs must specify the source of all FTB component materials, including the source pit for aggregate materials.

2.1B FTB mix designs must be engineered by a Seattle City Light-approved consultant.

2.1C FTB component materials may include:
   - 3/8” minus (medium) aggregate – ASTM C136 Sieve Analysis required for approval.
   - Building sand (fine aggregate) – ASTM C136 Sieve Analysis required for approval
   - Portland Cement – type I per ASTM C150
   - Fluidizer – Approved fluidizers are listed in Section 2.5.
   - Water – clean potable water required, or as approved by SCL.
   - Red concrete dye, where specified by Seattle City Light engineering.
   - Admixtures – Approved admixtures are listed in Section 2.6.

2.1D Mix Design Criteria: FTB mix designs shall meet or exceed the criteria in Table 4.1.

2.1E Air Content: The total air content of any FTB mix shall not exceed 2% by volume.

2.1F Substitutions: No substitutions allowed for any component material without Seattle City Light permission.

2.1G Withdrawal of Mix Design Approval: SCL reserves the right to temporarily suspend or permanently withdrawal approval of any mix design.
2.2 Seattle City Light-Owned Mix Designs

The mix designs in Table 2.2 may be used for all projects that specify FTB for Seattle City Light system construction. Any ready-mix concrete supplier may produce SCL-approved FTB from these formulas.

Table 2.2, Seattle City Light Mix Designs

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<thead>
<tr>
<th>Component</th>
<th>Low-Strength</th>
<th>High-Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>medium aggregate source</td>
<td>DuPont Pit #B-335</td>
<td>DuPont Pit #B-335</td>
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<td>medium aggregate quantity</td>
<td>1800</td>
<td>1700</td>
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<tr>
<td>fine aggregate source</td>
<td>DuPont Pit #B-335</td>
<td>DuPont Pit #B-335</td>
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<tr>
<td>water</td>
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2.3 Producer’s Identification Codes

The producer’s mix design identification code (Mix ID Codes) is provided for convenience in this document, but use of a specific mix ID does not imply conformance with the requirements in this Standard.

Table 2.3, Producer’s Mix ID Codes

<table>
<thead>
<tr>
<th>Producer</th>
<th>Low-Strength</th>
<th>High-Strength</th>
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<tr>
<td>Cadman</td>
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<td>Salmon Bay</td>
<td>S003100N</td>
<td>S3551006</td>
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<td>S &amp; G</td>
<td>307FTB</td>
<td>see 2.5B</td>
</tr>
<tr>
<td>Stoneway</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2.4 Seattle City Light-owned Special Application Mixes

This section is reserved for future development.

2.5 Approved Proprietary Mix Designs

The mix designs in Table 2.5B may be used for all projects that specify FTB for Seattle City Light system construction.

Table 2.5A, Low-Strength Approved Proprietary Mix Designs

<table>
<thead>
<tr>
<th>Producer</th>
<th>ID Code</th>
<th>Expiration</th>
</tr>
</thead>
<tbody>
<tr>
<td>none</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2.5B, High Strength Approved Proprietary Mix Designs

<table>
<thead>
<tr>
<th>Producer</th>
<th>ID Code</th>
<th>Expiration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stoneway</td>
<td>357370</td>
<td>12/31/2009</td>
</tr>
</tbody>
</table>

2.6 Requirements for Approval of Proprietary FTB Mix Designs

Seattle City Light encourages concrete producers to work directly with a qualified FTB consultant to produce FTB mix designs. Proprietary mix designs must meet the following conditions:

- 2.6A Each proprietary mix design shall conform to the specifications set forth in this Standard.

- 2.6B Proprietary mix designs not owned by Seattle City Light must be approved by Seattle City Light.

- 2.6C Each proprietary mix design must specify the source of each aggregate and the fluidizer.

- 2.6D Aggregates: Aggregates must be drawn from WSDOT-approved gravel pit, or the pit must be approved for FTB production by Seattle City Light.

- 2.6E Identification of Component Materials: Separate proprietary mix design approvals are required for any change to a source component, e.g. building sand drawn from two different pits requires a separate mix designation for each pit. Each mix design shall be assigned unique mix identification code by the ready-mix producer.
2.6 Requirements for Approval of Proprietary FTB Mix Designs, continued

2.6F Thermal Dryout Graph: The mix design owner shall supply a thermal dryout graph from a Seattle City Light-approved consultant for each FTB mix design. The graph shall demonstrate compliance with these specifications.

2.6G Compressive Strength Test: The mix design owner shall supply a 28-day compressive strength test per ASTM C39 for each mix design that demonstrates compliance with these specifications.

2.6H Expiration: Proprietary mix designs are approved for a period of two years from the date of Seattle City Light approval. The mix design may be renewed by providing new thermal dryout graphs and compressive strength tests that demonstrate compliance with these specifications.

2.7 Fluidizers

The purpose of fluidizer is to enhance flowability and inhibit segregation of materials in freshly mixed FTB, especially in low-strength mixes.

2.7A Fluidizer Approval

Seattle City Light-approved fluidizers may be used interchangeably where produced under the same ASTM specification. Unapproved fluidizers are not interchangeable with approved fluidizers. For example, approved fly ash (ASTM C618) may be used in any mix design that specifies fly ash but it may not be substituted for blast furnace slag (ASTM 989) in another mix design. Also, an approved fly ash may not be substituted for unapproved fly ash.

Fluidizer approval requires formulation of a mix design through an approved consultant, and two compliance certification reports that demonstrate consistent physical properties over a six-month period. Seattle City Light may withdraw approval at any time.

High-strength FTB mix designs may be formulated without fluidizer. Low-strength FTB mix designs must be formulated with fluidizer.

2.7B Fly Ash, per ASTM C618-05

Fly ash used in FTB mix designs shall be Class F per ASTM C618-05. Class C fly ash is not acceptable. New mix designs using fly ash for fluidizer should use SCL-approved fly ash sources. Approved Class F fly ash sources:

- Centralia Power Plant, Centralia, Washington
- Genesee Generating Station, Alberta, Canada

2.7C Ground Granulated Blast Furnace Slag (GGBFS), per ASTM C989-05

GGBFS used in low-strength FTB mix designs shall be Grade 80 per ASTM 989-05. Approved Grade 80 GGBFS sources: none

2.8 Admixtures

Admixtures must be approved for use in FTB by Seattle City Light. When allowed, the admixture shall be added per manufacturer recommendation.

2.8A Air Entraining Admixture

No air entrainment admixture shall be added to FTB under any circumstances.

2.8B Accelerating Admixture

The following accelerating admixture is approved for use in Seattle City Light FTB: Pozzolith NC 534, manufactured by BASF Admixtures, Inc.

2.8C Other admixtures require pre-approval by Seattle City Light engineering.

3. Delivery and Placement

3.1 Conformance to Mix Design

Quantities of batched component materials shall match those specified in the FTB mix design within the tolerances specified in City Spec 6-02.3(5)A, “Conformance To Mix Design”.

3.2 Documentation

The FTB supplier shall provide a Manufacturer’s Certificate of Compliance for each truckload of FTB as per City Spec 6-02.3(5)B, “Certification Of Compliance”. The Certificate shall also provide:
3.2 Documentation, continued
- Delivery location
- Quantity of water added to mix after batching

3.3 Delivery Time Limit
The duration between the time the ready mix concrete truck is batched with FTB at the central plant and the time the FTB pour begins shall be no longer than 90 minutes.

FTB shall not be batched at the installation site without permission from Seattle City Light engineering.

3.4 Retempering
Retempering is prohibited. Refer to City Spec 6-02.3(4)D.

3.5 FTB Placement
3.5A FTB shall be placed per the applicable provisions of City Spec 6-02.3(6). The requirement for electrical as-built drawings contained therein shall not apply. As-built drawing requirements shall be specified by Seattle City Light. Installers are advised to note the following requirement of 6-02.3(6):

If the concrete is to drop more than 5 feet, it shall be deposited through a sheet metal (or other approved material) conduit. No aluminum conduits or tremies shall be used to pump or place concrete.

3.5B FTB shall flow readily and fill all voids during installation. Formation of air pockets during installation shall be cause for rejection.

3.5C Conduit buoyancy: Conduits to be encased in FTB shall be adequately anchored so that they do not float during FTB placement. The water content of FTB may not be reduced to mitigate conduit buoyancy.

3.6 Vibration
3.6A SCL requires that FTB be formulated and installed with a nine-inch slump so it can flow around the duct bank and fill the voids without using vibration. A thin flowable mix is mandatory rather than a thick vibrated mix.

3.6B Where the standard FTB mixtures are too thin for the application described in 3.6A, e.g., on hillsides where FTB pools at the bottom, exceptions can be made. Such exceptions require contractors obtain special approval from SCL engineering.

In these cases the FTB shall be ordered with a three-inch slump (four-inch slump maximum) and the FTB shall only be vibrated lightly to ensure that the FTB surrounds the duct bank and chases out the entrapped air.

3.7 Remedies for Installation of Unapproved FTB Mixes
Installation of an FTB mix, where specified, that has not been approved by Seattle City Light requires one of the following remedies:

3.7A Removal and replacement of all non-compliant FTB with a Seattle City Light-approved mix.

3.7B In-field thermal testing of all non-compliant FTB as described under “FTB Mix Design and Field Test Approval Requirements” in this Standard. Any unapproved FTB that does not meet the FTB Mix Design Requirements set forth in this Standard shall be removed and replaced with a Seattle City Light-approved mix.

4. Testing Requirements
For SCL power system construction projects that require more than 100 cubic yards of any combination of FTB materials that are subject to this specification, the project manager shall provide an FTB thermal test and an FTB compressive strength test for each FTB mix design employed by the project. The testing shall be done at the beginning of FTB placement for that project. Both thermal and compressive strength samples shall be drawn from the same batch of FTB. This requirement may be waived with written permission from an SCL Engineering Supervisor.

4.1 Resistivity Testing
Approval criteria for testing FTB are provided in Table 4.1. The Mix Design parameters shall apply to mix designs submitted by an approved FTB consultant for SCL approval. The Field Test parameters shall apply to field approvals of FTB encasement and backfill where required.

The Thermal Resistivity requirement will be evaluated by comparing the FTB thermal test report specified under “Thermal Testing Procedure” below to the resistivity benchmarks from Table 4.1.

For the purposes of this Standard, the Moisture Content of the FTB will be expressed as percent moisture by weight. The Critical Moisture Content is 3% for low-strength FTB and 2% for high-strength FTB. The thermal resistivity must be less than the applicable values provided in Table 4.1 at the Critical Moisture Content.
Table 4.1, Mix Design and Field Test Criteria

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Unit</th>
<th>Low-Strength FTB</th>
<th>High-Strength FTB</th>
<th>Testing Method</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mix Design</td>
<td>Field Test</td>
<td>Mix Design</td>
</tr>
<tr>
<td>thermal resistivity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>maximum at 0% moisture content</td>
<td>°C-cm/W</td>
<td>100</td>
<td>110</td>
<td>75</td>
</tr>
<tr>
<td>maximum at critical moisture content</td>
<td>°C-cm/W</td>
<td>70</td>
<td>80</td>
<td>60</td>
</tr>
<tr>
<td>minimum 28-day compressive strength</td>
<td>lbs/sq in</td>
<td>none</td>
<td>none</td>
<td>3000</td>
</tr>
<tr>
<td>maximum 28-day compressive strength</td>
<td>lbs/sq in</td>
<td>100</td>
<td>150</td>
<td>none</td>
</tr>
<tr>
<td>minimum dry density</td>
<td>lbs/cu ft</td>
<td>130</td>
<td>130</td>
<td>136</td>
</tr>
<tr>
<td>minimum slump</td>
<td>in</td>
<td>6</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>maximum slump</td>
<td>in</td>
<td>9</td>
<td>9</td>
<td>9</td>
</tr>
</tbody>
</table>

Table 4.1 Note: Mix design criteria are intended to be equal to or stricter than field test criteria because of expected variation among batches during FTB production.

4.2 Spot Testing
Seattle City Light Field Inspectors may require field testing of FTB at the developer’s expense for quality assurance. The Inspector should show cause for spot testing.

5. Testing Procedure

5.1 Thermal Testing Procedure
Seattle City Light uses thermal testing results to assess FTB performance and to investigate FTB-related issues. FTB documentation shall be adequate to trace the source of each aggregate and the source of fluidizer material for each batch of FTB installed.

5.1A Where compressive strength testing and thermal testing is done on the same batch of FTB, the samples shall have identical sample locations (see 5.1F below), or other matching sample identification codes, assigned to both sets. The purpose is correlation of test data.

5.1B Thermal testing shall be conducted in compliance with IEEE Standard 442, “IEEE Guide for Soil Thermal Resistivity Measurements”.

5.1C Sample containers shall be cylindrical, 3” diameter and 6” tall.

5.1D A set of 3 sample containers are required for each thermal test.

5.1E The sample containers shall be prepared per ASTM C94, and sealed to prevent moisture loss.

5.1F Each sample container shall receive a label with the following information:

- Name of the SCL Inspector, SCL Crew Chief, or person responsible for sampling.
- Date of sample.
- Location where sampled FTB was installed. The description of the location should be detailed enough to determine which duct bank, or portion thereof, was sampled.
- Project name. The SCL Work Order number should be noted if known.
- Type of FTB (high-strength, low-strength, pumpable, etc.).
- FTB Producer.
- FTB Producer’s Mix Design No.

5.1G The concrete delivery ticket and batching compliance report shall be included with each set of samples. Legible copies are acceptable.

5.1H The samples shall cure 24 hours prior to shipping.

5.1J The samples shall be shipped in a cardboard box with adequate packing materials to prevent damage during shipping.
5.1 Thermal Testing Procedure, continued

5.1K The samples will be shipped to an SCL-approved thermal testing consultant.

5.1L The testing consultant shall provide a complete copy of the test report to SCL that includes:

- The name and contact information of the thermal testing consultant.
- The report date
- The concrete delivery ticket number
- The FTB Producer
- The FTB Producer’s Mix Design No.
- The dry density of each sample set, in pounds/cubic foot.
- The thermal dryout curve for each sample set that plots percent moisture content by volume on the abscissa and thermal resistivity (°C-centimeter/watt) on the ordinate. A sample report can be found under “Engineering Data” below.

5.2 Strength Testing

Strength testing for high-strength FTB shall be performed in compliance with ASTM C39-05, “Standard Test Method For Comprehensive Strength of Cylindrical Concrete Specimens”. A complete copy of the test report shall be provided to Seattle City Light.

Sampling shall be performed in compliance with ASTM C31-03a, and the samples shall be labeled as described in the Thermal Testing Procedure. When strength and thermal testing are to be performed on the same batch, the labeling of all samples shall match so the two test reports may be associated.

Table 6.1, Nominal Mix Design Properties

<table>
<thead>
<tr>
<th>Mix Design</th>
<th>Thermal Resistivity (°C-cm/W)</th>
<th>Zero Per Cent Moisture</th>
<th>Critical Moisture</th>
<th>Compressive Strength, psi</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCL Low Strength FTB</td>
<td></td>
<td>100</td>
<td>59</td>
<td>100</td>
</tr>
<tr>
<td>Stoneway 0305370 LS FTB (Icon)</td>
<td></td>
<td>95</td>
<td>62</td>
<td>250</td>
</tr>
<tr>
<td>Stoneway 0305370 LS FTB (Glacier)</td>
<td></td>
<td>95</td>
<td>56</td>
<td>250</td>
</tr>
<tr>
<td>SCL High Strength FTB</td>
<td></td>
<td>65</td>
<td>50</td>
<td>3000</td>
</tr>
<tr>
<td>Stoneway 357370 HS FTB (Icon)</td>
<td></td>
<td>68</td>
<td>61</td>
<td>3000</td>
</tr>
<tr>
<td>Stoneway 357370 HS FTB (Glacier)</td>
<td></td>
<td>68</td>
<td>49</td>
<td>3000</td>
</tr>
</tbody>
</table>

5.3 In-Field Thermal Testing


5.3B One test required for each batch of FTB installed, or every 30 linear feet of trench, whichever is greater.

5.3C The test report will contain the information specified under “Thermal Testing Procedure”, above

6. Engineering Data

The information in this section is provided for engineering convenience and does not include any contractual binding requirements.

6.1 Nominal Mix Design Properties

The Nominal Mix Design Properties in Table 6.1 may be useful to electrical design engineers and civil design engineers. The data represents properties achieved by the mix design consultant in a laboratory setting, and may not be representative of average values found in the field.

The Critical Moisture, as defined by Engineering Standards, is the moisture content value at the knee of the resistivity-moisture content curve for a specific FTB mix. See “FTB Mix Design and Field Test Approval Criteria” for values set by Engineering Standards. The critical moisture resistivity values in Table 2.2 may be valuable for modeling the cable ampacity effects of specific FTB mix designs.
6.2 Sample FTB Thermal Dryout Curve

Figure 6.2, Thermal Dryout Curve

The **Thermal Dryout Curves** were produced by an SCL-approved engineering consultant. Each curve represents a thermal resistivity test on a sample of FTB. The thermal dryout curve is used to determine if the anticipated thermal resistivity of the mix design or the installed FTB is adequate for SCL’s needs. The standard 0% moisture benchmark resistivity value should demonstrate that thermal runaway will be prevented. The standard critical moisture benchmark should establish the lowest possible resistivity values for local component materials under worst-case local soil moisture conditions. This makes the critical moisture resistivity useful in cable ampacity modeling.

**A**
**Wet Soil.** High water content provides for heat conduction (“thermal bridges”), therefore the soil thermal resistivity is low.

**B**
**Damp Soil.** As soil dries, discontinuities develop in the heat conduction path due to low water content, therefore the soil thermal resistivity increases.
6.2 Sample FTB Thermal Dryout Curve, continued

Table 6.2, Thermal Resistivity of Components

<table>
<thead>
<tr>
<th>Soil Grains</th>
<th>Thermal Resistivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>quartz</td>
<td>12</td>
</tr>
<tr>
<td>granite</td>
<td>30</td>
</tr>
<tr>
<td>limestone</td>
<td>40</td>
</tr>
<tr>
<td>sandstone</td>
<td>50</td>
</tr>
<tr>
<td>shale (sound)</td>
<td>60</td>
</tr>
<tr>
<td>shale (highly friable)</td>
<td>200</td>
</tr>
<tr>
<td>mica</td>
<td>170</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Others</th>
<th>Thermal Resistivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>ice</td>
<td>45</td>
</tr>
<tr>
<td>water</td>
<td>165</td>
</tr>
<tr>
<td>organics</td>
<td>~ 500</td>
</tr>
<tr>
<td>oil (petroleum)</td>
<td>~ 800</td>
</tr>
<tr>
<td>air</td>
<td>~ 4500</td>
</tr>
</tbody>
</table>

7. References

See also section 1.4, Industry Standards

“2005 City of Seattle Standard Specifications for Road, Bridge, and Municipal Construction” [City Spec]; City of Seattle; 2005 (The SCL Civil Inspector for the project shall perform the duties prescribed for the “Engineer” in this reference.)


“Design and Testing of Fluidized Thermal Backfill”; Deepak Parmar; Geotherm Inc. for Seattle City Light; November 15, 2002

Detter, Chris; SCL Engineer, subject matter expert for 7150.00 (chris.detter@seattle.gov)


Underground Cable Thermal Backfill; "Thermal Property Measurements Using a Thermal Probe"; J.E. Steinmanis; Pergamon Press, Toronto; 1982; pp.72-85
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Reference and standards listed herein are to be the latest edition available, unless specifically stated otherwise.

1.2 SUMMARY

A. Section includes expanded polystyrene (EPS) Geofoam.

B. Related sections include the following:
   1. Division 01 Section “Submittals Procedures.”
   2. Division 02 Section “Contractor Quality Control.”
   3. Division 03 Section “Cast-in-Place Concrete.”

1.3 REFERENCES


1.4 SUBMITTALS

A. Submit EPS Geofoam manufacturer’s product literature and TechData, including:
   1. Physical properties in compliance with ASTM D6817 Type specified.
   2. 20-year physical property warranty.

B. Shop drawings showing EPS Geofoam block layout.

C. Quality Assurance: Submit the following:
   1. Test Compliance: Summary of test compliance with specified performance characteristics and physical properties.
   2. Certificates: Manufacturer shall supply a product certificate showing evidence of Third Party Quality Control.

D. Research/Evaluation Reports: Evidence of EPS Geofoam compliance with ICC-ES.

E. Survey: Top of Triangle Garage elevations at each grid intersection shown on sheet SL102.

1.5 DELIVERY, STORAGE & HANDLING

A. Deliver EPS Geofoam labeled with material Type.

B. Store above ground, and protected from moisture and sunlight prior to installation.

C. Product should not be exposed to open flame or other ignition sources.
1.6 WARRANTY

A. Provide EPS Geofoam 20-year warranty covering the long-term physical property of expanded polystyrene Geofoam.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. ACH Foam Technologies, LLC, 5250 North Sherman St., Denver, CO 80216
2. ACH Foam Technologies, LLC, 111 W. Fireclay Ave., Murray, UT 84107
3. ACH Foam Technologies, LLC, 920 Kleppe Lane, Sparks, NV 89431
4. Big Sky Insulations, Inc., 15 Arden Drive, Belgrade, MT 59714
5. Branch River Plastics, Inc., 15 Thurber Boulevard, Smithfield, RI 02917
6. Flexible Packaging Group, PO Box 4321, Bayamon, PR 00958-1321
7. Insulfoam, 6004 N. Westgate Blvd Ste 120, Tacoma, WA 98406
8. NoArk Enterprises, Inc., 10101 Highway 70 East, North Little Rock, AR 72117
9. Pacific Allied Products, Ltd., 91-110 Kaomi Loop, Kapolei, HI 96707
11. Team Industries, Inc., 4580 Airwest Drive SE, Grand Rapids, MI 49588-8691
12. Team Industries, Inc., 326 McGhee Road, Winchester, VA 22603
13. Therma Foam, Inc., 1240 Hwy 77 North, Hillsboro, TX 76645
14. AFM Corporation, 211 S River Ridge Circle, Suite 102A, Burnsville, MN 55337

2.2 EPS GEOFOAM

A. Where used above the Triangle Garage for lightweight fill, EPS Geofoam shall be compliance with ASTM D6817 type EPS19. Minimum density shall be 1.15 pounds per cubic foot and minimum compressive resistance at 1% deformation shall be 5.8 psi.

B. Where used near the bridge as a compressible layer, EPS Geofoam shall be compliance with ASTM D6817 type EPS12. Minimum density shall be 0.70 pounds per cubic foot and minimum compressive resistance at 1% deformation shall be 2.2 psi.

C. All EPS Geofoam blocks shall be treated by the manufacturer with a tested and proven termite treatment for below grade applications, 3 year minimum field exposure. The treatment shall be EPA registered, meet requirements of ICC ES EG239, and be recognized in an ICC ES report.

2.3 GEOGRIPPER PLATES

A. GeoGripper® plates shall be used to restrain EPS Geofoam from moving laterally in layer over layer applications. The GeoGripper plate shall be manufactured by AFM Corporation, or approved equal. The plate shall be made of galvanized or stainless steel with two-sided multi-barbed design capable of piercing geofoam. Each plate shall be capable of a lateral holding strength of 60 lbs.
PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

A. Compliance: Comply with manufacturer's product data, including product technical bulletins, and product catalog.

3.2 EXAMINATION

A. Site Verification of Conditions: Verify substrate conditions, which have been previously installed under other sections, are acceptable for product installation, in accordance with manufacturer's instructions.

1. Verify conditions of substrate, grade and other conditions which affect installation of geofoam. Any adverse conditions shall be reported in writing. Do not proceed with installation until adverse conditions are corrected.

2. Verify details prior to starting EPS Geofoam installation.

3. Verify base preparation to support the EPS Geofoam.

3.3 INSTALLATION

A. Installation: Comply with manufacturer's installation requirements. Stagger adjacent EPS Geofoam blocks. Cut sloped profiles with hot wire EPS cutters. Provide at least one GeoGripper plate per 16 square feet of layered EPS Geofoam. Restrain EPS Geofoam blocks from moving during construction.

B. Tolerances: When used as concrete formwork, comply with tolerance requirements listed in Division 03 Section "Cast-In-Place Concrete."

C. Related Products Installation: Refer to other sections listed in Related Sections paragraph herein for related products installation.

3.4 FIELD QUALITY REQUIREMENTS

A. Manufacturer's Field Services: Upon Owner's request, provide manufacturer's field service, which consists of periodic site visits for inspection of product.

3.5 CLEANING

A. Cleaning: Remove temporary coverings and protection of adjacent work areas. Repair or replace damaged installed products. Remove construction debris from project site and legally dispose of debris.

3.6 PROTECTION

A. Protection: Protect installed product and finish surfaces from damage during construction.

END OF SECTION 31 23 23
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. References and standards listed herein are to be the latest edition available, unless specifically stated otherwise.

1.2 SUMMARY

A. This Work consists of constructing Mechanically Stabilized Earth (MSE) retaining walls.

B. Temporary MSE retaining walls are defined as those walls and wall components constructed and removed or abandoned before the Physical Completion Date of the project or as shown in the Plans. All other MSE retaining walls shall be considered as permanent.

C. Related Sections include the following:
   1. Division 31 Section “Gabion Boxes” for wall facing.

1.3 QUALITY ASSURANCE

A. The Contractor shall complete the base of the retaining wall excavation to within plus or minus 3 inches of the staked elevations unless otherwise directed by the Engineer. The Contractor shall place the external wall dimensions to within plus or minus 2 inches of that staked on the ground. The Contractor shall space the reinforcement layers vertically to within plus or minus 6 inch of that shown in the Plans.

B. The completed wall(s) shall meet the following tolerances:

<table>
<thead>
<tr>
<th>Permanent Wall</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Deviation from the design batter and horizontal alignment for the face when measured along a 10-foot straightedge at the midpoint of each wall layer shall not exceed:</td>
<td>3 inches</td>
</tr>
<tr>
<td>Deviation from the overall design batter per 10 feet of wall height shall not exceed:</td>
<td>2 inches</td>
</tr>
<tr>
<td>Maximum outward bulge of the face between backfill reinforcement layers shall not exceed:</td>
<td>4 inches</td>
</tr>
</tbody>
</table>

1.4 SUBMITTALS

A. At least 15 days prior to initiating the work, the contractor shall submit to the engineer for review and approval:
   1. Type, Manufacturer, Tensile Strength, and available test data for the reinforcement chosen by the contractor.
   2. Shop drawings and specifications for connection between reinforcement and permanent or buried structures as required by the plans.
3. Shop drawings and specifications for connection between reinforcement and gabion basket permanent facing.

4. Proposed construction methods and sequence.

5. Detailed wall plans showing the actual lengths proposed for the reinforcing layers and the locations of each reinforcement product proposed for use in each of the reinforcing layers.

6. The Contractor’s proposed wall construction method, including proposed reinforcement, types of equipment to be used, proposed erection sequence and details of how the backfill will be retained during each stage of construction.

7. Manufacturer certifications for the reinforcement and all connections.

8. Approval of the Contractor’s proposed wall construction details and methods shall not relieve the Contractor of their responsibility to construct the walls in accordance with the requirements of these Specifications.

1.5 PRECONSTRUCTION MEETING

A. A preconstruction meeting shall be held prior to the start of the work and shall be attended by the owner’s representatives, the engineer, the contractor, the excavation contractor, the Gabion Basket installer and MSE wall subcontractor. The preconstruction meeting shall be conducted to clarify the construction requirements for the work, to coordinate the construction activities, and to identify contractual relationships and responsibilities.

PART 2 - MATERIALS

A. Materials for construction of MSE walls shall be furnished new and without defects. Defective materials rejected by the engineer shall be removed by the contractor at no additional cost to the owner. Materials shall consist of the following:

1. Facing shall consist of Gabion Baskets per Plans.

2. Backfill shall consist of City of Seattle Mineral Aggregate Type 17 or approved equal.

3. Reinforcement shall have a long-term design strength of at least 1,500 lbs. per foot and shall be approved by the engineer and installed per the manufacturers specifications.

4. Perforated or slotted Pipe shall be Schedule 40 PVC per Plans.

PART 3 - EXECUTION

3.1 GENERAL

A. The construction sequence shall be as shown on the plans, or in accordance with the approved submittal, unless approved otherwise by the engineer. No excavations steeper or higher than those specified herein shall be made above or below the MSE wall without written approval of the engineer.

3.2 EXCAVATION AND FOUNDATION PREPARATION

A. Excavation dimensions shall conform to plans. Foundations soils found to be unsuitable shall be removed and replaced.

B. The Contractor shall direct all surface runoff from adjacent areas away from the retaining wall construction site.
3.3 ERECTION AND BACKFILL

A. The Contractor shall begin wall construction at the lowest portion of the excavation and shall place each layer horizontally as shown in the Plans. The Contractor shall complete each layer entirely before beginning the next layer.

B. Reinforcement splices shall consist of a manufacturer recommended and engineer approved method. The Contractor shall offset reinforcement splices in one layer from those in the other layers such that the splices shall not line up vertically. Splices parallel to the wall face will not be allowed, as shown in the Plans.

C. The Contractor shall stretch out the reinforcement in the direction perpendicular to the wall face to ensure that no slack or wrinkles exist in the reinforcement prior to backfilling.

D. For geogrids, the length of the reinforcement required as shown in the Plans shall be defined as the distance between the back of the Gabion basket and the last geogrid node at the end of the reinforcement in the wall backfill.

E. The Contractor shall place fill material on the reinforcement in lifts such that 6 inches minimum of fill material is between the vehicle or equipment tires or tracks and the reinforcement at all times. The Contractor shall remove all particles within the backfill material greater than 3 inches in size. Turning of vehicles on the first lift above the reinforcement will not be permitted. The Contractor shall not end dump fill material directly on the reinforcement without the prior approval of the Engineer.

F. Should the reinforcement be damaged or the splices disturbed, the backfill around the damaged or displaced area shall be removed and the damaged strip of reinforcement replaced by the Contractor at no expense to the Contracting Agency.

G. Structural backfill shall be placed and compacted in accordance with the Specifications Section 31 00 00, Earthwork.

3.4 WALL DRAINAGE

A. Description

1. The drainage network shall consist of installing the drainage material and wall footing drains as shown on the plans or as directed by the engineer.

B. Drainage Control

1. Localized areas of perched water may be encountered. The contractor shall notify the engineer if groundwater occurs in the excavation or at the excavation face.

2. The contractor shall provide positive control and discharge of all surface water encountered during construction to the extent necessary to prevent adverse conditions as determined by the engineer.

3. Footing drains shall consist of drainage aggregate and perforated PVC pipe and shall be constructed at the bottom of each wall as shown on the plans. All pipe joints shall be solvent-welded.

END OF SECTION 31 32 19
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. References and standards listed herein are to be the latest edition available, unless specifically stated otherwise.

1.2 SUMMARY

A. The work described in this section shall consist of installing soil nails and wall drainage as specified herein and shown on the plans. The work shall also include excavating in accordance with the staged lifts shown on the plans; drilling soil nail holes to the specified minimum length and orientation indicated on the plans; providing, placing, and grouting the nails in the drilled holes; placing drainage elements; and performing all soil nail pullout testing. The contractor shall furnish all labor, equipment, and materials required for completing the work.

B. The contractor is responsible for the construction means and methods and control the process of the work. This includes the construction sequence, the safety of workers, temporary handrails, excavation access, barriers, lifting of materials and construction equipment into and out of the excavation, temporary bracing of formwork, and the stability of all temporary cut slopes.

C. Construction of soil nail walls requires excavation in staged lifts and excavation in the vicinity of the wall face requires special care and effort compared to general earthwork excavation. The contractor should take this into account during bidding.

D. The soil nail walls are designed to support the excavation sidewalls once the components of the soil nails and facing system are completely installed for all lifts up to and including the current excavation lift. The stability of interim temporary face cuts that exist prior to installation of the wall facing is the sole responsibility of the contractor.

E. Related Sections include the following:

1. Division 03 Section “Shotcrete” for wall facing.

1.3 SUBMITTALS

A. At least 15 days prior to initiating the work, the contractor shall submit to the engineer for review and approval:

1. A detailed construction site drainage plan addressing all elements necessary to divert, control, and dispose of surface water.

2. Shop drawings and specifications for connection between geocomposite strips and weep holes.

3. Proposed construction methods and sequence.

4. Proposed drilling methods and equipment including drill rig type, use of cased or open-hole methods, proposed drillhole diameter, and method of cuttings removal to achieve the specified pullout resistance.

5. Nail grout mix design including: brand and type of Portland cement; source, gradation, and quality of all aggregates; proportions of mix by weight and water-cement ratio;
manufacturer and brand name of all admixtures; and compressive strength test results (per ASTM C109/AASHTO T105) verifying the specified minimum 3 and 28 day grout strengths.

6. Nail grout placement procedures and equipment.

7. Once available, certified mill test results for nail bars from each heat specifying the ultimate strength, yield strength, elongation, and composition.

8. Manufacturer certifications for the soil nail centralizers and bar couplers.

9. Nail testing methods and equipment including details of the jacking frame and appurtenant bracing, methods of isolating test nails during shotcrete application, and methods of grouting the unbonded length of test nails after testing.

10. Identification numbers and certified calibration records for each test jack and pressure gauge pair to be used. Calibration records shall include the date tested, device identification number, and the calibration test results and shall be certified for an accuracy of at least 2% of the applied certification loads by a qualified independent testing laboratory within 90 days prior to submittals.

11. Submittals shall be in accordance with Division 01 Section “Submittal Procedures” of project specifications.

1.4 PRECONSTRUCTION MEETING

A. A preconstruction meeting shall be held prior to the start of the work and shall be attended by the owner’s representatives, the engineer, the contractor, the excavation contractor, and the soil nail subcontractor. The preconstruction meeting shall be conducted to clarify the construction requirements for the work, to coordinate the construction activities, and to identify contractual relationships and responsibilities.

1.5 EXISTING SITE CONDITIONS, UTILITIES, AND UNDERGROUND OBSTRUCTIONS

A. The contractor shall visit the site prior to any construction activities for the purpose of observing and documenting the pre-construction condition of structures, sidewalks, roadways, and other infrastructure within and adjacent to the work area. The contractor shall observe the area behind all retaining walls on a daily basis during construction for signs of movement, settlement, or instability. The contractor shall notify the owner’s representative and the engineer if signs of movement such as new cracks in structures, increased size of old cracks or separation of joints in structures, foundations, streets, or paved and unpaved surfaces are observed. If the engineer determines that movement exceed those anticipated for typical soil nail walls and require corrective action, the contractor shall take corrective actions necessary to stop the movement or perform repairs. When due to the contractors’ methods or operations or failure to follow the specified/approved construction sequence, as determined by the engineer, the costs of providing corrective actions will be borne by the contractor.

B. The contractor shall notify the engineer of utility conflicts and seek approval to shift soil nail locations.

C. The contractor is responsible for removing abandoned utilities and other underground obstructions that may interfere with the installation of soil nail walls.

1.6 SURFACE WATER CONTROL

A. The contractor is responsible for providing construction site drainage, both behind and in front of the walls, that is independent of the wall drainage system.
B. In accordance with the submittals section, the contractor shall submit to the engineer for review and approval a detailed construction site drainage plan addressing all elements necessary to divert, control, and dispose of surface water. Control of surface water behind walls could be accomplished by sloping to promote runoff away from the excavation, trenches and sumps, or shotcrete gutters. The excavation should be graded to promote drainage away from the toe of the walls.

C. Existing subsurface drainage features encountered during excavation shall be brought to the immediate attention of the engineer. Work in these areas shall be suspended until remedial measures meeting the approval of the engineer are implemented by the contractor. Surface water runoff flow and flows from existing subsurface drainage features shall be captured independently of the wall drainage network and conveyed to an outfall structure or storm sewer meeting the approval of the engineer. Remedial measures for existing subsurface drainage features encountered during the work, which were not identified on the plans, will be paid for as extra work per the contract documents.

PART 2 - PRODUCTS

2.1 GENERAL

A. Materials for construction of soil nail walls shall be furnished new and without defects. Defective materials rejected by the engineer shall be removed by the contractor at no additional cost to the owner. Materials shall consist of the following:

1. Centralizers shall be Schedule 40 polyvinyl chloride (PVC), securely attached to the nail bar, sized to position the nail bar within 1 inch of the center of the drillhole, sized to allow tremie pipe insertion to the bottom of the drillhole, and sized to allow grout to flow freely up the drillhole.

2. Nail grout shall be a neat or sand/cement mixture with a minimum 3-day compressive strength of 1,500 pounds per square inch (psi) and a minimum 28-day compressive strength of 3,000 psi per American Society for Testing and Materials (ASTM) C109/American Association of State Highway and Transportation Officials (AASHTO) T106.

3. Cement shall conform to ASTM C150/AASHTO M85, Type I.

4. Fine aggregate shall conform to ASTM C33/AASHTO M6.

5. Solid nail bars for soil nails shall conform to ASTM A615/AASHTO M31, Grade 75 and be epoxy coated along the entire bar length. Epoxy coating shall be a minimum 16 mils thick.

6. Bar couplers shall be galvanized steel and develop the full ultimate tensile strength of the bar as certified by the manufacturer.

7. Bearing plates shall conform to ASTM A709/AASHTO M270, Grade 36.

8. Nuts and washers shall conform to AASHTO M291, Grade B, hexagonal fitted with beveled washer or spherical seat to provide uniform bearing.

9. Headed studs shall conform to ASTM A307 and be automatically end welded.

10. Geocomposite drain shall consist of Miradrain 6000 or an approved equivalent product. Geocomposite shall be installed in minimum 16-inch wide strips.

11. PVC pipe shall be minimum 2-inch diameter, Schedule 40 PVC.
2.2 HANDLING AND STORAGE

A. Cement shall be adequately stored to prevent moisture degradation and partial hydration. Cement that has become caked or lumpy shall not be used.

B. All nail bars shall be carefully handled and shall be stored on supports to keep the steel from contact with the ground. Nail bars shall be picked up in such a way as to prevent overstretching. Damage to the nail bar as a result of overstretching, abrasion, cuts, nicks, welds, and weld splatter shall be cause for rejection by the engineer. Grounding of welding leads to the nail steel shall not be allowed. Nail steel shall be protected from and sufficiently free of dirt, rust, and other deleterious substances prior to installation. Heavy corrosion or pitting of nails shall be cause for rejection by the engineer.

C. Drainage geotextile and geocomposite drains shall be provided in rolls wrapped with a protective covering and stored in a manner that protects the fabric from mud, dirt, dust, debris, and shotcrete rebound. Protective wrapping shall not be removed until immediately before the geotextile or geocomposite drain material is installed. Extended exposure to ultraviolet light shall be avoided.

PART 3 - EXECUTION

3.1 GENERAL

A. The construction sequence shall be as shown on the plans, or in accordance with the approved submittal, unless approved otherwise by the engineer. No excavations steeper or higher than those specified herein shall be made above or below the soil nail wall without written approval of the engineer.

B. Construction methods approved by the engineer do not relieve the contractor of all responsibility for stability of the temporary cut face until it is closed and stabilized with hardened shotcrete and the nail head connection is completely installed.

3.2 EXCAVATION

A. Mass Excavation

1. For distances away from the wall face greater than the current wall height, mass excavation may occur at any time, but with slopes no steeper than 1 horizontal to 1 vertical (1H:1V), unless approved otherwise by the engineer.

2. Mass excavation of the drill bench for the next row of soil nails may occur any time the day after the proceeding lift is shotcreted, provided such excavation occurs no closer than 5 feet from the face of the shotcrete. All temporary slopes that are higher than 4 feet shall not be steeper than 1H:1V, unless approved otherwise by the engineer. Wider benches may be required depending on encountered soil conditions.

3. During mass excavation of the drill bench for the next row of nails, the contractor shall maintain a bench of material to serve as both a platform for the drilling equipment, and as a stabilizing berm against the final wall excavation face near line. In accordance with that shown on the plans or approved otherwise by engineer, the material near the wall face may be (a) a native berm, (b) a fill berm, or (c) neat cut. In all three cases, the drill bench shall be established not more than 3 feet below the row of nails to be installed and shall extend out from the wall face a minimum distance necessary to provide a safe working bench for the drill equipment and workers. The contractor is completely responsible for the safety and stability of the temporary drill bench and wall face cut, until the corresponding shotcrete lift with connection hardware is constructed as shown on the plans.
4. Subsequent mass excavation beneath a preceding shotcrete lift, closer than 5 feet (horizontal) from the face of shotcrete, shall not occur until: (1) nail grout and shotcrete on the preceding lift shall have reached 50 percent of their specified 28-day compressive strengths; and (2) installation of connection hardware and nail testing for the preceding lift are complete and acceptable to the engineer. Mass excavation closer than 5 feet (horizontal) to the shotcrete face must be in accordance with the drill berm requirements described above and shown on the plans.

B. Wall Face Excavation

1. Excavation to the final wall excavation face (neat line) shall be done using procedures that (1) prevent ground loss, (2) prevent swelling, air slaking, or loosening of the soil face, (3) minimize degradation of soil bearing support below the overlying portions of the soil nail wall and below the soil nails currently being installed, (4) minimize soil moisture loss, and (5) prevent ground freezing.

2. Excavating of the ground beyond the final wall face shall not be allowed except as noted below. Inadvertent overexcavation beyond the final wall face shall be restored by the contractor using a method approved by the engineer and at no additional cost to the owner. Excavating of the ground beyond the final wall face shall be allowed as required to facilitate construction of the footing along the wall. Undermining of the soil below the wall shall be allowed when the soil remains stable for a sufficient time to allow the footings to be completed, and will be evaluated by the engineer on a case by case basis.

3. The duration of time between excavation to the final wall face (neat line) and application of the shotcrete shall be referred to as the “closure time.” The closure time shall be less than a single work shift, or as approved by the engineer.

4. Extensions of the closure time shall be submitted for approval. No approval for extension of closure time shall be granted until a test cut is constructed and the contractor demonstrates for each material type that the unsupported final excavation face will be stable over the proposed closure time. Extensions of the closure time may be revoked by the engineer at any time depending on the performance of the cut face.

5. Cobbles, boulders, rubble, or other objects that are encountered at the soil face during excavation and that protrude from the soil face shall be the responsibility of the contractor. The contractor shall be responsible for constructing the shotcrete construction facing and/or the finish structural facing to the specified minimum thickness and to the line and grade indicated on the plans. Methods for removal of face protrusions to accomplish this construction shall be determined by the contractor. The contractor shall notify the engineer of the proposed method of mitigation of face protrusions at least 24 hours prior to initiation of the work. Should the removal of face protrusions result in voids beyond the finish face line (neat line), the contractor shall determine the appropriate method of backfilling and shall submit to the engineer such method(s) at least 24 hours prior to initiating the work.

C. Temporary End of Wall Conditions

1. Where the contractor’s construction sequencing results in a discontinuous lift along any nail row, the ends of the lift shall extend beyond the ends of the next lower lift by at least 10 feet. Slopes/berms immediately beneath these stepped lifts shall be constructed to prevent sloughing or failure that would result in loss of the face support provided by the slopes/berms.

3.3 WALL DRAINAGE

A. Description
The drainage network shall consist of installing the prefabricated geocomposite drainage material, PVC connection pipes, and wall footing drains as shown on the plans or as directed by the engineer. Exclusive of the wall footing drains, elements of the drainage network shall be installed prior to shotcreting.

B. Drainage Control
   1. Localized areas of perched water may be encountered above the regional groundwater level. The contractor shall notify the engineer if groundwater occurs in the excavation or at the excavation face.
   2. The contractor shall provide positive control and discharge of all surface water encountered during construction to the extent necessary to prevent adverse conditions as determined by the engineer.

C. Geocomposite Drain Material
   1. Geocomposite drain material shall be installed as shown on the plans and in accordance with the manufacturer’s recommendations.
   2. The geocomposite drain material shall be secured to the excavation face with the geotextile side against the ground before shotcreting. Drain material shall be made continuous by using the “shingle” method of splicing with a 16-inch minimum overlap such that the flow of water from the geocomposite to the footing drain is not impeded.
   3. Full-face coverage may be necessary if excessive groundwater conditions are encountered as determined by the engineer. Payment shall be per the contract unit price.
   4. Geocomposite shall be protected from damage during excavation. Damaged or defective drain material shall be rejected by the engineer in accordance with the manufacturer’s recommendations.

D. Connection Pipes and Weepholes
   1. Connection pipes and weepholes shall be installed as shown on the plans in accordance with the manufacturer’s recommendations. Connection pipes shall be lengths of solid PVC pipe installed to direct water from the geocomposite drain material into the footing drain. In accordance with the submittals section, the contractor shall submit a method to connect geocomposite strips to weepholes. The joint between the drain pipe and the drain material, and the discharge end of the connector pipe shall be sealed to prevent shotcrete intrusion. Damage of the geocomposite drain material, which, in the opinion of the engineer, may cause interruption in flow, shall require installation of additional connection pipes or weepholes above the damaged section. Connection pipes shall be connected to the footing drain manifold.

E. Footing Drains
   1. Footing drains shall consist of drainage aggregate and perforated PVC pipe and shall be constructed at the bottom of each wall as shown on the plans. All pipe joints shall be solvent-welded.

3.4 NAIL INSTALLATION

A. General
   1. For each different method of installation used, two successful verification tests shall be completed in each soil unit identified on the plans. Verification tests shall be completed and approved by the engineer prior to installation of production nails in the corresponding
soil unit. The locations of the verification tests are to be determined by the contractor and approved by the engineer. Additional verification tests may be required if the contractor modifies the installation methods from those used during the installation of the approved verification test nails and will be conducted at the contractor’s expense.

2. Nails shall be installed prior to the application of shotcrete at the locations and to the lengths indicated on the plans. The engineer may add, eliminate, or relocate nails to accommodate actual field conditions.

B. Drilling

1. The contractor shall select drilling equipment and methods suitable for the ground conditions described in the geotechnical report. Drillhole diameter shall be selected to provide the minimum specified grout cover over the soil nail bar and to develop the specified pullout resistance. This project’s soil nail design assumes a minimum 6-inch drill hole diameter. Water, drilling muds, or other fluids used to assist in cutting removal shall not be used for uncased drillholes. Uncased drillholes shall be observed for cleanliness by the engineer or engineer’s representative prior to insertion of the soil nail bar. In caving ground, the contractor shall use cased or augercast drilling methods to support the sides of the drillholes.

2. The contractor shall immediately suspend drilling operations if evidence of ground movement is observed, if the soil nail wall is adversely affected, or if adjacent structures are damaged as a result of the drilling operation. The adverse conditions shall be stabilized immediately and the engineer shall be notified of such conditions within 24 hours of observation.

C. Nail Bar Installation

1. Nail bars shall be inserted into the drillhole to the required length without difficulty and in such a manner as to prevent damage to the drillhole. Nail bars that cannot be fully inserted to the design depth shall be removed from the drillhole and the drillhole shall be cleaned sufficiently to allow unobstructed installation of the bar.

2. If the nail bar is installed using cased or augercast methods, centralizers are not required provided the installation method ensures that the nail bar will remain in the central portion of the nail grout. In such situations, slump shall not exceed 8 inches.

D. Grouting

1. Grout equipment shall produce a uniformly mixed grout free of lumpy and undispersed cement. A positive displacement grout pump shall be used. The pump shall be equipped with a pressure gauge that can measure at least twice but no more than three times the intended grout pressure. The grouting equipment shall be sized to enable the entire nail to be grouted in one continuous operation. The mixer shall be capable of continuously agitating the grout during usage.

2. Uncased drill holes shall be grouted after installation of the nail bar. Grouting prior to insertion of the nail bar can be allowed provided neat cement grout is used and the nail bar is immediately inserted through the grout to the specified length without difficulty. No portion of the drillhole shall be left open for more than 1 hour prior to grouting unless determined otherwise by the engineer. The grout shall be injected at the lowest point of each drillhole through a tremie pipe, hollow-stem auger, or drill rods with the drillhole filled in one continuous operation. Cold joints in the grout placement are allowed for construction of test nails. The conduit delivering the grout shall be kept below the surface of the grout as the conduit is withdrawn. The grouting conduit shall be withdrawn as the drillhole is filled in a manner that prevents the creation of voids. The quantity of grout and the grouting pressures shall be recorded for each soil nail. Grout pressures shall be controlled to prevent excessive ground heave or fracturing.
3. During casing removal for drillholes advanced by either cased or augercast methods, the grout surface within the casing shall be continually monitored for maintenance of "head" sufficient to offset the external groundwater/soil pressure.

E. Grouting Testing

1. Nail grout shall have a minimum compressive strength of 1,500 psi in 3 days and 3,000 psi in 28 days. Nail grout shall be tested by the contractor in accordance with ASTM C109/AASHTO T106 at a frequency of no less than one test for every 50 cubic yards of grout placed or once per week, whichever occurs first.

3.5 NAIL TESTING

A. General

1. Verification tests shall be performed at the locations selected by the contractor and approved by the engineer. Proof tests shall be performed at the locations selected by the engineer. All test data shall be recorded by the engineer, unless approved otherwise. Pullout testing of nails shall not be performed until the nail grout and shotcrete facing have attained at least 50 percent of their specified 28-day compressive strengths.

2. Where temporary casing of the unbonded length of test nails is provided, the casing shall be installed to prevent any reaction between the casing and the grouted bond length of the nail and/or the stressing apparatus.

B. Test Nail Unbonded Length

1. Temporary unbonded lengths shall be provided for each test nail. The test nail bar shall be isolated from the shotcrete facing and the reaction frame during testing. Isolation of a test nail through the shotcrete facing shall not affect the location of the reinforcing steel under the bearing plate. Accepted proof test nails may be incorporated in the work provided the temporary test unbonded length is fully grouted subsequent to testing.

2. Test nail isolation methods, methods for providing an unbonded length, and methods for grouting the unbonded length subsequent to testing shall be submitted by the contractor to the engineer for review and approval in accordance with the requirements of the submittal section of this contract.

C. Nail Testing Equipment

1. Testing equipment shall include two dial gauges, a dial gauge support, jack and pressure gauge, a pump, and a reaction frame.

2. A minimum of two dial gauges capable of measuring to 0.001-inch shall be available at the site to measure the nail movement. The dial gauges shall have a minimum travel sufficient to allow the test to be performed without re-setting the dial gauge. The dial gauges shall be aligned within 5 degrees of the axis of the nail and shall be supported independent of the jacking setup and the wall. A hydraulic jack, pressure gage, and pump shall be used to apply and measure the test load.

3. The jack and pressure gauge shall be calibrated by an independent testing laboratory as a unit. The pressure gauge shall be graduated in 100 pounds per square inch (psi) increments or less and shall have a range not exceeding twice the anticipated maximum pressure during testing unless approved otherwise by the engineer. The ram travel of the jack shall be sufficient to enable the test to be performed without re-setting the jack. The jack shall be capable of applying each test load increment in less than 1 minute.

4. The jack shall be independently supported and centered over the nail so that the nail does not carry the weight of the jack. The stressing equipment shall be placed over the nail in such a manner that the jack, bearing plates, and stressing anchorage are in
alignment. The jack shall be positioned at the beginning of the test such that unloading and repositioning of the jack during the test will not be required.

5. The reaction frame shall be sufficiently rigid and of adequate dimension such that excessive deformation of the test apparatus requiring repositioning of any components does not occur during testing. Where the reaction frame bears directly on the shotcrete facing, the reaction frame shall be designed to prevent fracture of the shotcrete.

D. Verification Testing of Sacrificial Nails

1. Verification testing in each soil unit shall be performed prior to installation of production nails in that unit to verify the contractor’s installation methods, nail pullout capacity, and design assumptions. The nails used for the verification tests shall be sacrificial and shall not be incorporated as production nails. Payment for additional verification tests required due to differing site conditions, as determined by the engineer, shall be per the contract unit price.

2. Test nails shall be constructed using the same equipment, methods, and hole diameter as planned for the production nails. Changes in the drilling or installation method may require additional verification testing, as determined by the engineer, and shall be provided at no additional cost to the owner.

3. The unbonded length of the test nail shall be at least 3 feet unless approved otherwise by the engineer. The bonded length of the test nail shall be determined by the engineer based on the bar grade and size such that the allowable bar load is not exceeded, but shall not be less than 10 feet. The allowable bar load during testing shall not exceed 80 percent of the steel ultimate strength for Grade 150 bars or 90 percent of the yield strength for Grade 60 and Grade 75 bars.

4. The design test load (DTL) during testing shall be determined by multiplying the bond length of the nail times the applicable design adhesion as determined by the engineer. Verification test nails shall be incrementally loaded in accordance with the following schedule.

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<td>1.75DTL</td>
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5. The alignment load (AL) should be the minimum load required to align the testing apparatus and should not exceed 0.05DTL. Dial gauges should be zeroed after the alignment load has been applied.

6. Each load increment shall be held for at least 10 minutes. The verification test nail shall be monitored for creep for 60 minutes at the 1.50DTL load increment. Nail movements during the creep portion of the test shall be measured and recorded at 1, 2, 3, 5, 6, 10, 20, 30, 50, and 60 minutes.

E. Proof Testing of Production Nails

1. Proof testing shall be performed on approximately 5 percent of the production nails in each shotcrete lift as determined by the engineer or one nail per row, whichever is greater. If nail installation methods are substandard on any particular nail or series of nails, additional tests may be required.
2. The unbonded length of the test nails shall be at least 2 feet. The bonded length of the test nail shall be determined by the engineer using the applicable design adhesion such that the allowable bar load is not exceeded but shall not be less than 4 feet. The allowable bar load during testing shall not exceed 80 percent of the steel ultimate strength for Grade 150 bars or 90 percent of the steel yield strength for Grade 60 and Grade 75 bars.

3. Proof test nails shall be incrementally loaded in 0.25DTL increments to a maximum load of 1.50DTL. Each load increment shall be held until the dial gauge reading is stable.

4. The alignment load (AL) should be the minimum load required to align the testing apparatus and should not exceed 0.05DTL. Dial gauges should be zeroed after the alignment load has been applied.

5. All increments shall be maintained within 5 percent of the intended load. Depending on performance, either a 10- or a 60-minute creep test shall be performed at 1.50 DTL. Nail movement shall be measured and recorded at 1, 2, 3, 4, 6, and 10 minutes. Where the nail movement between 1 minute and 10 minutes exceed 0.04 inch, the maximum test load shall be maintained an additional 50 minutes and movements shall be recorded at 20, 30, 50 and 60 minutes.

F. Test Nail Acceptance Criteria

1. A test nail shall be considered acceptable when:
   a. For verification tests, a creep rate less than 0.08 inch per log cycle of time between the 6- and 60-minute readings is observed, and the rate is linear or decreasing throughout the creep test and load hold period.
   b. For proof tests, a creep rate less than 0.04 inch per log cycle of time between the 1- and 10-minute readings is observed or a creep rate less than 0.08 inch per log cycle of time between the 6- and 60-minute readings, and the creep rate is linear or decreasing throughout the creep test load hold period.
   c. The total movement at the maximum test load exceeds 80 percent of the theoretical elastic elongation of the test nail unbonded length.
   d. A pullout failure does not occur during testing. Pullout failure is defined as the load at which attempts to increase the test load results in continued pullout movement of the test nail.

2. At the contractor’s option, successful proof test nails meeting the above test acceptance criteria may be incorporated as production nails, provided that (1) the unbonded test length of the nail hole has not collapsed during testing, (2) the minimum required hole diameter has been maintained, and (3) the test nail length and bar size are equal to or greater than the scheduled production nail length and bar size. Test nails meeting these requirements shall be completed by satisfactorily grouting the unbonded test length. Maintaining the temporary unbonded test length for subsequent grouting is the contractor’s responsibility.

G. Inadequate Test Nail Performance

1. The engineer shall evaluate the results of each verification test. Installation methods that do not satisfy the nail testing requirements shall be considered inadequate. The contractor shall propose alternative methods and install replacement verification test nails. Replacement test nails shall be installed and tested at no additional cost to the owner.

2. The engineer may require that the contractor replace some or all of the production nails represented by the inadequate proof test nail. Alternatively, the engineer may require proof testing of additionally installed proof test nails be conducted to verify that adjacent
previously installed production nails have sufficient load carrying capacity. Additional proof tests or installation of additional or modified nails as a result of poor proof test nail performance shall be at no additional cost to the owner, unless determined by engineer to be due to causes beyond the contractor’s control.

H. Soil Nail Tolerances

1. The soil nails shall not extend beyond approved right-of-way or easement limits, unless approved otherwise. Bars shall be centered within 1 inch of the center of the drillhole. Individual nails shall be positioned plus or minus 12 inches from the design locations shown on the plans. Location tolerances shall be considered applicable to only one nail and not cumulative over large wall areas. The nail inclination shall be plus or minus 3 degrees of that shown in the plans. Nail splay angle shall be within plus or minus 3 degrees. Nails that encounter unanticipated obstructions during drilling shall be relocated by the engineer at the owner’s cost. Soil nails that do not satisfy the specified tolerances due to contractor’s installation methods shall be replaced to engineer’s satisfaction at no additional cost to the owner.

3.6 RETAINING WALL MONITORING

A. Surveying

1. Survey monitoring of soil nail walls shall be performed by a licensed surveyor. The contractor shall perform survey monitoring of the soil nail walls. Surveys shall be performed to determine the plan location and elevation of monitoring points before the start of construction and on a regular basis throughout construction to evaluate movements resulting from construction activity. Survey monitoring shall be continued 6 months after completion.

2. In general, monitoring points shall be surveyed and the results reported to the owner and engineer twice weekly during construction and once monthly after construction, unless excavation progress or post-construction results dictate less or more frequent surveys, as determined by the engineer. If any movements exceed ½-inch, monitoring points shall be surveyed daily in the areas of concern. If any movements exceed ½-inch between successive surveys, excavation progress in the areas of concern should be halted and remedial measures implemented. However, if wall movements appear to have stopped increasing at any monitoring point, then monitoring frequency may be reduced at the discretion of engineer.

B. Instrumentation

1. Survey monitoring of the soil nail walls shall be the responsibility of the contractor and shall consist of controlled survey monitoring of the elevation and plan location of survey points placed at the top of the soil nail walls and spaced no more than 20 feet on center along the lengths of all walls.

2. Monitoring points shall consist of bolts or rods embedded into the object of interest, or cross hairs scribed onto a plate that is attached to the face of the object of interest. Accuracy of the survey monitoring shall be +/- 0.005 feet.

3. Monitoring points shall be established at the top of the soil nail walls no more than 2 feet behind the face of the wall (or top of temporary cut slope) and spaced no more than 20 feet along the wall alignment. Monitoring points shall also be established on any settlement sensitive structure located within a distance from the shoring wall equal to the planned depth of the excavation.
3.7 SPECIAL INSPECTION

A. In accordance with the local building code, special inspection shall be provided by the owner’s representative for all soil nail installation and testing and for all shotcrete work. Such inspection shall include observation and testing of test panels and placement of reinforcing steel and shotcrete.

B. The engineer providing the special inspection shall be a qualified geotechnical engineer or his representative with experience monitoring soil nail wall construction. Accurate records documenting the soil nail wall construction shall be maintained by the engineer. The contractor shall assist the engineer as necessary to obtain the as-built nail locations, top of wall elevation, and all other information as required by the owner and engineer. Special inspection and testing of the shotcrete work shall be provided by a qualified materials testing agency approved by the engineer.

END OF SECTION 31 32 36
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. References and standards listed herein are to be the latest edition available, unless specifically stated otherwise.

1.2 SUMMARY

A. This Section specifies gabion boxes filled with rock for retaining wall and veneer applications.

B. Related Sections include the following:
   1. Division 31 Section “Earthwork” for excavation and structural backfill.

1.3 SUBMITTALS

A. General: Make submittals in accordance with Division 1 Section “Submittal Procedures.”

B. Product Data: For proprietary materials and items, including basket components, infill, and accessories.

C. Gradation: For rock fill. Gradation data shall be not more than 90 days old. No substitution of aggregate type or size from those submitted will be permitted.

D. Shop Drawings for gabion wall layout.

E. Qualification Data: For Installer.

F. Weight Data: For each box used in the mock up.

G. Minutes of preinstallation conference.

1.4 QUALITY ASSURANCE

A. Preinstallation Conference: Conduct conference at project site to comply with requirements in Division 01 Section “Project Management and Coordination.”

B. Installer Qualifications: Provide Site Supervisor with a minimum of 5 years of acceptable experience in installing similar types of gabion boxes.

1.5 MOCK UP

A. Visual Mock-Up: Build (3) courses of gabion boxes. Layout shall represent stepping per drawings. Top and bottom courses to include Type A rock fill and middle course to include Type B rock fill if selected for Add Alternate 2. Weigh all baskets.
PART 2 - PRODUCTS

2.1 WIRE BOXES

A. General: Gabions shall be constructed as shown on the plans and in conformance with these special provisions. Gabions shall be of a single unit construction. The base, ends, sides, and lid shall be either welded into a single unit or shall be connected in such a manner that strength and flexibility at the connection are at least equal to that of the wire mesh. The gabions shall be fabricated in such a manner than they can be assembled at the construction site with Spiral Binders and pre-formed stiffeners into rectangular baskets of the specified size. Standard gabion sizes and the overall plan and profile dimensions of the gabion structures shall be as shown on the plans. Each standard gabion size shall be divided into 36-inch long cells by diaphragm panels made of the same wire mesh as used for the gabion body. Each position on the basket shall be fabricated with the necessary diaphragm of diaphragms secured in proper position on the base in such a manner that no additional tying at the base will be necessary. Basket size shall be 2 feet by 2 feet by 6 feet. The width, height, or length of the standard gabions shall not vary more than five percent from the dimensions specified. Empty gabion baskets shall be assembled individually and joined successively. Individual gabion mesh panels (base, front, ends, back, diaphragms, and lid) and successive gabions shall be assembled so that the strength and flexibility along the joints is comparable to a single panel. The minimum unit weight of a rock-filled gabion shall be 110 pounds per cubic foot.

1. Available Products:
   a. Hilfiker Art Weld Gabions

B. Wire: Meet or exceed the following requirements:

1. Mesh: Three-inch by 3-inch 11 gage (.116 inches minimum) Welded Wire Fabric. Welds shall be made by resistance welding. Welds and panels shall conform to the requirements in ASTM Designation: A 185, except weld shears shall be 600 pounds minimum for 11 gage wires and 800 pounds minimum for 9 gage wires. Resistance welding shall occur prior to coating the wire with zinc. For each standard gabion size, the same mesh style shall be used for the base, front, ends, back, diaphragms, and lid panels. Individual wires of the welded-mesh style shall conform to the definitions and requirements in ASTM A 641/A 641M.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Test Designation</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum tensile strength</td>
<td>ASTM A 370</td>
<td>60 ksi</td>
</tr>
<tr>
<td>Wire Size</td>
<td>USA Steel Wire Gage</td>
<td>11</td>
</tr>
<tr>
<td>Wire Diameter (Minimum)</td>
<td>ASTM A 641/A 641 M</td>
<td>0.120 in</td>
</tr>
<tr>
<td>Galvanizing, Zinc</td>
<td>ASTM A 641/A 641M, Class 3</td>
<td>0.116 in</td>
</tr>
<tr>
<td></td>
<td>and ASTM A 90/A 90 M</td>
<td>0.80 oz/ft²</td>
</tr>
</tbody>
</table>
2. Joints: Standard tie wire and standard spiral binder shall conform to the definitions and requirements in ASTM Designation: A 641/A 641 M and shall conform to the following provisions:

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Test Designation</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum Tensile Strength</td>
<td>ASTM A 370</td>
<td>60 ksi</td>
</tr>
<tr>
<td><strong>Tie Wire</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wire Size (Minimum)</td>
<td>ASTM A 641/A 641M 13.5</td>
<td></td>
</tr>
<tr>
<td>Wire Diameter (Minimum)</td>
<td>ASTM A 641/A 641M 0.086 in.</td>
<td></td>
</tr>
<tr>
<td>Zinc Coating</td>
<td>ASTM A 641/A 641M, Class 3</td>
<td>0.70 oz/ft²</td>
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<tr>
<td></td>
<td>and ASTM A 90/A 90M</td>
<td></td>
</tr>
<tr>
<td><strong>Spirals</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wire Size (Maximum)</td>
<td>ASTM A 641/A 641M 9</td>
<td></td>
</tr>
<tr>
<td>Wire Diameter (Minimum)</td>
<td>ASTM A 641/A 641M 0.148 in.</td>
<td></td>
</tr>
<tr>
<td>Zinc Coating</td>
<td>ASTM A 641/A 641M, Class 3</td>
<td>0.85 oz/ft²</td>
</tr>
<tr>
<td></td>
<td>and ASTM A 90/A 90M</td>
<td></td>
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</tbody>
</table>

a. Spiral binders shall have a 3-inch separation between continuous, successive loops.

3. Internal Connecting Wire: Internal connecting wires shall be 13.5 gage minimum. Each wire shall conform to the minimum requirements for standard tie wire in these special provisions and shall be installed in conformance with the provisions in these special provisions and as shown on the plans.

2.2 ROCK FILL

A. Rock for filling gabions shall have a Degradations Factor of at least 30, and shall conform to the following:

<table>
<thead>
<tr>
<th>Sieve Size (Inches)</th>
<th>Percentage Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>100</td>
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<tr>
<td>4</td>
<td>0-5</td>
</tr>
<tr>
<td>6</td>
<td>75-90</td>
</tr>
<tr>
<td>% Fracture</td>
<td>75 min</td>
</tr>
</tbody>
</table>

1. Type A – Basalt Quarry Spalls, dark grey to black
2. Type B – Granite Quarry Spalls, if Add Alternate 2 is selected.

3. Available Suppliers:
   b. Cal Portland

2.3 ACCESSORIES

A. Anchorage Assembly: As shown on the structural drawings.

B. Filter Fabric
1. Available Products
   a. Mirafi

2.4 FOUNDATION
   A. As shown on the structural drawings.

2.5 WALL BACKFILL
   A. In accordance with Division 31 Section “Earthwork”.

PART 3 - EXECUTION

3.1 GRADING, EXCAVATION, AND BACKFILL
   A. Areas where gabions are to be placed shall be constructed to the lines and grades shown on
      the drawings. Excavation or backfill for achieving the required grades shall be in accordance
      with Division 31 Section “Earthwork”.

3.2 FOUNDATION PREPARATION:
   A. The foundation for the structure shall be graded level for a width equal to or exceeding the
      length of the reinforcement mat or as shown on the plans.

3.3 WALL CONSTRUCTION:
   A. Gabions shall be assembled individually as empty units. Each gabion shall be manufactured
      with the necessary panels, properly spaced and secured, so that the panels can be rotated into
      position at the construction site with no additional tying of the rotation joint. The panels and
      diaphragms shall be rotated into position and joined along the vertical edges. When standard
      tie wire is used as a joint connector for welded mesh, the joint shall constructed using
      alternating double and single half hitches (locked loops) in every mesh opening along the joint.
      When 9 gage spiral binders are used, the spiral shall be placed so that the spiral binder passes
      through each mesh opening along the joint. Both ends of all 9 gage spiral binders shall be
      crimped to secure the spiral in place. Temporary fasteners may be used to hold panels
      wherever gabion-to-gabion joints will be constructed. Temporary fasteners shall not remain in
      place.
   
   B. Assembly of successive gabion baskets (Gabion-to-Gabion joints)
      1. Gabion baskets shall be set in place. Individually constructed gabion baskets shall then
         be joined successively to the next gabion baskets with 13.5-gage tie wire or 9 gage
         standard spiral binder before filling the basket with rock. The 13.5 gage standard tie wire
         or 9 gage standard spiral binder shall secure, in one pass, all selvage or end wires of the
         panels of all adjacent baskets along the joint. Gabion baskets shall be joined along the
         front, back, and ends, including the tops and bottoms of the adjacent gabions.
   
   C. Assembly of multiple layered gabions
      1. Multi-layered gabion configurations shall be stepped and staggered as shown on the
         drawings. When constructing multi-layered gabion configurations, each layer of gabions
         shall be joined to the underlying layer along the front, back, and ends.

   D. Assembly of transitional gabions
1. To match the geometry of the planned gabion configuration, or to meet specific conditions, panels shall be folded, cut, and fastened as shown on the drawings.

E. Filling with rock

1. Before filling each gabion basket with rock, all kinks and folds in the wire fabric shall be straightened and all successive gabions shall be properly aligned. Rock shall be placed in the baskets to provide proper alignment, avoid bulges in the wire mesh, and provide a minimum of voids. All exposed rock surfaces shall have a smooth and neat appearance. Sharp rock edges shall not project through the wire mesh. Internal connecting wires shall be used to produce a flat, smooth external surface. If the Engineer determines that there is excessive bulging or dimpling of the outside panels, the unit shall be reconstructed at the Contractor’s expense. When filling 24-inch high gabions, rock shall be placed in two nominal 12-inch layers to allow placement of the 13.5-gage internal connecting wires. The wires shall be fastened as shown on the plans. The last layer of rock shall slightly overfill the gabion baskets so that the lid will rest on rock when the lid is closed.

F. Closure of Lids

1. Lids shall be tied along the front, ends, and diaphragms in conformance with the provisions in “Assembly of Successive Gabion Baskets (Gabion-to-Gabion Joints)” of this specification.

G. The overall vertical tolerance of the wall (top and bottom) after construction shall not exceed one (1) inch per ten (10) feet of wall height.

3.4 FILTER FABRIC PLACEMENT

A. Filter fabric shall be placed on the subgrade, backslope, and sides of excavations. If fill is to be placed over the gabions, filter fabric shall be placed on top of the gabions, before placing the earth fill.

3.5 PLACEMENT OF BACKFILL MATERIALS:

A. Backfill placement shall closely follow erection of each course of gabions. Backfill shall be placed in such a manner as to avoid any damage or disturbance to the wall materials or misalignment of the facing. Any wall materials that become damaged or disturbed during backfill placement shall be either removed and replaced at the Contractor’s expense or corrected as directed by the Engineer.

B. Backfill shall be compacted to 95 percent of AASHTO T 99 method C or D with oversize correction at optimum moisture content.

C. Backfill shall be placed in complete horizontal lifts. The maximum lift thickness after compaction shall not exceed twelve (12) inches. The Contractor shall decrease this lift thickness, if necessary, to obtain the required density.

D. Compaction within three (3) feet of the back face of the wall facing shall be achieved by at least three (3) passes of a light weight mechanical tamper, roller or vibratory system.

E. At the end of each day’s operation, the Contractor shall slope the last level of backfill away from the wall facing to rapidly direct run-off of rainwater away from the wall face. In addition, the Contractor shall not allow surface run-off from adjacent areas to enter the wall construction.
3.6 FIELD QUALITY CONTROL

A. Special Inspections:
   2. Anchorage of gabions to concrete walls.

3.7 DISPOSAL OF EXCESS AND WASTE MATERIALS:

A. Remove from the Owner's property, all waste materials, including all cut ends of steel wire mats, hardware cloth, filter fabric, and other debris. Dispose of all debris off site in a legal and timely manner. Provide dump receipts from an approved dumpsite if directed.

END OF SECTION 31 36 00
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including General and Supplementary
Conditions and Division 01 Specification Sections, apply to this section.

B. References and standards listed herein are to be the latest edition available, unless specifically
stated otherwise.

1.2 SUMMARY

A. This section includes temporary excavation support and protection systems. This work
includes, but is not limited to, the following:

1. Pile shaft drilling and pile installation.
2. Tieback hole drilling and tieback installation, where required.
3. Placement of grout, concrete, and slurry.
4. Placement of lagging.
5. Tieback testing.
7. Shoring removal, as required.

B. Related sections include the following:

1. Division 01 Section "Temporary Facilities and Controls" for temporary utilities and support
facilities.
2. Division 31 Section "Earthwork" for excavating and backfilling and for existing utilities.
3. Division 03 Section "Shotcrete" for use in excavation support and protection.
4. Division 03 Section "Cast-in-Place Concrete" for soldier pile backfill.

1.3 PERFORMANCE REQUIREMENTS

A. Furnish, install, monitor, and maintain excavation support and protection system capable of
supporting excavation sidewalls and of resisting soil and hydrostatic pressure and
superimposed and construction loads.

1. Prevent surface water from entering excavations by grading, dikes, or other means.
2. Install excavation support and protection systems without damaging existing buildings,
utilities, pavements, and other improvements adjacent to excavation.
3. Comply with local, state, and federal codes and ordinances of governing authorities
having jurisdiction.

B. Tiebacks: The Contractor shall be responsible for installing anchors which satisfy anchor
testing criteria for the design loads shown on the drawings. Anchor lengths shown on the
drawings are minimum lengths. Alternate tieback systems may be submitted for approval.
1.4 SUBMITTALS

A. Submit all submittals to the Engineer.

B. Submit shop drawings prior to any fabrication or construction for all structural items, including structural steel and miscellaneous metal.

C. Submit the ground anchor system and construction procedure intended for use.

D. Submit ground anchor construction details, including the following:
   1. Spacers and their location.
   2. Centralizers and their location.
   3. Unbonded length corrosion protection system.
   4. Anchor length corrosion protection system.
   5. Anchorage and trumpet.
   6. Anchorage corrosion protection system.

E. Submit mix designs for all grouts and concretes.

F. Maintain and submit a complete and accurate record of all soldier pile depths, concrete strengths, tieback grout strengths, quantity of concrete per pile, quantity of grout per tieback and applied tieback loads. Immediately report to Engineer any unusual condition encountered during installation.

G. Submit certification that all welders are qualified according to the Washington Association of Building Officials (WABO).

H. Submit calibration data for each load cell, test jack, pressure gauge and master pressure gauge to be used. The calibration tests shall have been performed by an independent testing laboratory and tests shall have been performed within 60 calendar days of the date submitted.

I. Work shall not begin until the appropriate submittals have been approved in writing by the Engineer.

J. Qualifications: The soldier pile tieback retaining wall, as specified herein and shown on the contract drawings, shall be installed by a Contractor with a minimum of 5 years experience in similar construction. The Contractor shall show evidence of successful completion of at least 3 similar retaining walls with temporary tiebacks.

K. Preconstruction Survey: Refer to Section 315000 Article "Shoring Monitoring."

L. Shoring Monitoring Readings and Results: Refer to Section 315000 Article "Preconstruction Survey."
1.5 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Architect and then only after arranging to provide temporary utility services according to requirements indicated.

1. Dimensions and locations of existing structures shall be verified prior to fabrication and installation of any structural member.

2. Utilize the services of the "Utility Locator Service" (1-800-424-5555) to verify the extent and locations of site utilities. If the actual field verified location of utilities could result in a conflict with the shoring, notify the Engineer immediately.

B. Project Site Information: A geotechnical report has been prepared for this project and is available for information only. The opinions expressed in this report are those of Geotechnical Engineer, and represent interpretations of subsoil conditions, tests, and results of analyses conducted by Geotechnical Engineer. The Owner will not be responsible for interpretations or conclusions drawn from this data.

1. Make additional test borings and conduct other exploratory operations necessary for excavation support and protection at no cost to the Owner.

2. Examine the site and the referenced geotechnical report for possible conflicts between existing conditions and the installation of the shoring.

3. The geotechnical report is referenced elsewhere in the Project Manual.

1.6 PRECONSTRUCTION SURVEY

A. Prior to construction, complete a written and photographic log of existing conditions of the adjoining construction and site improvements that might be misconstrued as damage caused by the absence of, the installation of, or the performance of excavation support and protection systems. Videotape may be used as part of the survey. The Contractor shall document all existing substantial cracks in adjacent streets, sidewalks, and existing structures.

PART 2 - PRODUCTS

2.1 STEEL MATERIAL

A. General Requirement: Used steel is allowed for temporary shoring. The bottom of the pile to be embedded in concrete shall be freshly brushed. Steel shall be free of rust scale. Welding shall comply with AWS Code.

B. Materials

1. Structural Steel from Rolled Shapes - ASTM A 992
2. Connection Material, Embedded - ASTM A 36
   Items, Miscellaneous steel
3. Structural Bolts - ASTM A 325-N
4. Welding Electrodes - E70XX
2.2 CONCRETE AND GROUT MATERIALS

A. General Requirements: Concrete and grout shall consist of a mixture of cement, a pozzolanic material when approved, fluidifier, aggregate, and water proportioned and mixed so as to produce a concrete grout capable of being pumped without difficulty, with an ultimate compressive strength as indicated on the drawings. In addition, the mix shall have a slump such that the aggregates are uniformly dispersed vertically in the placement.

B. Materials

2. Pozzolan: Fly ash or other approved pozzolanic material conforming to ASTM C 618.
3. Grout Fluidifier: Compound with characteristics which will increase the flowability of the mixture, assist in the dispersal of cement grains, and neutralize the setting shrinkage of the high strength cement mortar.
4. Water: ASTM C 94/C 94M.
5. Normal Weight Aggregate: Fine aggregate conforming to requirements of ASTM C 33, coarse aggregate, where required, conforming to requirements of ASTM C 33.
6. Admixtures: Certified by the manufacturer to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious materials. Do not use admixtures containing calcium chloride.
   a. Water-Reducing Admixture: ASTM C 494, Type A.
   b. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.
   c. High Range Water-Reducing Admixture: ASTM C 494, Type G.
   d. Plasticizing and Retarding Admixtures: ASTM C 1017/C 1017M, Type II.

2.3 TEMPORARY GROUND ANCHORS

A. General Requirements: The Contractor shall select a ground anchor type and the installation method, and determine anchor diameter and length in accordance with the plans, specifications and geotechnical report. The Contractor shall install ground anchors that will develop the design load indicated in the plans. Anchor type, if different from that shown on plans, shall be approved by Engineer.

B. Materials

2. Bearing and Anchor Plates: The bearing and anchor plates shall be fabricated from steel conforming to ASTM A 36 and sized in accordance with ACI 318.
3. Anchorage Hardware: Anchorage hardware shall be capable of developing at least 95 percent of the actual ultimate strength of the prestressing steel.
4. Couplers: Couplers for prestressing steel shall be capable of developing at least 95 percent of the actual ultimate strength of the prestressing steel and shall be used only by approval of Engineer.
5. Trumpet: The trumpet used shall provide transition from the anchorage to the unbonded length corrosion protection. It shall be fabricated from a steel pipe or tube conforming to the requirements of ASTM A 53 for pipe and ASTM A 500 for tubing. The trumpet shall have a minimum thickness of 0.20-inch.

6. Spacers and Centralizers: Spacers and centralizers shall be fabricated from plastic, steel or material which is nondetrimental to the prestressing steel. Wood shall not be used.

7. Corrugated Tubing: Corrugated tubing shall be fabricated from high-density corrugated polyethylene (PE) tubing conforming to the requirements of AASHTO M252 and having a minimum thickness of 30 mils.

8. Bond Breaker: The bond breaker shall be fabricated from a smooth plastic tube or pipe having the following properties:
   a. Resistant to chemical attack from aggressive environments, grout, or grease.
   b. Resistant to aging by ultraviolet light.
   c. Fabricated from material nondetrimental to the tendon.
   d. Capable of withstanding abrasion, impact and bending during handling and installation.
   e. Enable the tendon to elongate during testing and stressing.
   f. Allow the tendon to remain unbonded after lock-off.

9. Anti-Corrosion Grease: The anti-corrosion grease shall conform to the requirements of Section 3.2.5 of the Post-Tensioning Institute, “Specification for Unbonded Strand Tendons.”

2.4 LAGGING

A. Wood lagging shall be rough sawn from species and size shown on the drawings. Lagging shall be pressure-treated with waterborne preservative in accordance with AWPB LP-22 to a minimum retention of 0.4 pounds/cubic foot. Wood lagging need not be new, but shall be in serviceable condition and pressure-treated.

B. Different types of lagging, such as precast concrete panels, shotcrete, shall be prepared in accordance with corresponding sections of specifications.

PART 3 - EXECUTION

3.1 GENERAL

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.
   1. Shore, support, and protect utilities encountered.

B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
C. Locate excavation support and protection systems clear of permanent construction so that forming and finishing of concrete surfaces is not impeded.

D. Hole drilling for piles and ground anchors shall be done without loss of ground and without endangering previously installed shoring members or utilities. Casing or other methods shall be used, where necessary, to prevent loss of ground and collapse of the hole.

3.2 SOLDIER PILE INSTALLATION

A. The steel soldier pile shall be plumb and true in the augered hole and braced against displacement during grouting. The exposed face of the steel soldier pile shall be clean and dry immediately prior to field welding of studs, walers, or other structural members. A continuous "styrofoam" strip or other approved bond breaker may be fastened to the face of the soldier pile to facilitate concrete removal.

B. After the steel pile is centered in the hole and all loose material at the proper depth is removed, the concrete shall be placed. See the drawings for appropriate type of concrete to be placed below the base of excavation. Lean concrete may be used from the bottom of the excavation to the top of the pile.

C. Place concrete in a manner that will not cause segregation of the particles or permit infiltration of water or permit any other occurrence which would tend to decrease the strength of the concrete or the capacity of the finished drilled pile. At the Contractor's option, drilled piles with diameters larger than those shown may be constructed at the Contractor's expense.

3.3 GROUND ANCHOR INSTALLATION

A. Procedure

1. The method of installing the anchor shall ensure that the tendon is located in the middle third of the grout anchor section.

2. The anchor shall be inserted into the drill hole to the desired depth without difficulty. When the anchor cannot be completely inserted, the Contractor shall remove the anchor from the drill hole, and clean or redrill the hole to permit insertion. Partially inserted anchors shall not be driven or forced into the hole.

3. The grout equipment shall produce grout free of lumps and undispersed cement. A minimum of 100 psi pressure shall be maintained during pumping. The pump shall be equipped with a pressure gauge to monitor grout pressures. The pressure gauge shall be capable of measuring pressures of at least 200 psi or twice the actual grout pressures used by the Contractor, whichever is greater. The grouting equipment shall be sized to enable the grout to be pumped in one continuous operation. The mixer shall be capable of continuously agitating the grout.

4. The grout shall be injected from the lowest point of the drill hole. The quantity of the grout and the grout pressures shall be recorded. The grout pressures and grout takes shall be controlled to prevent excessive heave in soils or fracturing of rock formations.

5. After grouting, the anchor shall not be loaded until the grout has attained sufficient strength to carry the test load.

6. The grout at the top of the drill hole shall not contact the back of the pile. Only nonstructural compressive filler can be placed above the bonded anchor length grout prior to testing and acceptance of the anchor.
B. Excavation Below Anchors: Anchor installation and stressing shall be completed prior to excavating more than 2 feet below the anchor level.

3.4 LAGGING

A. Install lagging as excavation progress. Excavation to install lagging below the ground shall be limited to 4 feet.

B. Backfill voids between lagging and soil immediately after lagging installation. Material used for backfill of voids shall be free-draining. Maintain drainage behind wall.

3.5 TENDON STORAGE AND HANDLING

A. Tendons shall be handled and stored in such a manner as to avoid damage or corrosion. Damage to the prestressing steel as a result of abrasions, cuts, nicks, welds and weld splatter will be cause for rejection by the Engineer.

B. The prestressing steel shall be protected if welding is to be performed in the vicinity. Grounding of welding leads to the prestressing steel is forbidden. Prestressing steel shall be protected from dirt, rust and deleterious substances. A light coating of rust on the steel is acceptable. Heavy corrosion or pitting is not permitted.

C. The Contractor shall use care in handling and storing the tendons at the site. Prior to inserting a tendon in the drill hole, the Contractor shall examine the tendon for damage to the encapsulation and the sheathing. If the encapsulation is damaged, the Contractor shall repair the encapsulation in accordance with the Tendon's Supplier's recommendations. If, in the opinion of the Engineer, the smooth sheathing has been damaged, the Contractor shall repair it with ultra high molecular weight polyethylene (PE) tape. The tape shall be spiral wound around the tendon so as to completely seal the damaged area. The pitch of the spiral shall ensure a double thickness at all points.

3.6 TOLERANCES

A. Soldier Piles

1. Install tops of soldier piles shall be within 3 inches, plus or minus, horizontally of the location shown on the plans, except that piles shall not extend more than 1 1/2-inch into the excavation.

2. Soldier piles shall be within 1 percent of plumb.

B. Anchors

1. Deviation of anchor project angle shall be not more than 2 degrees vertically and horizontally.

2. Anchor clearance to the existing utilities shall be not less than 3 feet.

C. Lagging

1. Survey pile locations continuously as excavation proceeds and shall notify Engineer of piles that are out-of-tolerance before lagging is installed at those piles.

2. Adjust lagging locations as directed by Engineer for piles out-of-tolerance so as to maintain building wall location and thickness.
3.7 REMOVAL OF SHORING
A. Shoring shall not be removed.
B. Cut-off soldier piles 6 feet below sidewalk grade, unless noted otherwise by Engineer.

3.8 FIELD QUALITY CONTROL
A. The Owner will provide testing laboratories to furnish inspection and material testing services.
B. The Owner will retain the services of a Geotechnical Engineer to observe the shoring installation, including observation and recording of tests, for verification and production anchors.
C. The Testing Laboratory shall test concrete in accordance with Division 03 "Cast-in-Place Concrete."
D. The Testing Laboratory shall test tieback anchor grout in accordance with ASTM C 109 prior to tieback stressing.
E. The Testing Laboratory shall inspect welds in accordance with the structural drawings.
F. Anchor Performance Tests: Testing requirements per drawings.
G. Production Anchors: Testing requirements per drawings.
H. Jacking and Test Apparatus for Ground Anchors
   1. The anchor load shall be measured with a pressure gate calibrated with the jack and accurate enough to read 100 psi changes in pressure. The pump shall be capable of applying each load increment for performance and proof tests in less than 60 seconds.
   2. The movement of the anchor during testing shall be recorded to the nearest 0.001-inch.

3.9 SHORING MONITORING
A. Survey the top of every other soldier pile (vertical and horizontal displacement). Establish survey lines near the top of the wall and at distances up to the wall height, H, behind the wall face. These points should be spaced no more than 50 feet apart. Follow recommendations of geotechnical engineer of record for establishing the spacing and location of the monitoring points.

   Establish a baseline reading of the monitoring points on the ground surface behind the shoring walls before installing the shoring. A baseline reading of the survey points on the soldier piles shall be established prior to beginning excavation.

   Submit survey data to the Geotechnical Engineer, structural engineer, shoring designer and as required by the City.

B. The frequency of readings will depend on the results of previous readings and the rate of construction. As a minimum, readings will be taken once a week throughout construction until the shoring walls are completed. More frequent readings may be required at critical times during construction or if significant movement is indicated. All readings to be reviewed by the Geotechnical Engineer and the Engineer.
C. The Contractor shall provide and install inclinometer casing on soldier piles selected by the Geotechnical Engineer to facilitate measurement of wall deflections as the excavation and shoring installation proceeds.

D. Notify the Engineer, Department of Planning and Development (DPD), and Seattle Department of Transportation (SDOT) immediately if changes in the elevations or positions of shoring elements occur, or if cracks, sags, or other damage is evident in adjacent construction.

3.10 DISPOSAL OF MATERIALS

A. Remove surplus excavated material and legally dispose of it off site.

END OF SECTION 31 50 00
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section.

B. References and standards listed herein are to be the latest edition available, unless specifically stated otherwise.

1.2 SUMMARY

A. This section includes the following:
   1. Dry-installed drilled piers.
   2. Cased drilled piers.
   4. Dry-installed or slurry displacement-installed drilled piers at Contractor's choice.

B. Slurry shall not be used to construct drilled piers, unless approved by the Engineer.

C. Related sections include the following:
   1. Division 01 Section "Unit Prices" for list of unit prices.
   2. Division 01 Section "Temporary Facilities and Controls."
   3. Division 03 Section "Cast-in-Place Concrete" for general structural and building applications of concrete.

1.3 UNIT PRICES

A. Basis of Bids: Base bids on indicated number of drilled piers. Design length from top elevation to bottom of shaft, extended through the bell, if applicable; and diameter of shaft and bell.

B. Basis for Payment: Payment for drilled piers will be made on actual net volume of drilled piers in place and approved. Actual length and shaft diameter may vary to coincide with elevations where satisfactory bearing strata are encountered, and with actual bearing value of bearing strata determined by an independent testing and inspecting agency. Adjustments will be made on net variation of total quantities, based on design dimensions for shafts.

   1. Unit prices include labor, materials, tools, equipment, and incidentals required for excavation, trimming, shoring, casings, dewatering, reinforcement, concrete fill, and other items for complete drilled-pier installation.

   2. See Division 01 Section "Unit Prices" for list of unit prices.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Equipment and procedures (including casing withdrawal procedures, if required).

C. Shop Drawings: For concrete reinforcement detailing fabricating, bending, and placing.
D. Design Mixes: For each class of concrete. Include revised mix proportions when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.
   1. Laboratory Test Reports: For evaluation of concrete materials and mix design.

E. Slurry Mix: A test report from the Supplier giving the slurry type and admixtures, and the physical and chemical properties of the mixed slurry.

F. Welding certificates.

G. Qualification Data: For Installer, Land Surveyor, and Testing Agency.

H. Record drawings at project closeout according to Division 01 Section "Closeout Procedures."

1.5 QUALITY ASSURANCE


B. Survey Work: Engage a Qualified Land Surveyor or Professional Engineer to perform surveys, layouts, and measurements for drilled piers. Before excavating, lay out each drilled pier to lines and levels required. Record actual measurements of each drilled pier's location, shaft diameter, bottom and top elevations, deviations from specified tolerances, and other specified data.
   1. Record and maintain information pertinent to each drilled pier, and cooperate with the Owner's Testing and Inspecting Agency to provide data for required reports.

C. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 to perform material evaluation tests and to design concrete mixes, as documented according to ASTM E 548.

D. Welding Standards: Qualify procedures and personnel according to the following:
   1. AWS D1.1, "Structural Welding Code--Steel."
   2. AWS D1.4, "Structural Welding Code--Reinforcing Steel."

E. Drilled Pier Testing: Testing of piers to be as recommended by geotechnical report for project.

F. Trial Drilled Pier: Construct trial drilled pier of diameter and depth, and at location indicated or, if not indicated, of same diameter and depth as drilled piers located at least three diameters clear of permanent drilled piers, to demonstrate Installer's construction methods, equipment, standards of workmanship, and tolerances.
   1. Install reinforcement, fill with concrete, remove temporary casings, and terminate trial drilled pier 24 inches below subgrade and leave in place.
   2. Install permanent casings, excavate rock socket, and place slurry, as required for permanent drilled piers.
   3. If Engineer determines that trial drilled pier does not comply with requirements, excavate for and cast another until it is accepted.

G. Pile Load Tests: Conduct and perform pile load tests as indicated.

H. Preinstallation Conference: Conduct conference at project site to comply with requirements in Division 01 Section "Project Management and Coordination."

I. Installer Qualifications: Provide Site Supervisor with a minimum of 5 years of acceptable experience in installing similar types of drilled piers. If an installation method is specified, experience in the use of this method is required.

1.6 PROJECT CONDITIONS

A. Existing Utilities: Locate existing underground utilities before excavating drilled piers. If utilities are to remain in place, provide protection from damage during drilled-pier operations.
   1. Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, adapt drilling procedure if necessary to prevent damage to utilities. Cooperate with Owner and utility companies in keeping services and facilities in operation without interruption. Repair damaged utilities to satisfaction of utility owner.

B. Site Information: A geotechnical report has been prepared for this project and is referenced elsewhere in the Project Manual for information only.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

B. Low Alloy Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.

C. Epoxy-Coated Reinforcing Bars: ASTM A 775/A 775M or ASTM A 934/A 934M, as follows:
   1. Steel Reinforcement: ASTM A 615/A 615M, Grade 60, deformed.

D. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain. Cut bars true to length with ends square and free of burrs.

2.2 CONCRETE MATERIALS

A. Portland Cement: ASTM C 150, Type II.
   1. Fly Ash Admixture: ASTM C 618, Class C or F.
   2. Ground Granulated Blast Furnace Slag: ASTM C 989, Grade 100 or 120.

B. Normal Weight Aggregate: ASTM C 33, uniformly graded, 3/4-inch maximum aggregate size.

C. Water: ASTM C 94/C 94M.

D. Admixtures: Certified by manufacturer to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material and to be compatible with other admixtures and cementitious materials. Do not use admixtures containing calcium chloride.
1. Water-Reducing Admixture: ASTM C 494, Type A.
2. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.
3. High Range, Water-Reducing Admixture: ASTM C 494, Type G.
4. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

E. Sand-Cement Grout: Portland cement, ASTM C 150, Type II; clean, natural sand, ASTM C 404; and water to result in grout with a minimum 28-day compressive strength of 1,000 psi, of consistency required for application.

2.3 STEEL CASINGS

A. Permanent Casings
   1. Steel Pipe Casings: ASTM A 283/A 283M, Grade C; or ASTM A 36/A 36M, carbon steel plate, with joints full-penetration welded according to AWS D1.1.

B. Temporary Casings: Provide temporary casing of sufficient strength to withstand handling stresses, drilling stresses, concrete pressures, and surrounding earth and water pressures or, if required, for the protection of personnel, or to permit the advancement of the shaft through caving ground.

2.4 SLURRY

A. Slurry: Pulverized sodium bentonite, pulverized attapulgite, or polymers mixed with water to form stable colloidal suspension complying with ACI 336.1 for density, viscosity, sand content, and pH. Contents of slurry shall not pose a threat or cause harm to the environment or workers, and shall comply with all local, state, and federal environmental codes.

2.5 CONCRETE MIX

A. Prepare design mixes according to ACI 211.1 and ACI 301 for each type and strength of concrete determined by either laboratory trial mix or field test data bases.
   1. Use a Qualified Testing Agency for preparing and reporting proposed mix designs for laboratory trial mix basis.

B. Proportion mixes according to ACI 211.1 and ACI 301 to provide normal weight concrete with the following properties:
   1. Compressive Strength: As noted on the drawings.
   2. Do not air-entrain concrete for drilled piers.

C. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 limits as if concrete were exposed to deicing chemicals.

D. Limit water-soluble, chloride ion content in hardened concrete to 0.30 percent by weight of cement.

E. Concrete mix design adjustments may be considered if characteristics of materials, project conditions, weather, test results, or other circumstances warrant. Resubmit and obtain approval of proposed changes to concrete mix proportions.
2.6 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.
   1. Do not add water to concrete mix after mixing beyond that allowed by the batch ticket.
   2. Maintain concrete temperature to not exceed 90 degrees F.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, vibration, and other hazards created by drilled pier operations.

3.2 EXCAVATION

A. Excavate drilled piers to dimensions and required elevations shown on the drawings. Clear all obstructions encountered during excavation.
   1. Maintain sidewall stability during drilling.
   2. Remove loose material from bottom of excavation.
   3. Remove water from excavated shafts before concreting.
   4. Excavate rock sockets of dimensions indicated.
   5. Cut series of grooves about perimeter of shaft to height from bottom of shaft, vertical spacing, and dimensions indicated.

B. Notify and allow Owner's Testing and Inspecting Agency to test and inspect bottom of excavation. Owner's Representative Geotechnical Engineer will determine the actual final bearing levels during excavation and will determine the suitability of bearing stratum. If unsuitable bearing stratum is encountered, make adjustments to drilled piers as determined by Engineer.
   1. Do not excavate shafts deeper than elevations indicated, unless approved by Engineer.
   2. Additional authorized excavation will be paid according to contract provisions for changes in the work.

C. End Bearing Drilled Piers: Make auger probe to a depth below bearing elevation equal to diameter of the bearing area of drilled pier. Revise as required.
   1. Fill auger probe holes with grout.
   2. Owner's Representative Geotechnical Engineer may waive the requirements for auger probes.

D. End Bearing Drilled Piers: Make auger probe to a depth of 96 inches below bottom elevation of shaft and visually inspect and classify soil. Verify continuity and thickness of stratum.
   1. Frequency of tests to be determined by the Owner's Representative Geotechnical Engineer

E. Prevent surface water from entering excavated shafts. Conduct water to site drainage facilities.
F. Excavate shafts in a manner that will not disturb previously installed drilled piers. This may involve a staggered sequence of construction for closely spaced piers. Allow concrete to set at least 24 hours before excavating for another adjacent closely spaced drilled pier.

G. Slurry Displacement Method: Stabilize excavation with slurry maintained a minimum of 60 inches above groundwater level and above unstable soil strata to prevent caving or sloughing of shaft. Maintain slurry properties before concreting.
   1. Excavate and complete concreting of drilled pier on same day, if possible, or redrill, clean, and test slurry in excavation before concreting.
   2. Clean bottom of each shaft before concreting.

H. Temporary Casings: Install watertight steel casings of sufficient length and thickness to prevent water seepage into shaft; to withstand compressive, displacement, and withdrawal stresses; and to maintain stability of shaft walls.
   1. Coordinate casing withdrawal carefully with concrete placement. Maintain head of concrete to exceed the anticipated outside soil and water pressure above the bottom of the casing at all times during casing withdrawal. Remove temporary casings by maintaining a plumb casing position.
   2. Casing size shall allow minimum concrete pier diameter as indicated on the drawings throughout the full length of the pier. This includes the cased portion of the pier and below the casing.

I. Inspection: Each drilled pier must be inspected and tested by Owner's Testing and Inspecting Agency before placing concrete.
   1. Provide and maintain facilities with equipment required for safe testing and inspecting excavations. Provide casing if down hole inspection is required. Cooperate with testing and inspecting personnel to expedite the work.
   2. Notify Engineer and Testing Agency at least 24 hours before excavations are ready for tests and inspections.

J. Gases: Check each drilled pier for toxic and explosive gas prior to personnel entering and while personnel are in-hole. If gas is found, ventilate with forced air until safe for entry or follow alternative procedures acceptable to the Owner's Representative. Provide gas testing equipment and protective cage, or temporary casing of proper diameter, length, and thickness, plus other safety equipment called for by federal, state, and local laws for inspection and testing of drilled piers and protection of workers during hand-belling or other operations necessitating entry into the shaft.

3.3 PERMANENT STEEL CASINGS

A. Install steel casings of minimum wall thickness indicated and of inside diameter not less than diameter of drilled pier.
   1. Install casings as excavation proceeds to maintain sidewall stability.
   2. Fabricate bottom edge of lowest casing section with cutting shoe capable of penetrating rock and achieving water seal.
   3. Connect casing sections by continuous penetration welds to form watertight, continuous casing.
4. Remove and replace, or repair, casings that have been damaged during installation and that could impair strength or efficiency of drilled pier.

5. Fill annular void between casing and shaft wall with grout.

B. Corrugated Steel Casings: Provide corrugated steel casings formed from zinc-coated steel sheet.
   1. Corrugated casings may be delivered in sections or panels of convenient length, and field connected according to manufacturer's written instructions.

3.4 STEEL REINFORCEMENT

A. Comply with recommendations in CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

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

C. Fabricate and install reinforcing cages symmetrically about axis of shafts in a single unit.

D. Accurately position, support, and secure reinforcement against displacement during concreting. Maintain minimum cover to reinforcement.

E. Use templates to set anchor bolts, leveling plates, and other accessories furnished in work of other sections. Provide blocking and holding devices to maintain required position during final concrete placement.

F. Protect exposed ends of extended reinforcement, dowels, or anchor bolts from mechanical damage and exposure to weather.

G. Only every third vertical reinforcing bar shall be lap-spliced at the same elevation.

H. Reinforcement shall be placed before pier concreting begins, unless otherwise acceptable to the Owner's Representative Geotechnical Engineer.

3.5 CONCRETE PLACEMENT

A. Place concrete in continuous operation and without segregation immediately after inspection and approval of shaft by Owner's Independent Testing and Inspecting Agency.
   1. Complete placement of concrete in uncased excavations before the workday is completed.
   2. Construct a construction joint if concrete placement is delayed more than 1 hour. Level top surface of concrete. Before placing remainder of concrete, clean surface laitance, roughen, and slush concrete with commercial bonding agent or with sand-cement grout mixed at ratio of 1:1.

B. Dry Method: Place concrete with chutes, tremies, or pumps.
   1. Vibrate top 60 inches of concrete.

C. Dewatering: Dewater drilled pier excavation prior to placing concrete. Dewater in a manner that will not create subsidence or ground loss that might adversely affect the work or existing adjacent structures.
D. Slurry Displacement Method: Place concrete in slurry-filled shafts by tremie methods or pumping. Control placement operations to ensure that tremie or pump pipe is embedded no fewer than 60 inches into concrete, and flow of concrete is continuous from bottom to top of drilled pier.

E. Screed concrete at cutoff elevation level and apply scoured, rough finish. Where cutoff elevation is above the ground elevation, form top section above grade and extend shaft to required elevation.

F. Protect concrete work, according to ACI 301, from frost, freezing, or low temperatures that could cause physical damage or reduced strength.
   1. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
   2. Do not use calcium chloride, salt, or other mineral-containing antifreeze agents or chemical accelerators.

G. When hot weather conditions exist that would seriously impair quality and strength of concrete, place concrete according to ACI 301 to maintain delivered temperature of concrete at no greater than 90 degrees F.
   1. Place concrete immediately on delivery. Keep exposed concrete surfaces and formed shaft extensions moist by fog sprays, wet burlap, or other effective means for a minimum of 7 days.

3.6 ANCHORAGE EMBEDMENTS

A. Prior to placement, all anchorage components shall be free of any contaminating material or unacceptable corrosion.

B. Place anchorage components either by pushing into the fresh concrete or by setting in the open shaft. Vibrate concrete and consolidate around embedded anchorage components.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a Qualified Independent Testing and Inspecting Agency to sample materials, perform tests, and submit reports during excavation and concrete placement for drilled piers. Contractor will provide the Testing agency the means and opportunity to take samples and make tests.

B. A drilled-pier report will be prepared by Owner’s Testing and Inspecting Agency for each drilled pier as follows:
   1. Actual top and bottom elevations.
   2. Top of bearing strata elevation.
   3. Description of soil materials.
   4. Description, location, and dimensions of obstructions.
   5. Final top centerline location and deviations from requirements.
   6. Variation of shaft from plumb.
   7. Shaft excavating method.
   8. Levelness of bottom and adequacy of cleanout.
9. Groundwater conditions and water infiltration rate, depth, and pumping.
10. Description, diameter, and top and bottom elevations of temporary or permanent casings.
11. Description of soil or water movement, sidewall stability, loss of ground, and means of control.
12. Date and time of starting and completing excavation.
13. Inspection report.
15. Concrete placing method, including elevation of consolidation and delays.
17. Locations of construction joints.
18. Remarks, unusual conditions encountered, and deviations from requirements.
19. Concrete testing results.

C. Soil Testing: Bottom elevations, bearing capacities, and lengths of drilled piers indicated have been estimated from available soil data. Actual elevations and drilled pier lengths and bearing capacities will be determined by Owner's Testing and Inspecting Agency. Final evaluations and approval of data will be determined by Engineer.

1. Bearing Stratum Tests: Owner's testing agency will take undisturbed bearing strata core samples from drilled pier bottoms; test each sample for compression, moisture content, and density; and report results and evaluations.

D. Concrete: Sampling and testing of concrete for quality control may include the following:

1. Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94/C 94M.
   a. Slump: ASTM C 143/C 143M; one test at point of placement for each compressive strength test, but no fewer than one test for each concrete load.
   b. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 degrees F and below and when 80 degrees F and above, and one test for each set of compressive strength specimens.
   c. Compression Test Specimens: ASTM C 31/C 31M; one set of four standard cylinders for each compressive strength test, unless otherwise indicated. Mold and store cylinders for laboratory-cured test specimens, unless field-cured test specimens are required.
   d. Compressive Strength Tests: ASTM C 39; one set for each drilled pier, but not more than one set for each truck load. One specimen will be tested at 7 days, 2 specimens will be tested at 28 days, and one specimen will be retained in reserve for later testing if required.

2. When frequency of testing will provide fewer than five strength tests for a given class of concrete, testing will be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
3. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing in-place concrete.
4. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength, and no individual strength test result falls below specified compressive strength by more than 500 psi.

5. Test results will be reported in writing to Engineer, Concrete Manufacturer, and Contractor within 24 hours of testing. Reports of compressive strength tests will contain project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, concrete type and class, location of concrete batch in drilled pier, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

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

7. Additional Tests: Testing and inspecting agency will make additional tests of concrete when test results indicate concrete strengths or other requirements have not been met.
   a. Continuous coring of drilled piers may be required, at Contractor's expense, when temporary casings have not been withdrawn within specified time limits or where observations of placement operations indicate deficient concrete quality, presence of voids, segregation, or other possible defects.

3.8 TOLERANCES

A. General: Use tolerances in accordance with ACI 117, except as noted below.

B. Plan Location: Location variation at cut-off shall be no greater than 1/24 of the required shaft diameter or 3 inches, whichever is greater. If the as-installed shaft is larger than required, the center of the shaft may be measured as the center of the shaft having the required area that lies wholly within the as-installed shaft.

C. Vertical Alignment: The out-of-plumbness of piers shall not exceed 1.5 percent. If the as-installed shaft and bearing area are larger than required, the out-of-plumbness may be measured as follows:
   1. The center at cut-off may be the center as defined by the acceptable plan location above.
   2. The center at the bottom may be the center of an area equivalent to the required capacity that lies wholly within the as-installed shaft.

D. Bottom Area: Excavate the bottom of the pier to a level plane within a tolerance of 1 vertical to 12 horizontal, or as acceptable to the Owner's Representative Geotechnical Engineer. Provide bottom area not less than that shown on the drawings or as acceptable to the Owner's Representative Geotechnical Engineer.

E. Pier Shaft Diameter: Provide pier shaft diameter shown on the drawings or as accepted by the Owner's Representative Geotechnical Engineer. Maximum diameter shall be as accepted by the Owner's Representative.

F. Anchorage Embedment Tolerance: Limit the vertical and horizontal deviations of individual anchorage components from the design location to ±0.5-inch.
3.9 DISPOSAL OF MATERIALS

A. Excavate Soil: Remove surplus excavated material and slurry and legally dispose of it off Owner's property. Surplus excavated material may be disposed on-site at a location approved by the Engineer.

B. Slurry: Dispose of the slurry in a legal and acceptable manner.

END OF SECTION 31 63 27
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. References and standards listed herein are to be the latest edition available, unless specifically stated otherwise.

1.2 SUMMARY

A. This work consists of constructing micropiles as shown in the Plans and approved working drawings and as specified herein.

B. The Contractor is responsible for furnishing of all design, materials, products, accessories, tools, equipment, services, transportation, labor and supervision, and manufacturing techniques required for design, installation and testing of micropiles and micropile top attachments for this project.

C. The Contractor shall select the micropile type, size, micropile top attachment, installation means and methods, shall estimate the ground to grout bond value, and shall determine the required grout bond length and final micropile diameter. The Contractor shall design and install micropiles that will develop the load capacities specified in the Plans. The micropile load capacities shall be verified by proof load testing, and shall meet the test acceptance criteria specified in this Special Provision.

1.3 DEFINITIONS

**Admixture**: Substance added to the grout to control bleed and/or shrinkage, improve flowability, reduce water content, or retard setting time.

**Alignment Load (AL)**: A minimum initial load (5 percent DL maximum) applied to micropile during testing to keep the testing equipment correctly positioned.

**Bonded Length**: The length of the micropile that is bonded to the ground and conceptually to transfer the applied axial loads to the surrounding soil or rock. Also known as the load transfer length.

**Bond-breaker**: A sleeve placed over the steel reinforcement to prevent load transfer.

**Casing**: Steel tube introduced during the drilling process in overburden soil to temporarily stabilize the drill hole. This is usually withdrawn as the micropile is grouted although in certain types of micropiles, some casing is permanently left in place to provide added micropile reinforcement.

**Centralizer**: A device to support and position the reinforcing steel in the drill hole and/or so that a minimum grout cover is provided.

**Coupler**: The means by which the micropile load capacity can be transmitted from one partial of reinforcement to another.

**Creep Movement**: The movement that occurs during the creep test of a micropile under constant load.
Design Load (DL): The design load expected to be applied to the micropile during its service life. The design load (DL) is as specified in the bridge Plans.

Encapsulation: A corrugated or deformed tube protecting the reinforcing steel against corrosion.

Free (unbonded) length: The designed length of the micropile that is not bonded to the surrounding ground or grout.

Micropile: A small-diameter, bored, cast-in-place composite pile, in which the applied load is resisted by steel reinforcement, cement grout and frictional grout/ground bond.

Maximum Test Load: The maximum load to which the micropile is subjected during testing.

Nominal Grout-to-Ground Bond Strength: The estimated ultimate geotechnical unit grout-to-ground bond strength selected for use in design. Same as \( \alpha \) Bond Nominal Strength (SLD and LFD).

Overburden: Material, natural or placed, that may require cased drilling methods to provide an open borehole to underlying strata.

Post-grouting: The injection of additional grout into the load transfer length of a micropile after the primary grout has set. Also known as regrouting or secondary grouting.

Primary Grout: Portland-cement-based grout injected into the micropile hole prior to or after the installation of the reinforcement to direct the load transfer to the surrounding ground along the micropile.

Proof Load Test: Incremental loading of a production micropile, recording the total movement at each increment.

Reinforcement: The steel component of the micropile that accepts and/or resists applied loadings.

Sheathing: Smooth or corrugated piping or tubing that protects the reinforcing steel against corrosion.

Spacer: A device to separate elements of a multiple-element reinforcement to ensure full bond development of each steel element.

Water: Water used in the grout mix shall conform to AASHTO T 26 and shall be potable, clean, and free from substances that may be injurious to cement and steel.

1.4 REFERENCED CODES AND STANDARDS

The following publications form a part of this specification to the extent indicated by the references. The latest publication as of the issue date of this specification shall govern, unless indicated otherwise.

A. American Society for Testing and Materials (ASTM), American Association of State Highway and Transportation Officials (AASHTO), and WSDOT Standard Specifications

   WSDOT Std. Spec.
   Section, or AASHTO
   ASTM Specification Specification or Test

   A 36, A 572 Structural Steel
9-07.9 Cold-Drawn Steel Wire

A 252 Welded and Seamless Steel Pipe

9-07.3 Deformed Steel Reinforcing Bar

9-07.11 High-Strength Steel Reinforcing Bar

9-07.4 Epoxy-Coated Steel Reinf. Bar

M 80 Concrete Aggregate

T 106 Compressive Strength of Hydraulic Cement Mortar

T 133 Density of Hydraulic Cement

M 45 Aggregate for Masonry Mortar

9-01.2(1) Portland Cement

9-23.6 Chemical Admixtures for Concrete

D 1784 Polyvinyl Chloride (PVC) Pipe (Class 13464-B)

D 3350 M 252 Polyethylene Corrugated Tubing

9-25.1 Water for Concrete

B. American Welding Society (AWS)
   1. AWS/D1.1/D1.1M Structural Welding Code-Steel
   2. AWS/D1.2 Structural Welding Code-Reinforcing Steel

C. American Petroleum Institute (API)
   1. 5CT Specification for casing and tubing

1.5 MICROPILE DESIGN REQUIREMENTS

The micropiles shall be designed to meet the specified loading conditions, as shown in the Plans and the working drawings as approved by the Engineer. The Contractor shall design the micropiles in accordance with the Allowable Stress Design (ASD) design method.

Steel pipe used for micropile permanent casing shall incorporate an additional 1/16 inch thickness of sacrificial steel for corrosion protection. Where required as shown in the Plans, corrosion protection of the internal steel reinforcing bars, consisting of epoxy coating, or grout, shall be provided in accordance with subsection 2.01 of this Special Provision. Where permanent casing is used for a portion of the micropile, encapsulation shall extend at least five feet into the casing.

A minimum bond length of 15 feet shall be used for a minimum total length of 21 feet.

1.6 CONTRACTOR'S EXPERIENCE REQUIREMENTS AND SUBMITTAL

The micropile Contractor shall be experienced in the construction and load testing of micropiles and have successfully constructed at least three projects in the last five years involving construction within reduced overhead clearance spaces totaling at least 25 micropiles of equal or greater capacity than required for this project.

The micropile Contractor shall have previous micropile drilling and grouting experience in soil/rock similar to project conditions. The Contractor shall submit construction details, structural details and load test
results for at least three previous successful micropile load tests from different projects of similar scope to this project.

The micropile Contractor shall design the micropile system. The micropile system shall be designed by a Professional Engineer, licensed under Title 18 RCW State of Washington, with experience in the design of at least three successfully completed micropile projects over the past five years, with micropiles of equal or greater capacity than required in these plans and specifications. The micropile designer may be either an employee of the Contractor or a separate Consultant designer meeting the specified experience requirements. The on-site foremen and drill rig operators shall also have experience on at least three projects over the past five years installing micropiles of equal or greater capacity than required for this project.

At least 30 calendar days before the planned start of micropile construction, the Contractor shall submit in writing the completed project reference list, including a brief project description with the owner’s name and current phone numbers. The Contractor shall also submit a personnel list for the micropile system designer, supervising project Engineer, drill rig operators and on-site foremen to be assigned to the project. The personnel list shall contain a summary of each individual's experience and be complete enough for the Engineer to determine whether each individual satisfies the required qualifications. The Engineer will approve or reject the Contractor's qualifications within 15 calendar days after receipt of a complete submission. Additional time required due to incomplete or unacceptable submittals will not be cause for time extension or impact or delay claims. All costs associated with incomplete or unacceptable submittals shall be borne by the Contractor.

Work shall not be started, nor materials ordered, until the Engineer’s written approval of the Contractor's experience qualifications is given. The Engineer may suspend the Work if the Contractor uses non-approved personnel. If work is suspended, the Contractor shall be fully liable for all resulting costs and no adjustment in contract time will result from the suspension.

1.7 MICROPILE DESIGN SUBMITTALS

At least 30 calendar days before the planned start of micropile structure construction, the Contractor shall submit complete design calculations and working drawings to the Engineer for approval in accordance with Section 6-01.9. The submittal shall include all details, dimensions, quantities, ground profiles, and cross-sections necessary to construct the micropile structure. The Contractor shall verify the limits of the micropile structure and ground survey data before preparing the detailed working drawings.

1.8 DESIGN CALCULATIONS

Design calculations shall include, but not be limited to, the following items:

A. A written summary report which describes the overall micropile design, and its compatibility with the anticipated subsurface conditions as described by the contract test hole boring logs, the Summary of Geotechnical Conditions provided in the Appendix to the Special Provisions, and the geotechnical report(s) prepared for this project.

B. Applicable code requirements and design references.

C. Micropile structure critical design cross-section(s) geometry including soil strata and piezometric levels and location, magnitude and direction of design applied loadings, including slope or external surcharge loads.

D. Design criteria including, soil shear strengths (friction angle and cohesion), unit weights, and ground-grout bond values and micropile drillhole diameter assumptions for each soil strata.
E. Partial safety factors/strength factors (for Service Load Design) or load factors (for Load Factor Design) used in the design of the ground-grout bond values, surcharges, soil/rock and material unit weights, steel, grout, and concrete materials.

F. Design calculation sheets with the project number, micropile structure location, designation, date of preparation, initials of designer and checker, and page number at the top of each page. An index page shall be included with the design calculations.

G. Design notes including an explanation of any symbols and computer programs used in the design.

H. Other design calculations.

1.9 WORKING DRAWINGS

The Contractor shall submit working drawings in accordance with WSDOT Std. Spec. Section 6-01.9. The working drawings shall include all information required for the construction and quality control of the piling. Working drawings shall include, but not be limited to, the following items:

A. A plan view of the micropile structure identifying:
   1. A reference baseline and elevation datum.
   2. The offset from the construction centerline or baseline to the face of the micropile structure at all changes in horizontal alignment.
   3. Beginning and end of micropile structure stations.
   4. Subsurface exploration locations shown on a plan view of the proposed micropile structure alignment with appropriate reference base lines to fix the locations of the explorations relative to the micropile structure.

B. An elevation view of the micropile structure(s) identifying:
   1. Elevation view showing micropile locations and elevations; vertical and horizontal spacing; and alignment and the location of drainage elements (if applicable).
   2. Existing and finish grade profiles both behind and in front of the micropile structure.

C. Design parameters and applicable codes.

D. General notes for constructing the micropile structure including the overall construction sequence, micropile installation sequence at each footing, means and methods to prevent damage to existing adjacent piles and micropiles, and other special construction requirements.

E. A listing of the summary of quantities on the elevation drawing of each micropile structure showing pay item estimated quantities.

F. Micropile structure typical sections including micropile spacing and inclination; minimum drillhole diameter; pipe casing and reinforcing bar sizes and details; splice types and locations; centralizers and spacers; grout bond zone and casing plunge lengths and corrosion protection details; and connection details to the substructure footing, anchorage, plates, etc.

G. A typical detail of production proof test micropiles defining the micropile length, minimum drillhole diameter, inclination, and load test bonded and unbonded test lengths.
H. Details, dimensions, and schedules for all micropiles, casing and reinforcing steel, including reinforcing bar bending details.

The Contractor shall revise the approved working drawings when plan dimensions are changed due to field conditions or for other reasons. Within 30 days after completion of the work, submit as-built drawings to the Engineer.

The Contractor shall also provide revised design calculations signed by the approved Registered Professional Engineer for all design changes made during the construction of the micropile structure.

1.10 CONSTRUCTION SUBMITTALS

The Contractor shall prepare and submit to the Engineer, for review of completeness, 5 copies of the following for the micropile system or systems to be constructed:

A. Detailed step-by-step description of the proposed micropile construction procedure, including personnel, installation tolerances, testing, and equipment to assure quality control. This step-by-step procedure shall be shown on the working drawings in sufficient detail to allow the Engineer to monitor the construction and quality of the micropiles.

B. Discussion of how the Contractor's construction methods accommodate and are compatible with the anticipated subsurface conditions as described in the contract test hole boring logs, the Summary of Geotechnical Conditions provided in the Appendix to the Special Provisions, and the geotechnical report(s) prepared for this project.

C. Proposed start date and time schedule and micropile installation schedule providing the following:
   1. Micropile number
   2. Micropile design load
   3. Type and size of reinforcing steel
   4. Minimum total bond length
   5. Total micropile length
   6. Micropile top footing attachment

D. If welding of casing is proposed, the Contractor shall submit the proposed welding procedure for approval by the Engineer.

E. Manufacturer's information, model, size, and type of equipment to be used for installing micropiles, with appropriate manufacturer's literature for review. Include detailed description of the drilling equipment and methods proposed to be used to provide drillhole support and prevent detrimental ground movements.

F. Information on headroom and space requirements for installation equipment that verify the proposed equipment can perform at the site. Plan describing how surface water, drill flush, and excess waste grout will be controlled, collected, disposed of.

G. Certified mill test reports for the reinforcing steel and for the casing used in micropile installation. The ultimate strength, yield strength, elongation, and material properties composition shall be included. Tag sample verification may be substituted in place of certified mill test reports for micropile casing.
H. Proposed Grouting Plan. The grouting plan shall include complete descriptions, details, and supporting calculations for the following:

1. Grout mix design and type of materials to be used in the grout including certified test data and trial batch reports.

2. Grouting equipment, including capacity and relation to the grouting demand and working conditions as well as provisions for back-up equipment and spare parts.

3. Types and sizes of grout hoses, connections, and grout delivery systems.

4. Methods and equipment for placing, positioning, and supporting the steel pipe casing and reinforcing bars.

5. Methods and equipment for accurately monitoring and recording the grout depth, grout volume and grout pressure as the grout is being placed.

6. Procedures and schedules for grout batching, mixing, and pumping including provisions for handling drilling fluid and for post grouting.

7. Grouting rate calculations, when requested by the Engineer. The calculations shall be based on the initial pump pressures or static head on the grout and losses throughout the placing system, including anticipated head of drilling fluid to be displaced.

8. Contingency procedures for handling blockage of ducts or equipment breakdowns.

9. Estimated curing time for grout to achieve specified strength. Previous test results for the proposed grout mix completed within one year of the start of grouting may be submitted for initial verification and acceptance and start of production work. During production, grout shall be tested in accordance with subsection 3.20 of this Special Provision.


I. Detailed plans for the proposed micropile load testing method. This shall include all drawings, details, and structural design calculations necessary to clearly describe the proposed test method, reaction load system capacity and equipment setup, types and accuracy of apparatus to be used for applying and measuring the test loads and micropile top movements in accordance with subsection 3.22 of this Special Provision.

J. Calibration reports and data for each test jack, pressure gauge and master pressure gauge and electronic load cell to be used. The calibration tests shall have been performed by an independent testing laboratory, and tests shall have been performed within 90 calendar days of the date submitted. Testing shall not commence until the Engineer has reviewed and accepted the jack, pressure gauge, master pressure gauge and electronic load cell calibration data.

K. Discussion of the Contractor's contingency plan if a proof load test fails.

Work shall not begin until the construction submittals have been received, reviewed, and accepted in writing by the Engineer. Provide submittal items 1 through 6 at least 21 calendar days prior to initiating micropile construction and submittal items 7 through 11 at least 7 days prior to start of micropile load testing or incorporation of the respective materials into the work. The Contractor shall allow the Engineer 7 calendar days to review the construction submittals after a complete set has been received. Additional time required due to incomplete or unacceptable submittals shall not be cause for delay or impact claims. All costs associated with incomplete or unacceptable Contractor submittals shall be the responsibility of the Contractor.
1.11 PRE-CONSTRUCTION MEETING

A pre-construction meeting will be scheduled by the Engineer and held prior to the start of micropile construction. The Engineer, prime Contractor, micropile specialty Contractor, and excavation Contractor shall attend the meeting. Attendance is mandatory. The pre-construction meeting will be conducted to clarify the construction requirements for the work, to coordinate the construction schedule and activities, and to identify contractual relationships and delineation of responsibilities amongst the prime Contractor and the various Subcontractors - specifically those pertaining to excavation for micropile structures, anticipated subsurface conditions, micropile installation and testing, micropile structure survey control and site drainage control.

PART 2 - PRODUCTS

2.1 GENERAL MATERIAL REQUIREMENTS

A. Materials for micropiles shall consist of the following:

   a. Admixtures that control bleed, improve flowability, reduce water content, and retard set may be used in the grout, subject to the review and acceptance of the Engineer. Admixtures shall be compatible with the grout and mixed in accordance with the manufacturer's recommendations. Expansive admixtures shall only be added to the grout used for filling sealed encapsulations and anchorage covers. Accelerators are not permitted. Admixtures containing chlorides are not permitted.

2. Cement: All cement shall be Portland cement conforming to WSDOT Std. Spec. Section 9-01.2(1), except that the Types shall be II, III or V.

3. Centralizers and Spacers: Centralizers and spacers shall be fabricated from schedule 40 PVC pipe or tube, steel, or material non-detrimental to the reinforcing steel. Wood shall not be used. Centralizers and spacers shall be securely attached to the reinforcement; sized to position the reinforcement within 3/8 inch of plan location from center of micropile; sized to allow grout tremie pipe insertion to the bottom of the drillhole; and sized to allow grout to freely flow up the drillhole and casing and between adjacent reinforcing bars.

4. Epoxy Coating: The minimum thickness of coating applied electrostatically to the reinforcing steel shall be 1 mil. Epoxy coating shall conform to WSDOT Std. Spec. Section 9-07.3. Bend test requirements are waived. Bearing plates and nuts encased in the micropile concrete footing need not be epoxy coated.

5. Fine Aggregate: If sand - cement grout is used, sand shall conform to AASHTO M 45.

6. Grout: Neat cement or sand/cement mixture with a minimum seven day compression strength of 4,000 psi in accordance with WSDOT Std. Spec. Section 6-02.3(20).

7. Grout Protection: Provide a minimum 1 inch grout cover over bare or epoxy coated bars (excluding bar couplers) or minimum 1/2 inch grout cover over the encapsulation of encapsulated bars.

8. Pipe Casing: Steel pipe casing for micropiles shall have the diameter and at least the minimum wall thickness shown on the approved working drawings. Steel pipe micropiles shall conform to ASTM A 252, Grade 2 or 3, including tolerances for pipe diameter, edge alignment, end match marking, roundness and straightness and conform to the steel micropile splice welding requirements specified herein. The carbon equivalency (CE) as defined in AWS D 1.1, Section XI 5.1, shall not exceed 0.45. The sulfur content shall not exceed 0.05 percent.
a. Steel pipe shall not be joined by welded lap splicing. Steel pipe seams and splices shall be complete penetration welds. Partial welds of steel pipe may be restored to complete penetration welds in conformance with AWS D1.1.

b. The manufacturer or fabricator of steel piling shall furnish a certificate of compliance in accordance with WSDOT Std. Spec. Section 1-06.3 stating that the piling being supplied conforms to these specifications. The certificate of compliance shall include test reports for tensile and chemical tests. Samples for testing shall be taken from the base metal, steel, coil or from the manufactured or fabricated piling. The certificate of compliance shall be in English units.

c. Welded circumferential joints in pipe shall develop the strength of the pipe section. Threaded pipe joints shall develop at least the nominal resistance used in the design of the micropile.

9. Plates and Shapes: Structural steel plates and shapes for micropile top attachments shall conform to either ASTM A 36 or ASTM A 572 Grade 50.

10. Reinforcing Bars: Reinforcing steel shall be deformed bars in accordance with WSDOT Std. Spec. Sections 9-07.4 or 9-07.11. When a bearing plate and nut are required to be threaded onto the top end of reinforcing bars for the micropile top to footing anchorage, the threading may be continuous spiral deformed ribbing provided by the bar deformations or may be cut into a reinforcing bar. If threads are cut into a reinforcing bar, the next larger bar number designation from that shown on the Plans shall be provided, at no additional cost to the Contracting Agency.

11. Bar tendon couplers, if required, shall develop the ultimate tensile strength of the bars without evidence of any failure.

2.2 REINFORCING BAR CORROSION PROTECTION

A. Reinforcing bars for micropiles shall be epoxy coated in accordance with WSDOT Std. Spec. Section 6-02.3(24)H and 9-07.3.

PART 3 - EXECUTION

3.1 SITE DRAINAGE CONTROL

The Contractor shall control and properly dispose of drill flush and construction related waste, including excess grout, in accordance with Section 1-07.5(3) as supplemented in these Special Provisions and all applicable local codes and regulations.

3.2 EXCAVATION

The Contractor shall coordinate the work and the excavation so the micropile structures are safely constructed. The Contractor shall perform the micropile construction and related excavation in accordance with the Plans and approved submittals.

3.3 MICROPILE ALLOWABLE CONSTRUCTION TOLERANCES

A. Centerline of piling shall not be more than 3 inches from indicated plan location.

B. Micropile shall be plumb within 2 percent of total-length plan alignment.

C. Top elevation of micropile shall be plus 1 inch or minus 2 inch maximum from vertical elevation indicated.
D. Centerline of reinforcing steel shall not be more than 1/2 inch from indicated location.

3.4 MICROPILE INSTALLATION

The micropile Contractor shall select the drilling method, the grouting procedure, and the grouting pressure used for the installation of the micropiles. The micropile Contractor shall also determine the micropile casing size, final drillhole diameter and bond length, and central tendon reinforcement steel sizing necessary to develop the specified load capacities and load testing requirements. The micropile Contractor is also responsible for estimating the grout take.

3.5 DRILLING

The drilling equipment and methods shall be suitable for drilling through the conditions to be encountered, without causing damage to any overlying or adjacent structures or services. The drillhole shall be open along its full length to at least the design minimum drillhole diameter prior to placing grout and reinforcement. Temporary casing or other approved method of micropile drillhole support will be required in caving or unstable ground to permit the micropile shaft to be formed to the minimum design drillhole diameter. The Contractor's proposed method(s) to provide drillhole support and to prevent detrimental ground movements shall have received the approval of the Engineer. Detrimental ground movement is defined as movement which requires remedial repair measures. Use of drilling fluid containing bentonite is not allowed.

3.6 GROUND HEAVE OR SUBSIDENCE

During construction, the Contractor shall observe the conditions in the vicinity of the micropile construction site on a daily basis for signs of ground heave or subsidence. The Contractor shall immediately notify the Engineer if signs of movements are observed. The Contractor shall immediately suspend or modify drilling or grouting operations if ground heave or subsidence is observed, if the micropile structure is adversely affected, or if adjacent structures are damaged from the drilling or grouting. If the Engineer determines that the movements require corrective action, the Contractor shall take corrective actions necessary to stop the movement or perform repairs.

When due to the Contractor's methods or operations or failure to follow the specified/approved construction sequence, as determined by the Engineer, the costs of providing corrective actions will be borne by the Contractor in accordance with WSDOT Std. Spec. Section 1.07.13. When due to differing site conditions, as determined by the Engineer, the costs of providing corrective actions will be addressed in accordance with WSDOT Std. Spec. Section 1.04.4.

3.7 PIPE CASING AND REINFORCING BARS PLACEMENT AND SPLICING

Reinforcement may be placed either prior to grouting or placed into the grout-filled drillhole before temporary casing (if used) is withdrawn. Reinforcement surface shall be free of deleterious substances such as soil, mud, grease or oil that might contaminate the grout or coat the reinforcement and impair bond. Micropile cages and reinforcement groups, if used, shall be sufficiently robust to withstand the installation and grouting process and the withdrawal of the drill casings without damage or disturbance.

The Contractor shall check micropile top elevations and adjust all installed micropiles to the planned elevations.

Permanent casing shall be installed to 6 feet below existing grades.

Centralizers and spacers shall be provided at 10 feet centers maximum spacing. The upper and lower most centralizer shall be located a maximum of 5 feet from the top and bottom of the micropile. Centralizers and spacers shall permit the free flow of grout without misalignment of the reinforcing bar(s).
and permanent casing. The central reinforcement bars with centralizers shall be lowered into the stabilized drill hole and set. The reinforcing steel shall be inserted into the drill hole to the desired depth without difficulty. Partially inserted reinforcing bars shall not be driven or forced into the hole. The Contractor shall redrill and reinsert reinforcing steel when necessary to facilitate insertion.

Lengths of casing and reinforcing bars to be spliced shall be secured in proper alignment and in a manner to avoid eccentricity or angle between the axes of the two lengths to be spliced. Splices and threaded joints shall meet the requirements of item 9 of subsection 2.01 of this Special Provision. Threaded pipe casing joints shall be located at least two casing diameters (OD) from a splice in any reinforcing bar. When multiple bars are used, bar splices shall be staggered at least 1 foot.

3.8 GROUTING

Micropiles shall be primary grouted the same day the load transfer bond length is drilled. Prior to grouting, the drillhole shall be flushed with water and/or air to remove drill cuttings. The Contractor shall use a neat cement grout or a sand cement grout with a minimum seven day unconfined compressive strength of 4000 psi. Admixtures, if used, shall be mixed in accordance with manufacturer's recommendations.

The grouting equipment shall be colloidal mixers only (paddle mixers and other non-colloidal types of mixers shall not be used), and shall produce a grout free of lumps and undispersed cement. Contractor shall have means and methods of measuring the grout quantity and pumping pressure during the grouting operations. The grout pump shall be equipped with a pressure gauge to monitor grout pressures. A second pressure gauge shall be placed at the point of injection into the micropile top. The pressure gauges shall be capable of measuring pressures of at least 150 psi or twice the actual grout pressures used, whichever is greater. The grout shall be kept in agitation prior to mixing. Grout shall be placed within one hour of mixing. The grouting equipment shall be sized to enable each micropile to be grouted in one continuous operation.

The grout shall be injected from the lowest point of the drill hole and injection shall continue until uncontaminated grout flows from the top of the micropile. The grout may be pumped through grout tubes, casing, hollow-stem augers, or drill rods. Temporary casing, if used, shall be extracted in stages ensuring that after each length of casing is removed the grout level is brought back up to the ground level before the next length is removed. Additional grout shall be placed by the use of a tremie pipe at all times. The tremie pipe shall always extend below the level of the existing grout in the drillhole. The grout pressures and grout takes shall be controlled to prevent excessive heave or fracturing of rock or soil formations. Upon completion of grouting, the grout tube may remain in the hole, but must be filled with grout.

If the Contractor elects to use a postgrouting system, working drawings and details shall be submitted to the Engineer for review in accordance with subsection 3.10 of this Special Provision.

3.9 GROUT TESTING

Grout within the micropile proof test micropiles shall attain the minimum specified seven day design compressive strength prior to load testing. Previous test results for the proposed grout mix completed within one year of the start of work may be submitted for initial verification of the required compressive strengths for installation of initial production micropiles. During placement of proof test micropiles, and production micropiles, micropile grout will be sampled and tested by the Engineer for compressive strength in accordance with WSDOT Test Method 813 and AASHTO T 106 at a frequency of no less than one set of three 2 inch grout cubes from each grout plant each day of operation or per every 10 micropiles, whichever occurs more frequently. The compressive strength will be the average of the 3 cubes tested.
If a compressive strength test fails, the Engineer may require the Contractor to proof test some or all of the production micropiles installed since the last grout batch that met the specified compressive strength.

3.10 MICROPILE INSTALLATION RECORDS

The Contractor shall prepare and submit to the Engineer full-length installation records for each micropile installed. The records shall be submitted within the same work shift that micropile installation is completed. The data shall be recorded in the micropile installation log. A separate log shall be provided for each micropile.

3.11 MICROPILE LOAD TESTS

The Contractor shall perform proof testing of micropiles at the locations specified in this Special Provision or as otherwise specified by the Engineer, and shall perform tension load testing in accordance with ASTM D 3689, except as modified by this Special Provision. All load testing shall be performed in tension.

While completed production micropiles may be used as part of the reaction frame for proof load testing, no reaction bearing elements of the load test frame for proof load testing of micropiles shall bear on existing footing or other structure elements of the existing garage.

3.12 PROOF LOAD TESTS

A minimum of one successful proof load tests shall be completed for the project as specified by the Engineer. Additional proof tests will be required if modifications are made in the micropile installation methods or number of micropiles subsequent to the first production micropile.

3.13 TESTING EQUIPMENT AND DATA RECORDING

Testing equipment shall include dial gauges, dial gauge support, jack and pressure gauge, electronic load cell, and a reaction frame. The load cell is required only for the creep test portion of the proof test. The Contractor shall provide a description of test setup and jack, pressure gauge and load cell calibration curves in accordance with subsection 3.09 of this Special Provision. Additionally, the Contractor shall not use test jacks, pressure gauges and master pressure gauges, and electronic load cells greater than 90 calendar days past their most recent calibration date, until such items are recalibrated by an independent testing laboratory.

The Contractor shall design the testing reaction frame to be sufficiently rigid and of adequate dimensions such that excessive deformation of the testing equipment does not occur. The Contractor shall align the jack, bearing plates, and stressing anchorage such that unloading and repositioning of the equipment will not be required during the test.

The Contractor shall apply and measure the test load with a hydraulic jack and pressure gauge. The pressure gauge shall be graduated in 75 psi increments or less. The jack and pressure gauge shall have a pressure range not exceeding twice the anticipated maximum test pressure. Jack ram travel shall be sufficient to allow the test to be done without resetting the equipment. The Contractor shall monitor the creep test load hold during proof tests with both the pressure gauge and the electronic load cell. The Contractor shall use the load cell to accurately maintain a constant load hold during the creep test load hold increment of the proof test.

The Contractor shall measure the micropile top movement with a dial gauge capable of measuring to 1 mil (0.001 inch). The dial gauge shall have a travel sufficient to allow the test to be done without having to reset the gauge. The Contractor shall visually align the gauge to be parallel with the axis of the micropile and support the gauge independently from the jack, micropile or reaction frame. The Contractor
shall use two dial gauges when the test setup requires reaction against the ground or single reaction micropiles on each side of the test micropile.

The required load test data will be recorded by the Engineer.

3.14 PROOF TEST LOADING SCHEDULE

Test micropiles designated for proof testing shall be tension proof load tested to a maximum test load of 1.50 times the micropile Seismic Design Load (SDL) shown in the Plans or the working drawings as approved by the Engineer. Proof tests shall be conducted by incrementally loading the micropile in accordance with the following schedule, to be used for both compression and tension loading:

<table>
<thead>
<tr>
<th>LOAD</th>
<th>HOLD TIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>AL</td>
<td>1 minute</td>
</tr>
<tr>
<td>0.25 SDL</td>
<td>1 minute</td>
</tr>
<tr>
<td>0.50 SDL</td>
<td>1 minute</td>
</tr>
<tr>
<td>0.75 SDL</td>
<td>1 minute</td>
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<tr>
<td>1.00 SDL</td>
<td>1 minute</td>
</tr>
<tr>
<td>1.25 SDL</td>
<td>10 or 60 minute</td>
</tr>
<tr>
<td>AL</td>
<td>1 minute</td>
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</tbody>
</table>

Depending on performance, either a 10 minute or 60 minute creep test shall be performed at the 1.50 SDL Maximum Test Load. Where the micropile top movement between 1 and 10 minutes exceeds 0.03125 inch, the Maximum Test Load shall be maintained an additional 50 minutes. Movements shall be recorded at 1, 2, 3, 5, 6, 10, 20, 30, 50 and 60 minutes. The alignment load shall not exceed 5 percent of SDL. Dial gauges shall be reset to zero after the initial AL is applied.

The acceptance criteria for micropile proof load tests are:

1. The micropile shall sustain the tension maximum test load applied (1.5 SDL) with no more than 0.50 inch total vertical movement at the top of the micropile, relative to the position of the top of the micropile prior to testing.

2. At the end of the 1.50 SDL creep test load increment, test micropiles shall have a creep rate not exceeding 0.03125 inch/log cycle time (1 to 10 minutes) or 0.0625 inch/log cycle time (6 to 60 minutes). The creep rate shall be linear or decreasing throughout the creep load hold period.

3.15 PROOF TEST MICROPILE REJECTION

If a proof-tested micropile fails to meet the acceptance criteria, the Contractor shall proof test another micropile within that footing as selected by the Engineer. For failed micropiles and further construction of subsequent micropiles, the Contractor shall modify the design, the construction procedure, or both. These modifications may include installing replacement micropiles, incorporating micropiles at not more than 50 percent of the maximum load attained, post grouting, modifying installation methods, increasing the bond length, or changing the micropile type. Any modification that necessitates changes to the structure design will require the Engineer's prior review and acceptance.
END OF SECTION 31 63 33
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes
   1. Overhead contact system (OCS) pole drilled-pier foundations.
   2. OCS offset foundations.

B. Related Sections
   1. Section 31 00 00 – Earthwork
   2. Section 34 23 13 – OCS Metal Poles

1.3 REFERENCE STANDARDS.

A. Section incorporates by reference the latest revisions of the following documents:

B. American Concrete Institute (ACI)
   1. ACI 301, Specifications for Structural Concrete
   2. ACI 306.1, Standard Specification for Cold Weather Concreting
   3. ACI SP-66, ACI Detailing Manual

C. ASTM International (ASTM)
   1. ASTM C94/C94M, Standard Specification for Ready-Mixed Concrete

D. City of Seattle (COS)
   1. COS Street and Sidewalk Pavement Opening and Restoration Rules
   2. COS Standard Specifications for Road, Bridge and Municipal Construction 2011” (“Standard Specifications”)

E. Concrete Reinforcing Steel Institute (CRSI)
   1. CRSI Manual of Standard Practice

F. King County
   1. King County Metro Transit Division Trolley Overhead System Standards (“KCM Standards”)
      a. SA drawings:

1.4 SUBMITTALS

A. Procedures: Section 01 33 00, Submittal Procedures.

B. Furnish submittals specified in KCM Standards:
   2. Offset Foundations: KCM Standard Drawing SA-211 (if directed by Owner’s Representative to install an offset foundation).
C. Concrete Cylinders:
   1. Furnish test results as required by Owner’s Representative.

1.5 QUALITY ASSURANCE

A. Comply with ACI 301 and ACI SP-66.

B. Manufacturer Qualifications:
   1. A firm experienced in manufacturing ready-mixed concrete products and that complies with
      ASTM C94/C94M requirements for production facilities and equipment.

C. Preinstallation Conference: Conduct conference at Project site.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver anchor bolt sets to the site complete with associated fittings and accessories, properly
   packed and protected against damage and loss of parts.

B. Storage of anchor bolt sets:
   1. Fastener components shall be protected from dirt and moisture in closed containers at the
      storage area.
   2. Only as many fastener components as are anticipated to be installed during the work shift
      shall be taken from protected storage. Fastener components that are not incorporated into
      the Work shall be returned to protected storage at the end of the work shift.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials shall meet the requirements specified in KCM Standards:
   2. Offset Foundations: KCM Standard Drawing SA-211 (if directed by Owner’s Representative
      to install an offset foundation).

B. Anchor Bolts And Anchor Plates, Nuts And Washers
   1. Provide anchor bolts, nuts, and anchor plates for Standard Foundations and Offset
      Foundations as specified in KCM Standard Drawings referenced above.
   2. Bolts shall be marked with manufacturer’s mark and bolt grade.

C. Anchor Bolt Template: 1/4-inch steel. Provide separate templates for each bolt circle and bolt size.

D. Materials shall be the same type, brand, and source, throughout Project

2.2 RELATED MATERIALS

A. Joint-Filler Strips:
   2. Match adjacent sidewalk joint widths.

PART 3 - EXECUTION

3.1 CONSTRUCTION

A. Comply with Standard Specifications 8-32.3(2), Foundations, and the following KCM Standard
   Drawings:
2. Offset Foundations: KCM Standard Drawing SA-211 (if directed by Owner’s Representative to install an offset foundation).

B. Construction Sequence: Install OCS pole foundations sufficiently in advance of scheduled pole installation and pole loading to satisfy the requirements of Section 34 23 13, OCS Metal Poles.

C. Placement Guidelines
   1. Locate OCS pole foundations as specified and shown on the Contract Drawings.
   2. Contractor shall be responsible for field locating OCS pole foundations.
   3. Change of foundation location from Contract Drawings shall be approved in advance by the Owner’s Representative.

D. General Requirements:
   1. Place concrete for foundations in one continuous pour.
   2. Anchor bolts shall be vertical before, during, and after concrete is placed.
   3. Cold weather placement shall comply with ACI 306.1.
   4. Hot weather placement shall comply with ACI 301.

E. Sidewalks and Pavement:
   1. Opening and Restoration:
      a. Sidewalks and pavement shall be opened and restored in compliance with COS Street and Sidewalk Pavement Opening and Restoration Rules.
      b. Provide sidewalk and pavement restoration around the new pole.
      c. When saw cutting is required in a sidewalk or other concrete area, extend saw cuts beyond cracked or damaged areas. Where extended saw cut areas are extensive, the Contractor may be entitled to additional compensation.
   2. Protection
      a. Protect sidewalks while concrete is setting, by means of barriers and proper warning signs.

3.2 EXCAVATION:

A. Excavation shall conform to the requirements specified in this section and in Section 31 00 00, Earthwork.

B. Underground Utilities:
   1. Contact underground utility owners to locate utilities before boring or excavating for foundations.
   2. After the utility locate, hand excavate each foundation location to a depth of four feet and to the width shown on the referenced KCM Standards.
   3. Additional excavation may be performed by other methods.
   4. If a utility conflict is discovered, the Owner’s Representative may determine that an offset foundation is required.
   5. For the purpose of this section, an existing underground utility shall be considered in conflict with the Work if it crosses or projects into the required excavation for the foundation at an elevation between the top and bottom of the foundation.

C. Drilled-Pier Foundations:

END OF SECTION 31 66 05
PART 1 - GENERAL

1.1  RELATED DOCUMENTS

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

B. References and standards listed herein are to be the latest edition available, unless specifically stated otherwise.

1.2  SUMMARY

A. The work includes constructing asphalt concrete pavement on pedestrian paths and Burke Gilman Trail indicated on the drawings.

B. Related Sections:
   1. Division 01 Section “Submittals Procedures.”
   2. 31 20 00 Earthwork
   3. 32 13 00 Rigid Paving

1.3  SUBMITTALS

A. General: Make submittals in accordance with Division 1 Section “Submittal Procedures.”

B. Product Data: Submit product data showing material and installation instructions for the asphalt mix and tack coat.

1.4  QUALITY ASSURANCE

A. All Work shall conform with the City of Seattle Standard Specifications for Road, Bridge and Municipal Construction and City of Seattle Standard Plans, 2011 edition, as modified herein, and with the Street and Sidewalk Pavement Opening and Restoration Director's Rule, 5-2009.

B. The Contractor shall have one copy of the Standard Specifications and Standard Plans at the job site.

C. The Standard Specifications apply only to performance and materials and how they are to be incorporated into the work. The legal/contractual relationship sections, and the measurement and payment sections, do not apply to this document.

PART 2 - PRODUCTS

2.1  ASPHALT CONCRETE

A. Asphalt Concrete shall be Hot Mix Asphalt (HMA) Class 1/2 inch per City of Seattle Standard Specification Sections 5-04, 9-02, and 9-03.8.

PART 3 - EXECUTION

3.1  Asphalt Concrete Pavement

A. Asphalt concrete pavement shall be constructed in conformance with Section 5-04.3 of the City of Seattle Standard Specifications, except as modified herein. Prime coat is not required and tack coat is required as specified therein.
B. Asphalt concrete pavement more than 3 inches thick shall be placed in multiple layers. Each layer shall not exceed 3 inches in thickness, or be less than 2 inches. Asphalt concrete pavement 3 inches thick or less may be placed in one layer.

3.2 ASPHALT TREATED BASE

A. Asphalt-treated base shall be constructed in conformance with Section 4-06.3 of the COS Standard Specifications.

END OF SECTION 32 12 16
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. References and standards listed herein are to be the latest edition available, unless specifically stated otherwise.

1.2 SUMMARY

A. Section Includes: Road base and Graspave2 products.

B. Related Sections:
   a. Division 01 Section "Submittals Procedures."
   2. 31 00 00 Earthwork
   3. 32 90 00 Planting

1.3 STANDARD SPECIFICATIONS

A. All work shall conform to the 2011 Standard Specifications and Standard Plans for Road, Bridge and Municipal Construction, as published by the City of Seattle (COS) unless otherwise indicated herein.

B. The contractor shall have one copy of the Standard Specifications and Standard Plans at the job site.

C. The Standard Specifications apply only to performance and materials and how they are to be incorporated into the work. The legal/contractual relationship sections and the measurement and payment sections do not apply to this document.

1.4 SUBMITTALS

A. Submit for review and approval prior to placement:
   1. "Graspave2": Provide manufacturer's product data and installation instructions.
   2. Product data for each proposed product.
   3. Submit a 10'' x 10'' section of Graspave2 material.

1.5 QUALITY ASSURANCE

A. Delivery, Storage, and Handling
   1. Protect paving units from damage during delivery and store under tarp when time from delivery to installation exceeds one week.

1.6 QUALIFICATIONS

A. Installation: Performed only by skilled work people with satisfactory record of performance on landscaping or paving projects of comparable size and quality.
1.7 PROJECT CONDITIONS

A. All hard surface paving adjacent to reinforced turf areas, including concrete walks and asphalt paving, must be completed prior to installation of paving units.

B. Cold weather:
   1. Do not use frozen materials or materials mixed or coated with ice or frost.
   2. Do not build on frozen work or wet, saturated or muddy subgrade.

C. Protect partially completed paving against damage from other construction traffic when work is in progress.

D. Protect adjacent work from damage during reinforced turf installation.

PART 2 - PRODUCTS

2.1 PAVING UNITS

A. Material: 100% post-consumer recycled plastic resins, reinforced high density Polyethylene (HDPE), with minimum 3% carbon black concentrate added for UV protection.

B. Units may be ordered in pre-assembled rolls that vary from 108 square feet to 1,345 square feet, with hollow rings rising from a strong open grid allowing maximum grass root penetration and development.

C. Color: “Black”.

D. Unit weight = 510 grams (18 oz).

E. Manufacturer: Grasspave2, Hydrogrow Invisible Structures, Inc., 1600 Jackson Street, Suite 301, Golden, Colorado 80401. Phone: (800) 233-1510 Fax: (303) 233-8282.

2.2 OTHER MATERIALS

A. Grasspave road base per Section 31 00 00 – Earthwork.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine subgrade and base course installed conditions.
   1. Do not start “Grasspave2” installation until unsatisfactory conditions are corrected.
   2. Check for poor drainage, improperly compacted trenches, debris, and improper gradients.

B. Installation constitutes acceptance of existing conditions and responsibility for satisfactory performance. If existing conditions are found unsatisfactory, contact Architect for resolution.

3.2 PREPARATION OF SUBGRADE AND BASE

A. Cut to subgrade per plan and compact subgrade surface to 95% maximum dry density per ASTM D 1557.

B. Prevent vehicle traffic on the prepared subgrade and protect from weather if exposed for more than 1 week.
C. Place base course in 6" lifts (max.) and compact to 95% maximum dry density per ASTM D 1557.

3.3 INSTALLATION OF PAVING UNITS

A. Install the paving units by placing units with rings facing up, and using pegs and holes provided to maintain proper spacing and interlock the units. Top of rings shall be between 6mm to 13mm (0.25" to 0.5") below the surface of adjacent hard-surface pavement.

B. Install sand in rings as they are laid in sections by "back-dumping" directly from a dump truck, or from buckets mounted on tractors, which then exit the site by driving over rings already filled with sand. The sand is then spread laterally from the pile using flat bottomed shovels and/or wide "asphalt rakes" to fill the rings. A stiff bristled broom should be used for final "finishing" of the sand. The sand must be "compacted" by using water from hose, irrigation heads, or rainfall, with the finish grade no less than the top of rings and no more than 6 mm (0.25") above top of rings.

3.4 CLEANING

A. Perform cleaning during the installation of work and upon completion of the work.

1. Remove and replace segments of Grasspave2 units where three or more adjacent rings are broken or damaged, reinstalling as specified, so no evidence of replacement is apparent. Repair any damage to adjacent materials and surfaces resulting from installation of this work.

2. Perform cleaning during the installation of work and upon completion of the work. Remove all excess materials, debris, and equipment from site. Repair any damage to adjacent materials and surfaces resulting from installation of this work.
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. References and standards listed herein are to be the latest edition available, unless specifically stated otherwise.

1.2 SUMMARY

A. The work includes Portland cement concrete pavements for road restoration, extruded curbs, curb and gutter, sidewalks, bridge topping slab, and driveways.

B. Related Sections:
   1. Division 01 Section "Submittals Procedures."
   2. 03 30 00 Cast-In-Place Concrete
   3. 07 92 05 Joint Sealants
   4. 31 20 00 Earthwork
   5. 32 12 16 Asphalt Paving
   6. Attached King County Metro Transit Division Construction Requirements

1.3 SUBMITTALS

A. General: Make submittals in accordance with Division 1 Section “Submittal Procedures.”

B. Design Mixtures: For each concrete pavement class, provide technical data demonstrating compliance with the City of Seattle Standard Specifications.

C. Manufacturers technical data demonstrating how each one of the following meets the requirements of the City of Seattle Standard Specifications:
   1. Cement
   2. Aggregate
   3. Admixtures
   4. Joint materials
   5. Reinforcing bar, tie and dowel bars
   6. Epoxy coating
   7. Curing compound

D. Prior to beginning construction, submit the following:
   1. A plan showing the proposed location of all pavement joints. Show field verified locations of surface features such as existing pavement joints, buildings, curbs, manhole, vault lids, and cane bolt sleeve etc. Show the proposed location of joints in relation to the surface features. Demonstrate compliance with the type of joints, dimensions, and spacing shown in the Contract Drawings.
   2. Proposed schedule and sequence for concrete placement and pavement related work.
   3. A schedule for making the cuts required for the control joints.
1.4 QUALITY ASSURANCE

A. All Work shall conform with the City of Seattle Standard Specifications for Road, Bridge and Municipal Construction and City of Seattle Standard Plans, 2011 edition as modified herein and with the Street and Sidewalk Pavement Opening and Restoration Director’s Rule, 5-2009.

B. The Contractor shall have one copy of the Standard Specifications and Standard Plans at the job site.

C. The Standard Specifications apply only to performance and materials and how they are to be incorporated into the work. The legal/contractual relationship sections, and the measurement and payment sections do not apply to this document.

D. Mock-ups: For pavement Types 1B, 4, and 7 provide 10’ x 10’ cast mockups of full size sections of concrete sidewalk to demonstrate typical joints, surface finish, texture, color and standard of workmanship.
   1. Mockup to include control and expansion joints.
   2. Notify Landscape Architect seven days in advance of dates and times when mockups will be constructed.
   3. Obtain Landscape Architect’s approval of mockups before starting construction.
   4. Maintain approved mockups during construction in an undisturbed condition as a standard for judging the completed pavement.
   5. Demolish and remove the approved mockups from the site when directed by the Landscape Architect.

E. Proposed scoring patterns and mockups shall be subject to the review of the project Landscape Architect and Civil Engineer.

PART 2 - PRODUCTS

2.1 CONCRETE

A. Portland Cement Concrete for City Road Panels Roadway Cement Concrete, high-early-strength (HES) per City of Seattle Standard Specification 5-05.

B. Portland Cement Concrete for sidewalk construction shall be Non-Roadway Cement Concrete, HES, High Strength per City of Seattle Standard Specification 5-05.

C. Portland Cement Concrete for driveways shall be Roadway Cement Concrete, HES, High Strength per City of Seattle Standard Specification 5-05.

D. Portland Cement Concrete for Type 410c curb construction shall be Non-Roadway Cement Concrete per City of Seattle Standard Specification 5-05. Slump shall not exceed 3 1/2 inches.

E. Portland Cement Concrete for Type 410b curb construction shall be Non-Roadway Cement Concrete per City of Seattle Standard Specification 5-05. Slump shall not exceed 3 1/2 inches.

F. Portland Cement Concrete for Pervious Concrete Sidewalk construction shall be per City of Seattle Standard Specification 5-06.

G. Portland Cement Concrete for topping slab construction shall be Non-Roadway Cement Concrete, HES, High Strength per City of Seattle Standard Specification 5-05, and shall have:
   1. Maximum water-to-cement ratio of 0.40.
   2. Maximum total water content of 255 pounds per cubic yard or 0.035% shrinkage limit at 35 days.
2.2 REINFORCING STEEL
A. Deformed steel bar meeting the requirements of ASTM A 706 Grade 60.
B. Wire mesh shall conform with City of Seattle Standard Specification 9-07.7

2.3 TIE AND DOWEL BARS
A. Dowel bars shall conform with City of Seattle Standard Specification 9-07.5.
B. Tie bars shall conform with City of Seattle Standard Specification 9-07.6.
C. Curb dowel pins shall conform with City of Seattle Standard Specification 8-04.3(5)A.

PART 3 - EXECUTION

3.1 GENERAL
A. Portland Cement Concrete pavement installation shall conform with City of Seattle Standard Specification 5-05 and Directors Rule 5-2009.
B. Curb dowel pins shall be installed where Type 410c curb is supported by concrete pavement.
C. Portland Cement Concrete sidewalks shall conform with City of Seattle Standard Specification 8-14 as modified by the joint and finish details on the Drawings.
D. Portland Cement Concrete driveway pans shall conform with City of Seattle Standard Specification 8-19 as modified by the joint and finish details on the Drawings.
E. Portland Cement Concrete curbs and curb and gutters shall conform with City of Seattle Standard Specification 8-04.

3.2 FINISHES FOR EXTERIOR CONCRETE SURFACES
A. Paving Type 1A: Finish and scoring per City of Seattle Standard Plan No. 420.
B. Paving Type 1B: Finish and scoring per City of Seattle Standard Plan No. 425.
C. Paving Type 4
   1. Finish: Exposed Aggregate, 3/8” pea gravel, washed (retarded) exposure, refer to Landscape Architect’s sample.
   2. Scoring: Saw-cut joints as indicated on plans.
D. Paving Type 5
   1. Finish: Exposed Aggregate, 3/8” pea gravel, washed (retarded) exposure, refer to Landscape Architect’s sample.
   2. Scoring: Saw-cut joints as indicated on plans.
E. Paving Type 7
   1. Finish: Medium Broom Finish, perpendicular to primary path of travel.
   2. Scoring: Tooled joints as indicated on plans.
F. Paving Type 8
   1. Finish: Medium Broom Finish, perpendicular to primary path of travel.
   2. Scoring: Tooled joints as indicated on plans.

G. Driveways: Provide a rough finish perpendicular to the direction of travel per City of Seattle Standard Specification 5-05.3 (11).

H. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.
   1. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.

I. Monolithic Exposed-Aggregate Finish: Expose coarse aggregate in paving surface as follows:
   1. Immediately after float finishing, spray-apply chemical surface retarder to paving according to manufacturer’s written instructions.
   2. Cover paving surface with plastic sheeting, sealing laps with tape, and remove when ready to continue finishing operations.
   3. Without dislodging aggregate, remove mortar concealing the aggregate by lightly brushing surface with a stiff, nylon-bristle broom. Do not expose more than one-third of the average diameter of the aggregate and not more than one-half of the diameter of the smallest aggregate.
   4. Fine-spray surface with water and brush. Repeat cycle of water flushing and brushing until cement film is removed from aggregate surfaces to depth required.

3.3 CONTROL JOINTS

A. Saw cut control joints to dimensions indicated on the drawings

B. Saw cut as soon as concrete has hardened sufficiently to prevent aggregates being dislodged by saw. Complete within 24 hours after concrete placement.

C. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows:
   1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch (6-mm) radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate grooving-tool marks on concrete surfaces.
      a. Tolerance: Ensure that grooved joints are within 3 inches (75 mm) either way from centers of dowels.
   2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3-mm-) wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
a. Tolerance: Ensure that sawed joints are within 3 inches (75 mm) in both directions from center of dowels.

3. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

3.4 JOINT SEALANTS

A. Joint sealants shall be per specification section 07 92 05.

END OF SECTION 32 13 00
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. References and standards listed herein are to be the latest edition available, unless specifically stated otherwise.

1.2 SUMMARY

A. Section includes:
   1. Pervious unit pavers.
   2. Sand set bedding course.
   3. Paver Restraint Edging
   4. Filter Fabric

B. Related Sections
   1. Division 01 Section "Submittals Procedures."
   2. 31 00 00 Earthwork

1.3 PREINSTALLATION MEETINGS

A. Conduct a pre-installation conference with the Landscape Architect.

1.4 SUBMITTALS

A. Product Data: For the following:
   1. Pervious unit pavers.
   2. Paver restraint edging.
   3. Filter Fabric.

B. Sieve analysis for grading of sand set bedding course.

C. Samples: Full-size units of pervious unit paver.

1.5 INFORMATIONAL SUBMITTALS

A. Material Certificates: For unit pavers. Include statements of material properties indicating compliance with requirements, including compliance with standards. Provide for each type and size of unit.

B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for unit pavers, indicating compliance with requirements.
1. For grid paving units, include durability test data based on testing according to proven field performance requirements of ASTM C 1319 performed on units subjected to three years’ exposure to same general type of environment, temperature range, and traffic volume as Project.

1.6 QUALITY ASSURANCE

A. Mockups: Provide a 10’ x 10’ mock-up of full section of porous unit paving. Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Landscape Architect specifically approves such deviations in writing.

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store pavers on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting.

B. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.

PART 2 - PRODUCTS

2.1 PERVIOUS UNIT PAVERS

A. Unit pavers shall be Mutual Materials ‘Eco-Priora’ Permeable pavers.

B. Paver size shall be 4”x8”x3-1/8”

C. Paver color: Cascade Blend.

D. Installation Pattern as indicated on Plans.

2.2 FILTER FABRIC

A. Material: The filter geotextile shall be a high modulus, woven, polypropylene fabric with the following physical properties:

1. Apparent opening size to be between US Sieve #70 to #100 when tested in accordance with ASTMD4751.

2. Puncture resistance to be 125 lbs minimum when tested in accordance with ASTM D 4833.

B. Acceptable Products/Manufacturers: The woven geotextile fabric shall be one of the following, or approved equal:

1. MIRAFI 700X as manufactured by MIRAFI Inc.
2. Amoco 1199 as manufactured by Amoco Fabrics and Fibers Company

2.3 BEDDING SAND

A. The bedding sand shall conform to the requirements of ASTM C 33 except for the gradation requirements. The sand shall be clean, naturally occurring sand free from deleterious or foreign materials. The sand shall contain no more than 10% acid soluble material. It shall be delivered to the site in a moist condition.

B. The bedding sand shall be composed of sub-angular to sub-rounded particles as described in ASTM D2488. Manufactured sand shall not be used.

C. When tested in accordance with ASTM C 136 the sand gradation shall conform to the following grading requirements such that it shall not vary from the high limit on one sieve to the low limit on the next sieve or vice versa.

<table>
<thead>
<tr>
<th>ASTM Sieve Size</th>
<th>Percent Passing by Weight</th>
</tr>
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<tbody>
<tr>
<td>3/8&quot;</td>
<td>100</td>
</tr>
<tr>
<td>3/16&quot;</td>
<td>95-100</td>
</tr>
<tr>
<td>No. 8</td>
<td>80-100</td>
</tr>
<tr>
<td>No. 16</td>
<td>50-85</td>
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</tr>
<tr>
<td>No. 100</td>
<td>0-10</td>
</tr>
<tr>
<td>No. 200</td>
<td>0-1</td>
</tr>
</tbody>
</table>

D. When tested in accordance with ASTM C 117 the sand shall not contain more than 2 percent of material by weight passing the No. 200 sieve.

2.4 PAVER RESTRAINT EDGING

A. Paver Restraint Edging shall be Sure-Loc Aluminum Paver Restraint ‘L-Edge’.

PART 3 - EXECUTION

3.1 PREPARATION

A. Proof-roll prepared subgrade according to requirements in Section 31 00 00 "Earthwork" to identify soft pockets and areas of excess yielding. Proceed with porous paver installation only after deficient subgrades have been corrected and are ready to receive base course for pavers.
3.2 INSTALLATION, GENERAL

A. Do not use unit pavers with chips, cracks, voids, discolorations, and other defects that might be structurally unsound or visible in finished work.

B. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.

C. Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.

D. Tolerances:
   1. Variation in Plane between Adjacent Units (Lipping): Do not exceed 1/16-inch unit-to-unit offset from flush.
   2. Variation from Level or Indicated Slope: Do not exceed 1/8 inch in 24 inches and 1/4 inch in 10 feet or a maximum of 1/2 inch.

E. Provide edge restraints as indicated. Install edge restraints before placing unit pavers.
   1. Install edge restraints to comply with manufacturer's written instructions. Install stakes at intervals required to hold edge restraints in place during and after porous paver installation.
   2. For metal edge restraints with top edge exposed, drive stakes at least 1 inch below top edge.

3.3 SETTING BED INSTALLATION

A. Compact soil subgrade uniformly to at least 95 percent of ASTM D 1557 laboratory density.

B. Proof-roll prepared subgrade to identify soft pockets and areas of excess yielding. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

C. Place filter fabric over prepared subgrade, overlapping ends and edges at least 12 inches.

D. Place aggregate subbase compact by tamping with plate vibrator, and screed to depth indicated.

E. Place aggregate base compact to 100 percent of ASTM D 1557 maximum laboratory density, and screed to depth indicated.

F. Place filter fabric over compacted base course, overlapping ends and edges at least 12 inches.

G. Place leveling course and screed to a thickness of 1-1/2 – 2 inches taking care that moisture content remains constant and density is loose and constant until pavers are set and compacted.

3.4 PAVER INSTALLATION

A. Set unit pavers on leveling course, being careful not to disturb leveling base. Place pavers with a 1/16-inch minimum and 1/8-inch maximum joint width. Use string lines to keep straight lines.
B. Compact pavers into leveling course with a low-amplitude plate vibrator capable of a 3500- to 5000-lbf compaction force at 80 to 90 Hz. Use vibrator with neoprene mat on face of plate or other means as needed to prevent cracking and chipping of pavers. Perform at least three passes across paving with vibrator.

1. Compact pavers when there is sufficient surface to accommodate operation of vibrator, leaving at least 36 inches of uncompacted pavers adjacent to temporary edges.
2. Before ending each day's work, compact installed concrete pavers except for 36-inch width of uncompacted pavers adjacent to temporary edges (laying faces).
3. As work progresses to perimeter of installation, compact installed pavers that are adjacent to permanent edges unless they are within 36 inches of laying face.
4. Before ending each day's work and when rain interrupts work, cover pavers that have not been compacted and leveling course on which pavers have not been placed with non-staining plastic sheets to protect them from rain.

C. Place soil fill as follows, immediately after vibrating pavers into leveling course. Spread and screed soil fill level with tops of pavers. Vibrate pavers and add soil fill until porous paving is filled to about 3/4 inch from top surface; remove excess soil fill if any.

1. Before ending each day's work, place soil fill in installed porous paving except for 42-inch width of unfilled paving adjacent to temporary edges (laying faces).
2. As work progresses to perimeter of installation, place soil fill in installed paving that is adjacent to permanent edges unless it is within 42 inches of laying face.
3. Before ending each day's work and when rain interrupts work, cover paving that has not been filled with non-staining plastic sheets to protect it from rain.

D. Place graded aggregate fill immediately after vibrating pavers into leveling course. Spread and screed aggregate fill level with tops of pavers.

1. Before ending each day's work, place aggregate fill in installed porous paving except for 42-inch width of unfilled paving adjacent to temporary edges (laying faces).
2. As work progresses to perimeter of installation, place aggregate fill in installed paving that is adjacent to permanent edges unless it is within 42 inches of laying face.
3. Before ending each day's work and when rain interrupts work, cover paving that has not been filled with non-staining plastic sheets to protect it from rain.

E. As work progresses, remove and replace pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.

END OF SECTION 32 14 13
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. References and standards listed herein are to be the latest edition available, unless specifically stated otherwise.

1.2 SUMMARY

A. The work includes crosswalk striping, stop lines, lane markings, curb markings, bus lane markings on Northeast Pacific Place, Northeast Pacific Street, Montlake Boulevard Northeast, and Stevens Way as indicated on the drawings.

B. Related Sections:
   1. Division 01 Section “Submittals Procedures.”
   2. 32 12 16 Asphalt Paving
   3. 32 13 00 Rigid Paving

1.3 SUBMITTALS

A. General: Make submittals in accordance with Division 1 Section “Submittal Procedures.”

B. All products.

1.4 QUALITY ASSURANCE

A. All work shall conform with the 2011 Standard Specifications and Standard Plans for Road, Bridge and Municipal Construction, as published by the City of Seattle (COS) unless otherwise indicated herein.

B. The Contractor shall have one copy of the Standard Specifications and Standard Plans at the job site.

C. The Standard Specifications apply only to performance and materials and how they are to be incorporated into the work. The legal/contractual relationship sections, and the measurement and payment sections do not apply to this document.

PART 2 - PRODUCTS

2.1 PAINT

A. Paint for pavement markings shall be lead-free and shall comply with Section 9-29 of the COS Standard Specifications. The paint shall be factory mixed, quick drying, non-bleeding and free of any materials or products containing lead. Colors shall be as indicated on the drawings.

2.2 THERMOPLASTIC

A. Thermoplastic pavement markings shall comply with Section 9-29 of the COS Standard Specifications.
PART 3 - EXECUTION

3.1 PAINT

A. Painted pavement marking installation shall conform with Section 8-22.3 of the COS Standard Specifications, except that the Contractor shall be responsible for all layout and control points, striping shall not deviate more than 1/4-inch in 10 feet from a straight line and striping shall not be more than 1-inch from the specified locations. Paint striping shall only be applied after the pavement has been allowed to cure 14 days minimum, when the pavement is clean and dry and when the temperature is above 50 degrees F.

B. Thermoplastic pavement marking installation shall conform with Section 8-22.3 of the COS Standard Specifications, except that the Contractor shall be responsible for all layout and control points, striping shall not deviate more than 1/4 inch in 10 feet from a straight line, and striping shall not be more than 1 inch from the specified locations.

END OF SECTION 32 17 23
PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Chain-link Fence Type F1.

B. Related Sections:

1. Section 03 30 00 "Cast-in-Place Concrete" for cast-in-place concrete post footings.

1.2 PERFORMANCE REQUIREMENTS

A. Structural Performance of Chain-link Fence: Provide fence capable of withstanding the following structural loads without exceeding allowable design working stresses of materials for fence and associated anchors and connections:

Fence: Capable of withstanding the following loads applied as indicated.

1. Concentrated load of 200 lbf applied at any point and in any direction.
2. Uniform load of 50 lbf/ft. applied horizontally and concurrently with uniform load of 100 lbf/ft. applied vertically downward.
3. Concentrated and uniform loads above need not be assumed to act concurrently.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for chain-link fences and gates.

1. Fence and posts, rails, and fittings.
2. Chain-link fabric, reinforcements, and attachments.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

C. Samples for Initial Selection: For components with factory-applied color finishes.

D. Samples for Verification: Prepared on Samples of size indicated below:

1. Polymer-Coated Components: In 6-inch lengths for components and on full-sized units for accessories.

E. Delegated-Design Submittal: For chain-link fences indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

F. Product Certificates: For each type of chain-link fence from manufacturer.

G. Product Test Reports: For framing strength according to ASTM F 1043.
H. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For the following to include in operation and maintenance manuals:

   1. Polymer finishes.

1.5 PROJECT CONDITIONS

A. Field Measurements: Verify layout information for chain-link fences shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of chain-link fences that fail in materials or workmanship within specified warranty period.

   1. Failures include, but are not limited to, the following:
      a. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

   2. Warranty Period: 15 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CHAIN-LINK FENCE FABRIC

A. General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist. Comply with CLFMI Product Manual and with requirements indicated below:

   1. Fabric Height: As indicated on Drawings.
   2. Steel Wire Fabric: Wire with a diameter of 0.148 inch.
      a. Mesh Size: 2 inches.
      1) Color: As selected by Architect from manufacturer's full range, complying with ASTM F 934.
      c. Coat selvage ends of fabric that is metallic coated before the weaving process with manufacturer's standard clear protective coating.

   3. Selvage: Knuckled at both selvages.

2.2 FENCE FRAMING

A. Posts and Rails: Comply with ASTM F 1043 for framing, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F 1043 based on the following:
1. Fence Height: As indicated on Drawings.

   a. Line Post: 1.9 inches in diameter.
   b. End, Corner and Pull Post: 2.375 inches.

   a. Top Rail: 1.66 inches in diameter.


5. Metallic Coating for Steel Framing:
   a. Type B, zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. (0.27 kg/sq. m) of zinc after welding, a chromate conversion coating, and a clear, verifiable polymer film.

6. Polymer coating over metallic coating.
   a. Color: As selected by Landscape Architect from manufacturer's full range, complying with ASTM F 934.

2.3 TENSION WIRE

A. Polymer-Coated Steel Wire: 0.148-inch-diameter, tension wire complying with ASTM F 1664, Class 2A, over zinc-coated steel wire.

   1. Color: As selected by Landscape Architect from manufacturer's full range, complying with ASTM F 934.

2.4 FITTINGS

A. General: Comply with ASTM F 626.

B. Post Caps: Provide for each post.

   1. Provide line post caps with loop to receive tension wire or top rail.

C. Rail and Brace Ends: For each gate, corner, pull, and end post.

D. Rail Fittings: Provide the following:

   1. Top Rail Sleeves: Pressed-steel or round-steel tubing not less than 6 inches long.

E. Tension and Brace Bands: Pressed steel.

F. Tension Bars: Steel, length not less than 2 inches shorter than full height of chain-link fabric. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.

G. Truss Rod Assemblies: Steel, hot-dip galvanized after threading rod and turnbuckle or other means of adjustment.
H. Tie Wires, Clips, and Fasteners: According to ASTM F 626.
   1. Standard Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, complying with the following:
      a. Hot-Dip Galvanized Steel: 0.148-inch diameter wire; galvanized coating thickness matching coating thickness of chain-link fence fabric.
      b. Color to match chain link fabric.

I. Finish:
   1. Metallic Coating for Pressed Steel or Cast Iron: Not less than 1.2 oz./sq. ft. (366 g/sq. m) zinc.
      a. Polymer coating over metallic coating.

2.5 GROUT AND ANCHORING CEMENT

A. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout, recommended in writing by manufacturer, for exterior applications.

B. Erosion-Resistant Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with potable water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended in writing by manufacturer, for exterior applications.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.
   1. Do not begin installation before final grading is completed unless otherwise permitted by Landscape Architect.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Stake locations of fence lines and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 INSTALLATION, GENERAL

A. Install chain-link fencing to comply with ASTM F 567 and more stringent requirements indicated.
   1. Install fencing on established boundary lines inside property line.
3.4 CHAIN-LINK FENCE INSTALLATION

A. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.

B. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.
   1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
   2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
      a. Concealed Concrete: Top 2 inches below grade as indicated on Drawings to allow covering with surface material.

C. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment of as indicated on Drawings.

D. Line Posts: Space line posts uniformly at 10 feet o.c.

E. Post Bracing and Intermediate Rails: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Diagonally brace terminal posts to adjacent line posts with truss rods and turnbuckles. Install braces at end posts and at both sides of corner and pull posts.

F. Tension Wire: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Pull wire taut, without sags. Fasten fabric to tension wire with 0.120-inch diameter hog rings of same material and finish as fabric wire, spaced a maximum of 24 inches o.c. Install tension wire in locations indicated before stretching fabric. Provide horizontal tension wire at the following locations:
   1. As indicated.

G. Top Rail: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer.

H. Chain-Link Fabric: Apply fabric to outside of enclosing framework. Leave 1 inch between finish grade or surface and bottom selvage unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.

I. Tension or Stretcher Bars: Thread through fabric and secure to end, corner and pull posts with tension bands spaced not more than 15 inches o.c.

J. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric per ASTM F 626. Bend ends of wire to minimize hazard to individuals and clothing.
   1. Maximum Spacing: Tie fabric to line posts at 12 inches o.c. and to braces at 24 inches o.c.
K. Fasteners: Install nuts for tension bands and carriage bolts on the side of the fence opposite the fabric side.

3.5 CLEANING

A. After completing fence installation, inspect all components. Remove spots, dirt, and debris. Repair damaged finishes to match original finish or replace component.

1. Follow Manufacturer’s instructions.

3.6 PROTECTION

A. Protect fence installation from damage due to other construction operations.

END OF SECTION 32 31 19
PART 1 GENERAL

1.01 SUMMARY

A. Furnishing all labor, materials, equipment, facilities, transportation and services to complete all water supply, irrigation system and related work as shown on the Drawings and specified herein.

B. Description of work: The landscape irrigation system for the Montlake Triangle and Lower Rainier Vista in Seattle, Washington. The system is divided into two control areas, effectively creating two systems with separate controllers and points of connection. System C1 irrigates the area of the Project north of Pacific Place. System C2 irrigates the Montlake Triangle bounded by Montlake Boulevard, Pacific Place, and Pacific Street. System design parameters are as described on the Drawings.

C. Scope of work: The general extent of the irrigation system work is shown on the Drawings and includes, but is not necessarily limited to the following:

1. Installation of all irrigation distribution equipment, such as turf rotor sprinkler heads, pop-up sprinkler heads, emitter type dripline, etc.
2. Installation of related control equipment, such as remote control valves, valve decoders, manual isolation valves, quick coupler valves, drain valves, etc.
3. Installation of distribution piping, fittings, and appurtenances.
4. Installation of one new irrigation controller, and one converted existing irrigation controller, flow sensors, including necessary electrical connections, low-voltage wiring, communication wiring, lightning protection, grounding, shielding, bonding, and rain sensor.
5. The control system for both areas is a "two-wire" system. Routes a single pair of communication cable wires (14 AWG/2c or 12 AWG/2c) as the primary two-wire path from the control Irrigation Controller to the location of the last valve on that two-wire path. Anywhere along that two-wire path, a field decoder can be spliced into that path. From the field decoder, communication cable can be routed to the control valve(s) it is signaling. Each decoder has a unique address code, so it will be programmed, monitored, and evaluated back at the central control computer.
6. The Contractor shall provide a total 'turn-key' installation for the site. This includes all equipment necessary to install the primary two-wire path, connecting the field controller, including necessary wiring, communication equipment, and lines needed to communicate with the central control system. Contractor shall include all equipment and labor necessary to provide a fully functional, centrally controlled irrigation system installation at the point of final acceptance and turn-over to the Owner.

1.02 RELATED SECTIONS

A. Included Division 02 through Division 48 Technical Specifications.

1.03 SUBMITTALS

A. Procedures: Furnish technical data describing the quality and performance of each material component or system to be used in the Work as required by the Drawings or Specifications.

B. Provide complete product submittals for each equipment item described within this section. Submittals shall indicate model selected and where more than one type shall be used, contractor shall indicate the intended application of each.
C. Contractor shall submit shop drawings illustrating schematic layout, and a list of components needed for modifying the existing irrigation controller to a two-wire system and for interfacing with the University’s existing central control irrigation system.

D. Contractor shall mock-up ALL assemblies as noted in the drawings with “mock-up required” for review and approval prior to proceeding with connections extending out from those assemblies. In place mock-ups are acceptable where practical for construction and review.

1.04 PROGRESS DRAWINGS

A. Comply with all applicable technical specifications.

B. Accurately record locations of all piping and equipment that varies from what is shown on the Drawings horizontally to within one (1) foot and vertically to within 0.5 feet.

C. Progress drawings shall be kept on-site and updated on a daily basis.

D. Upon completion of the installation, an 11”x17” laminated color-coded zone directory and irrigation plan shall be provided to the University Irrigation Manager.

1.05 QUALITY ASSURANCE

A. Contractor’s Quality Assurance Responsibilities: Contractor is solely responsible for quality control of the Work.

B. The publications and standards listed below form a part of this specification to the extent referenced. The publications and standards are referred to in the text by the basic designation only.

C. University of Washington Facilities Design Guide
   1. Mechanical - Metering and Gauges
   2. Civil - Irrigation

D. Seattle Public Utilities
   1. SPU Metering Compatibility for Submetering Applications

E. American Society for Testing and Materials (ASTM)
   1. ASTM D 3350-02 - Standard Specifications for Pipe Resin Materials
   2. ASTM D 2737 - Standard Specifications for Pipe Manufacturing
   3. ASTM F 714 - Standard Specifications for Pipe Manufacturing
   4. AWWA C 901 - Standard Specifications for Pipe Pressure Classifications
   5. AWWA C 906 - Standard Specifications for Pipe Pressure Classifications
   6. NSF 61 - Standard Specifications for Pipe Agency Listing of Pipes Suitable as a Pressure Conduit
   7. ASTM D 3261 - Standard Specifications for Manufacturing of Butt Fusion Fittings
   8. ASTM F 1055 - Standard Specifications for Manufacturing of Electrofusion Fittings
   9. ASTM F2164 - Field Leak Testing of Polyethylene Pressure Piping Systems Using Hydrostatic Pressure
   10. ASTM B 62-85 - Standard Specifications for Composition Bronze or Ounce Metal Castings
   13. ASTM D 2241-84 - Standard Specifications for PVC Pressure-Rated Pipe (SDR Series)
   15. ASTM F477 - Specification for Electrometric Seals (Gaskets) For Joining Plastic Pipe

F. Standards: Comply with all applicable provisions of the latest edition of the following codes:
1. UPC Uniform Plumbing Code
2. BOCA Buildings Officials and Codes Administrators
3. UBC Uniform Building Code
4. NEC National Electric Code
5. Institute of Electrical and Electronics Engineers - IEEE 1100-1999 Recommended Practice for Powering and Grounding Electronic Equipment
6. Plastics Pipe Institute (PPI) - Polyethylene Joining Procedures
7. Plastics Pipe Institute (PPI) - recommendations for hydrostatic design stresses for PVC Pipe
8. Local codes and jurisdiction requirements for The City of Seattle, Washington.

G. Permits, Fees and Licenses: Contractor is responsible to obtain all required permits and pay all associated fees unless otherwise noted.

H. Provide labeled equipment certifying approval, as hereinafter specified, by the following organizations:
   1. NSF National Sanitation Foundation
   2. UL Underwriters Laboratories

1.06 DELIVERY, STORAGE, AND HANDLING

A. During loading, transportation and unloading, every precaution shall be taken to prevent injury to the pipe. No pipe shall be dropped from cars or trucks, or allowed to roll down slides without proper retaining ropes. During transportation each pipe shall rest on suitable pads, strips, skids or blocks securely wedged or tied in place. Any pipe damaged shall be replaced.

B. Pipe and Large Fitting Handling: A nylon fabric choker sling capable of safely handling the weight of the pipe or fitting, shall be used to lift, place and move pipe and fittings.

C. Store PVC pipe in a neat and orderly manner fully supported and protected from sunlight.

D. All equipment shall be delivered, unloaded and handled so as to protect from damage at all times.

1.07 PROJECT / SITE CONDITIONS

A. PVC shall not be cemented during wet or freezing conditions per the discretion of Owner’s Representative.

B. Trench excavation and backfilling shall not be performed during excessively wet conditions per the discretion of Owner’s Representative.

1.08 SEQUENCE AND SCHEDULING

A. The Contractor shall be solely responsible for coordinating, sequencing and scheduling all work with all applicable trades and/or sub-contractors so as to insure proper and timely performance.

1.09 REVIEWS

A. An Authorized Representative of the Owner shall review all work. The Authorized Representative will provide site observation reports to the Owner.

B. Review Milestones: In addition to normal progress inspection, the Contractor shall give at least 72 hours notice to Owner’s Representative for observation of the work as follows:
   1. Layout of the system
   2. Review of mock-ups
   3. Observation of trenches, backfilling, and equipment
   4. Flushing operation
   5. Pressure testing mains and laterals
   6. Coverage test prior to planting
7. Coverage adjustment
8. Automatic operation and initial start-up
9. Final observation

1.010 SITE COORDINATION AND PRE-CONSTRUCTION MEETINGS
   A. The contractor is responsible for scheduling the following preconstruction coordination meetings:
   1. Prior to commencing irrigation system installation for System C1 and system C2 (separately if the construction start will occur in each area separated by more than forty-five days)
   2. Prior to commencing the installation of irrigation controller C2 and POC C2

1.011 WARRANTY
   A. Conform to all applicable technical specifications.
   B. Contractor shall provide a written warranty covering the entire system against defects in installation, workmanship and equipment for a period of one year from date of Final Acceptance.
   C. After the system is installed and approved, the Contractor shall facilitate a meeting(s) to instruct the irrigation manager, groundskeeper personnel and maintenance staff in the complete operation, winterization, and maintenance of the system.
      1. Irrigation Contractor shall provide a minimum of 10 hours of on-site training to the Owner’s landscape management company after acceptance of the project.

1.012 MANUFACTURER’S WARRANTY
   A. Contractor shall provide Owner with a warranty transfer that shall confer all applicable product warranties and replacement benefits to the Owner upon final acceptance.
   B. Provide this warranty transfer for each manufacturer whose products have been installed on the project.

1.013 MAINTENANCE
   A. Service: Contractor shall service and maintain system until the work has been deemed Substantially Complete.
   B. Irrigation shall be under full automatic operation for a period of two days prior to any planting in a given area.
   C. Final Acceptance and start of warranty period shall occur upon reaching Substantial Completion.
   D. The Contractor shall drain the irrigation system in the fall of the first year and re-start system in the following spring.

PART 2 PRODUCTS

2.01 GENERAL
   A. Manufacturer: Subject to compliance with requirements, provide products of the following:
      1. RainBird Sprinkler Mfg., Co.
      3. TORO Irrigation
      4. Rain Master
5. Approved equal.

B. Use only new materials of brands shown on Drawings, specified herein or as acceptable to the Owner's Representative.

2.02 PIPE MATERIALS

A. General:
   1. Irrigation piping flow velocity shall not exceed five (5) feet per second.

B. PVC Pipe:
   1. Mainline and laterals): Schedule 40, Type 1120-1220 polyvinyl chloride (PVC); ASTM D1784 and D1785; uniformly white in color.
   2. Points of connection; new vault, and penetrations: Schedule 80, Type 1120-1220 Polyvinyl Chloride (PVC), uniformly white in color.

C. Copper Pipe (if used for point of connection C2): Seamless Copper Pipe: ASTM B88, Type K.
   1. Copper Unions: ASME B16.18, cast copper alloy body, hexagonal stock, with ball-and-socket joint, metal-to-metal seating surfaces, and solder-joint, threaded or solder-joint, and threaded ends.

D. Steel Pipe (if used): Schedule 40 Carbon steel pipe ASTM Grade B seamless, .188 minimum wall thickness. Welded joints will be used in fabricating sections under pavement.

E. Ductile Iron Pipe (if used): AWWA C151, with cement mortar lining complying with AWWA C104; Class 51 unless otherwise indicated.

F. Sleeves: All new sleeves shall be PVC Schedule 80.

G. Swing Assemblies:
   1. Rotor Heads: Shall be a 12” pre-assembled swing joint.
   2. Pop-up Spray Heads: Shall be a 12” pre-assembled swing joint.
   3. Spray Heads on Fixed Height Risers: Shall be a fabricated and pre-assembled fixed riser.
   4. Swing assemblies shall not exceed 12 inches.

2.03 FITTINGS

A. PVC:
   1. Mainline 3” or smaller: Same as lateral.
   2. Lateral: ASTM D 2467, Schedule 40, socket-type, Type 1, Grade 1 polyvinyl chloride (PVC) with solvent weld or threaded connections in conformance with ASTM D1784 and D2466: uniformly white in color.

B. Copper: ANSI B16.22 wrought copper or cast brass, recessed solder joint type fittings.

C. Metallic: Cast bronze with standard iron pipe thread; 125 lb. class rating in conformance with ANSI B16.15.
   1. Dielectric Fittings: Assembly or fitting with insulating material isolating joined dissimilar metals to prevent galvanic action and stop corrosion. These devices are a combination of copper alloy and ferrous metal; threaded- and solder-end types, matching piping system materials.
   2. Dielectric Unions: Factory-fabricated, union assembly, designed for 250 psig minimum working pressure at 180° F (82° C). Include insulating material isolating dissimilar metals and ends with inside threads according to ASME B1.20.1.
   3. Dielectric Flanges: Factory-fabricated, companion-flange assembly for 150 psig or 300 psig minimum pressure to suit system pressures.
4. Copper-PVC Transition Fittings: Manufactured assembly or fitting, with pressure rating at least equal to that of system and with ends compatible to piping where fitting is to be installed.

D. Nipples:
1. Metallic: Schedule 40 red brass (35% copper, 15% zinc) pipe: threaded both ends. Pipe shall be in accordance with ASTM B43.
2. Plastic: Factory-threaded Schedule 80, Type 1, Grade 1 polyvinyl chloride (PVC) pipe, threaded both ends. Pipe shall be in conformance with ASTM D1784 and D1785. Color: gray.

2.04 JOINING METHODS AND MATERIALS
A. PVC Pipe and Fittings
1. Solvent Cement: ASTM F 656 primer and ASTM D 2564 solvent cement in color other than orange, compatible with PVC pipe and of proper consistency.
2. Cement: IPS Corporation Weld-on #705 for Class 200 P.V.C. or schedule 40 P.V.C. IPS Corporation Weld-on #795 for flexible P.V.C. to rigid P.V.C. connections.
3. Primer: IPS Corporation Weld-on #P-70.

B. Copper Pipe and Fittings
1. Solder: ASTM B 32, Alloys Sn95 and E.

C. Miscellaneous Pipe and Fittings
1. Gaskets and Fasteners for Metal and Metal-to-Plastic Flanged Joints: ASME B16.21, nonmetallic, asbestos-free, flat, 1/8-inch thickness gaskets and ASME B18.2.1, carbon steel bolts, nuts, and washers.
2. Gaskets for Plastic Flanged Joints: Materials recommended by plastic pipe and fitting's manufacturer.

2.05 VAULT (POINT OF CONNECTION C2)
A. Vault: Vault shall be a custom panel vault as manufactured by Oldcastle/Auburn Precast. Vault shall have a diamond plated steel, spring loaded lid. Contractor shall submit a manufacturer's shop drawing to the Landscape Architect for review and approval, prior to commencing fabrication.

2.06 DEDUCT WATER METER
A. The Contractor shall provide and install the following approved deduct water meters for System C2:
1. 2" Hersey 500 Series Deduct water meter (Model # 572IIS) per UW FSDG standards wired into the UW DDC System, with the following components for a remote sensing device:
   a. Hersey Translator Encoder Register with AMR (Automatic Meter Reading System) and 22 AWG 3-strand wire cable.
   b. Hersey 4-20mA FLO Unit and Frequency Transmitter Kit, requiring a 10V -35V DC external power source (typically from information management, SCADA, or Datalogger)
   c. Or approved equal.
2. City of Seattle, Seattle Public Utilities compatible Meter for Submetering Applications
   a. Provide Badger M170, 2-inch, elliptical flange inlet/outlet (ELL), with Absolute Digital Encoder (ADE), register measuring in cubic feet (CF), programmed for 100 CF upload, 25 foot cable lead, in-line connector, 100W endpoint (radio transmitter).
2.07 Backflow Prevention Assemblies (System C2)

A. Backflow preventer: double-check valve assemblies:
   1. Febco 805 Series
   2. Watts 007 Series

2.08 VALVES

A. Manual Isolation Valves:
   1. Manual Gate Valves (Mainline)
      a. Nibco T-113 with Bronze Handwheel
   2. Manual Drain Valves
      a. All manual drain valves shall be 2-inch Mueller Oriseal or approved equal and
         installed as per details on the drawings (at low points in the mainline to
         accommodate a minimum mainline slope of 1%. This valve is to be installed on
         mainlines only.
   3. Remote Control Zone Isolation Ball Valves (Between Mainline and RCV)
      a. Spears TRUE UNION BALL VALVES, size per pipe

B. Remote Control (Zone) Valves:
   1. Spray head and rotor Zone Remote Control Valves: Shall be RainBird PEB Series
      valves, or approved equal. Refer to drawings for size and location of valves.
      a. A pressure regulating module (RainBird Series PRS-Dial) shall be installed on all
         remote control valves.

C. Drip Zone Control Valves: See Item 2.010 Low Volume (Drip) Irrigation Equipment, A. Control
   Zone Kit in this specification section for low volume irrigation control valve information.

D. Master Valve:
   1. At Grade:
      a. 2” Superior 3300 Series master valve, normally open.

E. Quick Coupler:
   1. All quick couplers shall be a two-piece, rubber cover Buckner QB44RC-10 Series, or
      approved equal.
   2. Quick coupler keys shall be Buckner or RainBird (44K) with 1-inch FIPT by 1-inch FIPT
      metal ball valve downstream of key, and a 1-inch FIPT by ¾-inch male hose thread hose
      swivel (SH-1), connected by a galvanized 2-inch nipple.
   3. Swing Joint and Locking Anchor: Dura 1-A4-1-11-18 swing joint with DL-010 quick lock,
      or approved substitution.
   4. Protection Device: concrete ring – Owner Supplied, Contractor Installed

F. Pressure Reducing Valves:
   1. If a pressure reducing valve is required, it shall be a Watts, Febco, or approved equal.

G. In-line Check Valves:
   1. Hunter HCV HC-50F-50F as required to reduce and/or equally distribute low line
      drainage.
   2. KBI CV-0500 FF as required to reduce and/or equally distribute low line drainage.
   3. Approved Substitution

H. Valve Boxes and Box Extension: Valve boxes and extensions shall be of a variety as
   produced by Carson. Contractor shall provide black valve boxes, extensions, and covers for
   landscape planting beds and turf areas.
   1. Valve box covers shall be non-hinged and sized adequately to allow room for testing,
      manual operation, calibration, removal, repair and maintenance of the equipment. 1-inch
      to 2-inch clearances shall be accommodated between piping, valves and valve boxes,
      and 3 to 4 inches between valves and subgrade gravel level. Valve boxes shall be set on
compacted subgrade with masonry units or recycled blocks under each corner. Openings around the valve boxes shall be sealed with filter fabric affixed to the outside of the box.

2. Size valve boxes as follows:
   a. Gate Valve – 910 Series
   b. Wye Strainer – 1419 Series (for 1.5-inch strainer)
   c. Wye Strainer – 1220 Series (for 2-inch strainer)
   d. Backflow Assembly – 1730 Series
   e. Master Valve – 1419 Series
   f. Flow Sensor – 1410 Series
   g. Quick Coupler Valve – 910 Series
   h. Remote Control (Zone) Valves – 1220 Series (1-inch valves)
   i. Remote Control (Zone) Valves – 1324 Series (1.25-inch and larger valves)

2.09 SPRINKLER HEADS
A. All heads shall be as specified on the drawings or approved equal. Nozzle patterns are indicated and shown, however, specific site conditions may require that different nozzle patterns be used. Contractor shall adjust patterns to provide adequate coverage. Sprinkler heads shall be:
   1. Pop-up Spray Heads:
      a. RainBird 1812-SAM-PRS-P45 Series pop-up spray heads, or approved equal.
      b. Hunter MP Rotator Series nozzles will be used. See irrigation zone chart for nozzle size, color, and performance data.
   2. Lawn Area Rotor Heads:
      a. Hunter I-40 Series rotor heads with a 4” stainless steel riser and check valve, or approved equal.
      b. Hunter I-40 Ultra Series nozzles will be used. See irrigation zone chart for nozzle number and performance data.
   3. Spray Heads on Fixed Height Risers:
      a. Hunter MP Rotator Series nozzles will be used. See irrigation zone chart for nozzle size, color, and performance data.

2.010 LOW VOLUME (DRIP) IRRIGATION EQUIPMENT
A. Control Zone Kit:
   1. Each dripline zone shall be controlled by a Control Zone Kit, as manufactured by RainBird Model XCZ-150-COM, or approved equal. The Control Zone Kit shall include a 1½” PEB valve, a 200 mesh in-line Quick Check Basket filter, and an in-line pressure regulator providing an outlet pressure of 40 psi at a flow rate of 40 GPM. The valve body shall have a 1½” FNPT inlet and a 1” outlet.
B. Drip Tubing:
   1. Emitter dripline shall be:
C. Subterranean Box:
   1. The emitter box shall be manufactured by RainBird Model SEB - 6X, or approved equal. Box shall consist of rugged UV-resistant thermoplastic construction. The emitter box body and cap shall be black in color. Two slots in the bottom of the box shall be provided to allow for installation of distribution tubing onto the emission device. The dimensions on the unit shall be as follows: Height = 10.25", Top Diameter = 5.0", Base Diameter = 7.75”.
D. Flush Valves:
   1. Toro FCH-H auto flush in a 6-inch round RainBird SEB-6X enclosure.
E. Air Relief Valves:
   1. AVP-1 air vent in a 6-inch round RainBird SEB-6X enclosure. Provide air relief valves to reduce soil ingestion.

F. In-line Check Valves:
   1. Hunter HCV HC-50F-50F as required to reduce and/or equally distribute low line drainage.
   2. KBI CV-0500 FF as required to reduce and/or equally distribute low line drainage.
   3. Approved Substitution

G. In-line Pressure Reducing Valves:
   1. RainBird Series PSI-M40X, rated for 40 psi.

H. Flexible Hose:
   1. The flexible hose shall be manufactured by RainBird Model SPX-Flex, or approved equal. The tubing shall have an operating pressure rating of 80 psi at 110F degrees.

I. Fittings: The Easy Fit Compression Fitting & Adapter System (Easy Fit System) shall be used to connect ½" polyethylene tubing (.630"-.710", or 16mm-18mm outside diameter) to the following threaded components:
   1. ½" and ¾" Male Pipe Thread
   2. ½" and ¾" Female Pipe Thread
   3. ¾" Female Hose Thread
      a. The Easy Fit System consists of 3 fittings (tee, coupling and elbow) plus 5 adapters and two removable flush caps. The Easy Fit Compression Fitting shall accept all polyethylene tubing from .630" to .710" (16mm-18mm) OD, and it shall provide a leak-free compression fit and connections to threaded components. The operating range for the Easy Fit System shall be 0-60 PSI. The adapters shall be made of UV-resistant ABS materials and shall only be used with Easy Fit Compression Fittings. The adapters shall be installed in the Easy Fit Compression Fittings and threaded onto ½" or ¾" Male- or Female-threaded components. Pressure loss for the Easy Fit Compression Fittings shall be comparable to standard compression fittings. Pressure loss for the Easy Fit Adapters is a maximum of .1 PSI for each adapter used. The removable black or purple flush cap shall be used to close off a line. The purple flush cap shall be used to close off a line containing non-potable water. The Easy Fit System shall be manufactured by Rain Bird Corporation, Azusa, California.

2.011 LANDSCAPE IRRIGATION AUTOMATIC CONTROLLER C1 - (POINT OF CONNECTION #1)

A. Contractor shall preserve and re-use the RainMaster Eagle-i Plus Series automatic controller that is located in an existing cabinet east of Rainier Vista between the landscape area and the sidewalk to the west of Wilson Annex. This controller is identified on drawing sheet L604 as “C1”. The controller cabinet shall stay in the same location as it currently exists, adjacent to irrigation Point of Connection #1 (please refer to drawing sheet L604 for the approximate location). The irrigation design for the new landscape irrigation system north of NE Pacific Place, requires additional station capacity as shown in the drawings and zone charts. The controller requires conversion to a two-wire controller which allows for future system expansion or adjustment. The Contractor shall perform the following activities:
   1. Contractor shall order and install terminal boards and connecting cables to support the two-wire/decoder configuration.
   2. Contractor shall allow for ample lead time, so controller is available and fully operational in order to support new plantings upon their installation.
   3. Contractor shall synchronize all stations with the irrigation design and irrigation zone chart.
2.012 LANDSCAPE IRRIGATION AUTOMATIC CONTROLLER C2 - (POINT OF CONNECTION #2)

A. Contractor shall provide a RainMaster Eagle-i Plus Two-Wire Series automatic controller that is located east of NE Pacific Street adjacent to the east-facing wall of the parking garage access elevator. This controller is identified on drawing sheet L606 as “C2”. The controller cabinet shall be located adjacent to irrigation Point of Connection #2 (please refer drawing sheet L606 for the approximate location). The irrigation design for the new landscape irrigation system within the Montlake Triangle (System C2) requires an irrigation controller with station capacity, as shown on the drawings and zone charts. The controller will need to be a two-wire controller, with a 2-wire interface module, and the TWICE 2-wire communication protocol, which allows for future system expansion or adjustment. The Contractor shall perform the following activities:
1. Contractor shall order and install a new RainMaster Eagle-i Plus, complete with stainless steel exterior cabinet.
2. Contractor shall allow for ample lead time, so controller is available and fully operational in order to support new plantings upon their installation.
3. Contractor shall synchronize all stations with the irrigation design and irrigation zone chart.

B. Exterior Control Enclosure:
1. RainMaster T-Series (Model # RME36EG-T), stainless steel cabinet.

2.013 FLOW SENSING EQUIPMENT

A. Point of Connection (POC) C1 is existing and includes a fully functioning and integrated flow sensor.
B. One (1) Flow Sensor shall be provided for the POC C2. Locate downstream of the backflow preventer and master valve.
C. Flow Sensors:
   1. Acceptable networked digital flow sensors for exterior landscape irrigation use include:
      a. Data Industrial 220P-1.5 1.5-inch PVC 8 - 180 GPM

2.014 TWO-WIRE DECODERS

A. Decoders: RainMaster Decoders shall be used for master valves and remote control valves, or approved equal.
1. TW-D-1 Decoders: For single valve control.
2. TW-D-2 Decoders: For dual valve control.
3. TW-D-4 Decoders: For quad valve control.

2.015 GROUNDING

A. It is the responsibility of the Irrigation Contractor to provide grounding for all electrical equipment installed by him/her in relation to the irrigation control system. Said grounding shall include but not be limited to the items described in the following paragraphs.
B. Components: The contractor shall use UL listed grounding electrodes or those that meet the minimum requirements of the National Electrical Code (NEC) at each controller location. At the very minimum, the contractor shall connect a solid bare copper wire to the building grounding systems, as defined herewith and per following detail.
1. Connections: All ground circuit connections shall be made using an exothermic welding process by utilizing products such as the Cadweld “One-Shot” kits. Solder shall not be allowed to make connections. The wires are to be installed in as straight a line as possible, and if it is necessary to make a turn or a bend it shall be done in a sweeping curve with a minimum radius of 8” and a minimum included angle of 90°.
clamps shall be permitted temporarily during the resistance test process, but shall be replaced with Cadweld “One-Shot” kits immediately thereafter.

2. Shielding: The shielding requirements for wires and cables shall consist of the installation of a network of solid bare copper wire, per manufacturer’s recommendations, over the main bundles of wires and cables as shown in the details and described herein. The solid bare copper wire shall be installed 8” below finished grade. This bare conductor shall be placed above all other valve/power/communication wires and cables per detail. The conductor shall be laid in as straight a line as possible, and when necessary to make bends, they shall be made in a sweep style. It is not necessary to install this conductor over short wire runs (less than 150 feet) away from the main bundles. This solid bare copper wire shield network shall be connected to all controllers ground lug, which in turn are connected to grounding electrodes.

3. Bonding: All supplementary grounds for each controller will be bonded to the service entrance ground, per the requirements of the NEC and IEEE standards. The shield wire network as described above shall be used to bond each supplementary ground to the service entrance ground.

4. Bare Copper Wire Connections (Shield and Bonding Wires): When joining bare copper wires, it shall be done using an ERICO PG11L exothermic welding kit, or approved equal. Wire connectors, terminal ends, lugs or other types of connectors are not acceptable alternatives.

2.016 SPARE WIRES

A. Spare Wire: The contractor shall provide 10 feet of spare two-wire path that is terminated, coiled, and capped within a valve box at the end of each dedicated mainline branch. Each coil spare wire shall be tagged (labeled) with the appropriate markings to identify it as spare two-wire path.

2.017 SUPPORTING DEVICES

A. Provide all necessary inserts, fasteners, clamps rods, hangers, saddles, supports, anchor bolts, nuts, washers, and steel plates and shapes as required to properly support all piping and equipment included under this section.

B. Supporting devices shall be as manufactured by Grinnell or equivalent, and recommended for the application.

2.018 MISCELLANEOUS TOOLS & EQUIPMENT

A. Two-Wire Path for all Decoders:
   1. Wire shall be 14 AWG-2UF double jacketed. Maximum wiring distance shall not exceed 450 feet.
   2. Contractor shall provide and install a Decoder Cable Switching Device (DCSD) by Paige Electric at all locations where two-wire paths split, and half-way between long runs of two-wire path (over 100-feet in length).

B. Shielded Cable for Flow Sensors:
   1. Cable shall be rated for direct bury, shielded, 2-18 AWG copper wires, with drain wire.
      a. Rain Master EV-CAB-SEN 2-conductor direct burial shielded copper wire.
      b. Houston Wire D1501802.
      c. or approved substitution.

C. Wire Splice Kits:
   1. Splice kits shall be 3M-DB Series, properly sized for wire size and quantity per manufacturer’s recommendations. Follow the manufacturer’s instructions on the package.
      a. DBY-6.
b. DBR-6.
c. or approved substitution.

D. Trace Wiring: Dedicated trace wiring shall be installed with all irrigation mainline and each zone.

E. Pipe Detection Tape: "Sentry Line" three (3) inch wide, detectable, "Caution Water Line Buried Below" tape as available from Terra Tape Inc. Houston, Texas (800)-231-6074, or acceptable equal.

F. Valve Tags: Provide identification tag on flow control handle shaft, aluminum, plastic or other durable material, with valve station and controller number identified in 1/8” minimum letters.

G. Drainage Backfill: Cleaned gravel or crushed stone, graded from 3 inches maximum to 3/4 inch minimum.

H. Pressure Gauges: ASME B40.1, 4-1/2-inch (115 mm) diameter dial, with dial range of 2 times system operating pressure and bottom outlet.

PART 3 EXECUTION

3.01 GENERAL

A. Verification of Conditions: Examine the areas to receive the Work and the conditions under which the Work would be performed. Remedy conditions detrimental to the proper and timely completion of the Work. Do not proceed until unsatisfactory conditions have been corrected.

B. The Contractor shall install all irrigation system components in accordance with the Irrigation Plans, Details and these Specifications. The workmanship of the entire job must in every way be first class, and only experienced and competent contractors who are certified and have a minimum of 3 years of experience with installing two-wire systems will be allowed to work on the project.

C. Supervision: The Contractor, personally or through an authorized and competent representative shall supervise the work constantly, and shall as far as possible keep the same foremen and workmen on the job from commencement to completion. The workmanship of the entire job must in every way be first class, and only experienced and competent workmen shall be utilized for installation.

D. Schedule of Work: The Irrigation Contractor shall be responsible for the installation of the piping and equipment in a manner that will effect the earliest completion of the work in conformance with the construction progress schedules of other Contractors and Trades, and these Specifications.

3.02 PROTECTION

A. The Contractor shall be responsible for storage of materials and any damage to the work covered by these Specifications before the final acceptance of the work.

B. Protect work and materials from damage during construction. Storage of polyvinyl chloride (PVC) pipe and fittings shall be protected from direct sunlight. Beds on which materials are stored must be the full length of the pipe to avoid damage. Any pipe that has been damaged or dented shall not be used in the work.

C. Any existing structures, equipment, utilities, pavement, landscaping, etc., damaged by Irrigation Contractor during the course of the work, including any damage caused by leakage or settling of piping systems being or having been installed by them, shall be restored at Contractor's expense and to the Owner's satisfaction.
D. Securely cover openings into the system and cover apparatus, equipment, and appliances, both before and after being set in place, to prevent obstruction in the pipes and the breakage, misuse or disfigurement of the apparatus, equipment, or appliances.

3.03 LAYOUT AND VERIFICATION

A. The Contractor shall stakeout the locations of all pipe circuits, quick coupling valves, sleeves, and irrigation heads in accordance with the Drawings. The Contractor shall check and verify dimensions of layout and report variations to the Owner’s Representative prior to commencing installation. Layout work as accurately as possible to the drawings.

B. Minor changes in locations to the above from locations shown shall be made as necessary to avoid existing or proposed planting, piping, utilities, structures, etc., at the Contractor’s expense, or when directed by the Owner’s Representative, providing such change is ordered before such items or work directly connected to same are installed, and providing no additional materials are required.

C. The Contractor will be held responsible for the relocating of any items without first obtaining the Owner’s Representative approval of location per A, above. The Contractor shall remove and relocate such items, at his expense, if so directed by Owner’s Representative via a written request for information.

D. Before starting work on irrigation system, carefully check all grades to determine that work may safely proceed, keeping within the specified material depths. The Contractor shall be aware of the fact that the drawings are horizontal dimensions.

E. No fittings shall be installed on pipe underneath pavement or walls except where noted on the Irrigation drawings. If such a need should occur, the Contractor shall bring it to the attention of Owner’s Representative.

F. Exact dripline and sprinkler head placement is based on and shall be coordinated with actual planting layout and shall be verified by Owner’s Representative.

3.04 TRENCHING, BORING AND ENCASEMENT

A. As stated on the Irrigation Drawings, trenching is not permitted within the tree protection zones. All trenching should stop at the edge of the tree protection zone for existing trees to remain, and tunneled under the tree root system. Prior to commencing any trenching activities, confirm that all critical root zones are identified and clearly marked with paint, flags, and as per 01 56 39 TEMPORARY TREE AND PLANT PROTECTION.

B. Excavation. Trenches shall be excavated in accordance with the plans and specifications. OSHA standards or Owner safety policies regarding safety shall be followed regarding trench safety. If groundwater is encountered, it shall be removed by the Contractor. Shoring of the trench, where required is the responsibility of the contractor.

C. Make trenches for main and laterals straight and true with the bottoms graded on uniform slopes to low points. Excavate trenches wide enough to allow a minimum of 4" (100 mm) between parallel pipe lines, 8" (200 mm) from lines of other trades. Do not install lines parallel and directly over one another. Maintain 2" (50 mm) vertical clearance between irrigation lines; minimum transverse angle is 45 degrees. A maximum of 2 lines per trench. No irrigation lines shall extend above subgrade.

3.05 PIPELINE ASSEMBLY

A. General:
   1. Provide flanges or unions as indicated and as necessary to allow removal and re-installation of any item of equipment or accessory without cutting, welding or soldering.
   2. Provide discharge piping of proper size for all air vent, solenoid, and relief valves. Extend to nearest drain or drain rock sump, see drawings.
3. Provide 1/2" gate valve with hose connection at all low points in the system and immediately upstream of check valves as necessary to allow the system to be completely drained.
4. Cut pipe to measurements established at the site. Work into place without springing or forcing.
5. Protect all openings in piping during construction to prevent entrance of foreign matter.
6. Cut pipe and tubing ends square. Remove rough edges and burrs so that a smooth and unobstructed flow will be obtained.
7. Close or short nipples should be used only where shown on the drawing, or absolutely necessary to satisfy dimensional constraints.
8. Make changes in pipe size using reducing fittings. Use bushings only if shown on the drawings.
9. Connections to equipment or accessories shall be screwed for sizes 2" and smaller, flanged for sizes 2 1/2" and larger.

B. Installation of all pipes and fittings shall be in strict accordance with the manufacturer's written specifications. Deviations from these specifications shall be permitted only with the written approval of Owner's Representative.

C. PVC pipe and fittings:
1. Plastic pipe and fittings shall be solvent welded using solvents and methods as recommended by manufacturer of the pipe, except where screwed connections are required. Pipe and fittings shall be thoroughly cleaned of dirt, dust and moisture before applying solvent with a non-synthetic bristle brush.
2. Install PVC pipe in dry weather when temperature is above 40°F in strict accordance with manufacturer's instructions.
3. Pipe may be assembled and welded on the surface. Snake pipe from side to side of trench bottom to allow for expansion and contraction.

D. Connections between plastic pipe and metal valves shall be made using plastic male adapters and applying the recommended threaded joint compound.

E. All metal screwed joints shall be tightened with tongs or wrenches and employ the specified joint compound. Caulking of any kind is not permitted.

F. All lines to be laid under hard surfaces shall be installed in a Sleeve. Depth of sleeves to be determined by the type of line that is to be placed in sleeve, see details for line depths for mainlines and laterals. All sleeves are to be place prior to lying of any hard surface. All sleeve locations shall be placed and marked in accordance with the details.

G. Pipe sections under public right-of-way or flexible pavement shall be steel pipe within PVC sleeve as shown on the details. Encase each crossing as required by local jurisdiction.

H. Install emitter line and related equipment as per manufacturer’s recommendations written instructions. Avoid placing emitter line in direct sunlight. Maintain consistent spacing of dripline within planter beds to provide even distribution throughout the area.

3.06 EQUIPMENT INSTALLATION
A. Manual Drain Valves: Install manual drain valve at all low points in irrigation supply line as described on the drawings.
1. Gravel sumps of size shown on details shall be of clean gravel, shall be located at all manual and automatic drain valves, control valves and gate valves.

3.07 AUTOMATIC CONTROLLERS
A. The automatic controllers shall be provided with direct surge protection. The Contractor shall verify power location and type, as well as power connection requirements at each location.
The Contractor shall connect the power to each controller. Locate each controller as shown on the drawings, as directed by the Owner's Representative.

B. Each controller shall be grounded per manufacturer’s recommendations.

3.08 ELECTRICAL CONTROL WIRES

A. Electrical control wires shall be installed in the same trench as the main line wherever possible. Wires shall be laid alongside the pipe by "snaking" in to the trench to allow as much slack as possible for contraction and expansion of the wire. All wire connections at remote control valves and at all wire splices will be left with two feet of wire so that the splice or the valve manifold can be brought to the surface for repairs without disconnecting the wires.

B. The joint shall be absolutely waterproof so that there is no chance for leakage of water and corrosion build-up on the connection. All wiring shall be accomplished with a few splices as possible.

C. Mainline runs with control wires or communication cable present shall be shielded with solid bare copper wire installed per the manufacturer’s recommendations. Shield wire may be utilized for bonding requirements as well.

3.09 FIELD QUALITY CONTROL

A. Notify Owner’s Representative

B. Provide equipment and/or personnel required to conduct tests.

C. Provide up-to-date Progress Drawings at each review.

D. If Owner’s Representative is called out for review prior to the system being ready, the contractor will be back-charged for the cost of the review including all associated travel, fees, and expenses.

3.010 CLOSING OF PIPE AND FLUSHING LINES

A. Closing: Openings in laterals and mains shall be capped or plugged, leave caps and plugs in place until removal is necessary for completion of installation. Contractor shall take other precautions as necessary to prevent dirt and debris from entering pipe or equipment.

B. Flushing: Lines shall be thoroughly flushed out before installing quick coupling valves sprinklers or emitters. (After flushing, main line pipe may be partially backfilled, butt joints, fittings and connections shall remain free and visible).

C. Test in accordance with 3.012 Hydrostatic Testing. Upon completion of the testing, the Contractor shall complete assembly and adjust sprinkler heads for proper distribution.

3.011 PURGING

A. Immediately prior to hydrostatic testing, all irrigation lines shall be thoroughly purged of all entrapped air. Introduce water into lines to be tested at full operating head. Observe water flow at end of discharge point until determination is made that all air and residual debris has been expelled from the line.

3.012 HYDROSTATIC TESTING

A. While the necessary piping system components are exposed, all mainline piping is to be subjected to a hydrostatic test. Owner’s Representative should be on premises for overall check of the system.

B. Install automatic (auto) remote control valves, quick couplers, and all other appurtenances prior to testing. Open all Isolation Ball Valves upstream from auto valves, auto valve flow controls open/up, and auto valves hydraulically closed.
C. Testing shall occur with joints visible. Small amounts of backfill between fittings shall be allowed to prevent pipe displacement. All fittings shall be visible prior to testing.

D. Pressure gauges shall be read in PSI. Calibration shall be such that accurate determination of potential pressure loss can be ascertained.

E. For PVC pipe:
   1. Test pressure irrigation supply (main) lines under hydrostatic pressure of 125 PSI minimum. Pipe shall hold pressure for a period of one (1) hour with zero (0) PSI lost in order to pass test.
   2. Lateral lines shall be tested under hydrostatic pressure of 80 PSI for a period of fifteen (15) minutes with zero (0) PSI lost in order to pass test. Cap all swing assemblies on downstream Marlex, and center load pipe between fittings before testing.

F. Re-test as required until the system meets the requirements. During the tests, regardless of the amount of leakage, all detectable leaks are to be stopped and all defects corrected.

3.013 BACKFILLING AND COMPACTING

A. Backfilling of PVC pipe:
   1. Rock free backfill material for mainline pipe is to be tamped in 4" (100 mm) layers under the pipe and uniformly on both sides of the full width of the trench or as shown, and the full length of the pipe. Materials are to be sufficiently damp to permit thorough compaction under and on each side of pipe, to provide support free of voids. PVC pipe is not to rest on concrete, rock, wood blocks, or similar items.

B. All pipe is to be immediately backfilled with preliminary backfill sufficient to prevent arching or slipping under pressure. Do not cover joints or fittings.

C. Upon approval of Owner's Representative, proceed to place remaining (final) backfill. Final backfill material will be clear of all debris (i.e. roots, limbs, rocks, boulders, clumps, or frozen clods) larger than 2" (50 mm) in diameter, or any object that could damage the pipe. Finish grade of all trenches must conform to adjacent grades without dips, sunken areas, humps or other irregularities. Dispose of excess debris.

D. Restore all surfaces, existing underground installations, damaged or cut as a result of the excavations to their original condition.

3.014 ADJUSTING THE SYSTEM

A. Adjust alignment and coverage of all heads. If it is determined that adjustments in the irrigation equipment will provide proper and more adequate coverage, make all necessary changes or make arrangements with the manufacturer to have adjustments made, prior to any planting. These changes or adjustments shall be made without additional cost.

B. Adjust and balance system to eliminate over spray and fogging and as directed by Landscape Architect.

3.015 TURN-OVER MATERIALS

A. Final Record Drawings: Three sets of these shall be produced, one for placement at or within each irrigation controller cabinet reduced to 11" x 17" and one full size set. Provide the full-size set to the Owner.

B. Both sets shall have the entire irrigation valve zone lateral lines color-coded so as to readily distinguish between adjacent zones. The valve size, station number and gallons per minute shall be legible at each valve and shall match how the controller is wired and programmed. Additionally, each valve shall be annotated to describe which type of irrigation it is, i.e.: spray, rotor, bubbler, etc. Color-coded copies shall then be professionally laminated in 5 mil clear plastic.
C. Operational and Maintenance Data: Submit two copies of manufacturer's data, maintenance schedule and operational schedule in a three ring binder, labeled and indexed.

D. Equipment: Provide the following to the Owner’s Representative:
1. One (1) Quick Coupler, equipped with standard thread hose bib per (5) Quick Couplers installed on the project.
2. One (1) key for locking Quick Coupler covers per (5) Quick Couplers installed on the project.
3. Two (2) valve stem keys (48").
4. Six (6) spare heads of each series specified for this project.
5. A total of four (4) irrigation zone remote control valves and two (2) drip zone control valve kits of each type used for this project.
6. A total of 300 LF of spare dripline used on this project.
7. A total of 10 spare dripline fittings of each type used on this project.
8. Two (2) spare Toro FCH-H Series auto flush valves.
9. Two (2) spare AVP-1 Series air relief valves.
10. Two (2) spare Hunter HC-50F-50F Series check valves.
11. One (1) spare dripline tube cutter.

3.016 WARRANTY AND MAINTENANCE INSTRUCTIONS

A. Fill and repair all depressions and replace all planted areas due to the settlement of irrigation trenches for one year following the completing and acceptance of the job. Use only approved fill materials.

B. Instruct Owner’s personnel in complete and proper operation, maintenance and winterization of the system prior to Final Acceptance.

C. Provide digital recording of operational, maintenance and winterization procedures for each component aspect of the system.

D. Provide Owner’s Representative with all Record Drawing submittals, turnover materials, salvaged items and warranty requirements prior to Final Review.

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY
A. This section includes the procurement and installation of the following items:
   1. Trees
   2. Shrubs
   3. Groundcover
   4. Vines
   5. Stakes and Guys
   6. Root Protection Barrier
   7. Maintenance
B. Related Sections
   1. Section 01 25 00 – Substitution Procedures
   2. Section 01 33 00 – Submittal Procedures
   3. Section 31 36 13 – Gabion Boxes
   4. Section 32 80 00 – Irrigation
   5. Section 32 91 00 – Soil Preparation
   6. Section 32 92 00 – Lawns

1.2 DEFINITIONS
A. Backfill: The earth or topsoil used to replace or the act of replacing earth or topsoil in an excavation.
B. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.
C. Balled and Potted Stock: Plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required.
D. Bare-Root Stock: Plants with a well-branched, fibrous-root system developed by transplanting or root pruning, with soil or growing medium removed, and with not less than minimum root spread according to ANSI Z60.1 for type and size of plant required.
E. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.
F. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.
G. Fabric Bag-Grown Stock: Healthy, vigorous, well-rooted plants established and grown in-ground in a porous fabric bag with well-established root system reaching sides of fabric bag. Fabric bag size is not less than diameter, depth, and volume required by ANSI Z60.1 for type and size of plant.
H. Finish Grade: Elevation of finished surface of planting soil.
I. 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.

J. 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.

K. Planting Area: Areas to be planted.

L. Planting Soil: Refer to 32 91 00 Soil Preparation.

M. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.

N. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.

O. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.

P. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

Q. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

R. 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.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated, including soils.


2. Pesticides and Herbicides: Include product label and manufacturer's application instructions specific to the Project.

3. Plant Photographs: Include color photographs in digital format or 5- by 7-inch print format of each required species and size of plant material as it will be furnished to the Project. Take photographs from an angle depicting true size and condition of the typical plant to be furnished. Pictures shall not be cropped; they should include the full height and width of the plant material. Include a scale rod or other measuring device in each photograph. For species where more than 5 plants are required, include a minimum of three photographs showing the average plant, the best quality plant, and the worst quality plant to be furnished. Identify each photograph with the full scientific name of the plant, plant size, and name of the growing nursery.

B. Samples for Verification: For each of the following:

C. Qualification Data: For qualified landscape Installer. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.

D. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:

1. Manufacturer's certified analysis of standard products.

2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.

E. Material Test Reports: For existing in-place surface soil and imported or manufactured topsoil.
F. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before start of required maintenance periods.

G. Warranty: Sample of special warranty.

H. Planting Schedule: Indicating anticipated planting dates for exterior plants.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Firm experienced in performing planting operations similar in complexity to those required for this Project, and whose work has resulted in the successful establishment of plants.

1. Experience: Installer shall have five years experience in landscape installation in addition to requirements in Division 1 Section “Contractor Quality Control.”

2. Installer’s Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.

B. Provide quality, size, genus, species, and variety of exterior plants indicated, complying with applicable requirements in ANSI Z60.1, "American Standard for Nursery Stock”.

C. Tree and Shrub Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.

1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 6 inches (150 mm) above the root flare for trees up to 4-inch (100-mm) caliper size, and 12 inches (300 mm) above the root flare for larger sizes.

2. Other Plants: Measure with stems, petioles, and foliage in their normal position.

D. Plant Material Observation: Architect may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Architect retains right to observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and to reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.

1. Notify Architect of sources of planting materials fourteen days in advance of delivery to site.

E. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination”.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: 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 if applicable.

B. 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 and soil amendments with appropriate certificates.
C. Deliver bare-root stock plants freshly dug. Immediately after digging up bare-root stock, pack root system in wet straw, hay, or other suitable material to keep root system moist until planting.

D. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.

E. All plant material shall be transported to planting locations with care to prevent damage. Branches shall be tied back, as necessary, and bark protected with burlap from chafing by ropes at all times. No plant material shall be dragged along the ground without proper protection of the root and branches.

F. Handle planting stock by root ball.

G. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.

1. Heel-in bare-root stock. Soak roots that are in dry condition in water for two hours. Reject dried-out plants.

2. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.

3. Do not remove container-grown stock from containers before time of planting.

4. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly-wet condition.

5. Do not heel in plants for more than one week.

H. Topsoil: The Contractor is responsible for coordinating blending, shipping, delivery, and installation of soils so that the following conditions are met:

1. Components of stockpiled mixes do not segregate or become contaminated.

2. Placement and compaction of the soils shall be coordinated to avoid damage to other installed work, such as roof waterproofing systems, subdrainage, or irrigation systems.

3. Requirements and conditions as specified in Section 32 91 00 Soil Preparation.

1.6 PROJECT CONDITIONS

A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.

B. Interruption of Existing Services or Utilities: Do not interrupt services or utilities to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary services or utilities according to requirements indicated:

1. Notify Architect no fewer than three days in advance of proposed interruption of each service or utility.

2. Do not proceed with interruption of services or utilities without written permission from Architect.

C. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.

1. Spring Planting: March 15 to June 1.

2. Fall Planting – deciduous species: September 15 to November 1.
D. Planting Restrictions for Turf (Lawn) Installation: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.

1. Spring Planting: March 15 to June 1.
2. Fall Planting: September 15 to November 1.

E. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements. Under no circumstances is planting to be permitted during freezing weather, in frozen ground, excessive moisture, drought or other unsatisfactory conditions.

F. Coordination with Sod Installation: Plant trees, shrubs, and other plants after finish grades are established and before planting sod areas unless otherwise indicated.

1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

1.7 WARRANTY

A. Contractor shall furnish imported plant materials, move and/or remove on-site plants specified, and install all plant materials indicated on the drawings, provide maintenance and care of plant material, cleanup, and provide warranty as outlined in this Section.

B. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.

1. Failures include, but are not limited to, the following:

   a. Death and unsatisfactory growth, except for defects resulting from incidents that are beyond Contractor's control.
   b. Structural failures including plantings falling or blowing over.
   c. Faulty performance of tree stabilization or edgings.
   d. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Period is 1 year from Date of Substantial Completion.

3. Include the following remedial actions as a minimum:

   a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
   b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
   c. A limit of one replacement of each plant will be required except for losses or replacements due to failure to comply with requirements.
   d. Provide extended warranty for period equal to original warranty period, for replaced plant material.

1.8 MAINTENANCE SERVICE

A. Initial Maintenance Service: Provide maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established but for not less than maintenance period below.

1. Maintenance Period: 12 months from date of Substantial Completion.

B. Watering: Provide and maintain temporary piping, hoses, and lawn-watering equipment to convey water from sources and to keep lawn uniformly moist to a depth of 4 inches.
1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.

PART 2 -PRODUCTS

2. PLANT MATERIALS

2.1 GENERAL: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated on Drawings and complying with ANSI Z60.1.

2.2 NAME: True to botanical name, common name and variety as adopted by the American Joint committee on Horticultural Nomenclature, Standardized Plant Names, latest edition, which are true to type and species.

2.3 HEALTH: Comply with local, state and federal laws pertaining to the inspection for diseases and insect infestation, scale and shipment of plant materials.

2.4 QUALITY: Plants to possess normal, well-developed branch systems; sound crotches; vigorous fibrous root systems; trees with straight trunks and leader intact; healthy vigorous plants; densely foliared when in leaf and free from defects, disfiguring knots, sunscald or windburn injuries, disfigurement and abrasions of the bark, disease, pests, eggs, and larvae. Freshly dug at time of delivery.

1. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than 3/4 inch (19 mm) in diameter; or with stem girdling roots will be rejected.

2. Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.

3. All trees to be field grown. No potted or bagged plants will be accepted.

2.5 GRADE: Provide plants of sizes and grades complying with ANSI Z60.1 for type of plant material required. Plants of a larger size may be used if acceptable to Architect, with a proportionate increase in size of roots or balls.

2.6 NURSERY GROWN PLANTS: Unless approved by Architect, provide plant materials grown within 1 hardiness zone of the Project, for a minimum of 3 years prior to the date of planting. Periodically root-pruned and cared for in compliance with good horticultural practices.

2.7 SPECIMEN PLANTS: Select for special qualities as indicated such as form, size and character. Inspection with Architect in growing fields or by Architect’s approved photograph review required before digging. Selection and acceptance by photos does not preclude right of rejection at Project Site or right of rejection of any plants arriving in a damaged or impaired condition.

2.8 MULTI-STEM TREES: Branched or pruned naturally according to species and type, with relationship of caliper, height, and branching according to ANSI Z60.1.

1. STEM FORM: Shrub.

2. VINES: Provide vines of species indicated complying with requirements in ANSI Z60.1 as follows:

1. Plants with heavy, well-branched tops, with not less than 3 runners 18 inches (450 mm) or more in length, and with a vigorous well-developed root system.

2. BALLED AND BURLAPPED PLANTS: Balls firm and unbroken of natural earth in which the plant has been growing, and of sufficient diameter and depth to adequately enclose all fibrous and feeding roots. Do not use manufactured, artificially produced, or mudded-in balls or any plant materials in which the ball has been broken or cracked either before or during planting operations.

3. CONTAINER GROWN PLANTS: Grown in container for not less than one year with sufficient root growth to hold soil in place when removed from pot. Plants are not to be root-bound.
L. Root prune 6 months prior to transplanting with root cut approximately 3 inches inside transplant cut.

M. Label each plant with securely attached, waterproof tag bearing legible designation of common name and botanical name, including genus and species.

N. If formal arrangements or consecutive order of trees or shrubs is shown, select stock for uniform height and spread, and number label to assure symmetry in planting.

2.2 TREE STABILIZATION MATERIALS

A. Stakes and Guys:
   1. Upright and Guy Stakes: Smooth, sound, new Douglas Fir or Lodgepole Pine stakes, free of knots, holes, cross grain, and other defects, 2 by 2 inches by length indicated, pointed at one end.
   2. Guy and Tie Wire: ASTM A 641/A 641M, Class 1, galvanized-steel wire, 2-strand, twisted, 0.106 inch in diameter.
   4. Hose Chafing Guard: Reinforced rubber or plastic hose at least 1/2 inch in diameter, black, cut to lengths required to protect tree trunks from damage.
   5. Flags: Standard surveyor’s plastic flagging tape, white, 6 inches long.
   6. Deadmen: Smooth, sound, new Douglas Fir, or Hemlock, free of defects, 2” X 6” nominal, by 3’-0” length. Do not use chemically treated wood as anchors.

2.3 MISCELLANEOUS PRODUCTS

A. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.

B. Trunk-Wrap Tape: Two layers of crinkled paper cemented together with bituminous material, 4-inch- wide minimum, with stretch factor of 33 percent.

C. Planter Drainage Gravel: Washed, sound, crushed stone or gravel complying with ASTM D 448 for Size No. 8.

D. Filter Fabric: Non-woven, needle-punched, geotextile filter sheet manufactured for separation applications and made of non-rotting polypropylene fibers to prevent particles from washing through the system.

PART 3 -EXECUTION

3.1 EXAMINATION

A. Examine areas to receive exterior plants for compliance with requirements and conditions affecting installation and performance. Proceed with installation only after unsatisfactory conditions have been corrected.

   1. Verify that final grades have been established, and that foreseeable plant growth will not interfere with previously completed work, especially underground utilities.
   2. Verify plant material is free of injury and insect infestation, and has been properly pruned.
   3. Verify that the soils in the areas where plant materials are to be installed have satisfactory drainage.
   4. Verify that the soils in the areas where plant materials are to be installed contain no toxic materials or construction waste, trash, debris, stones larger than 1” in diameter or length, or any other objects that would interfere with soil preparation.
   5. Verify that all irrigation mainlines are installed.
6. Where planting will occur over structure:
   a. Verify that all protection board and membranes are in place.
   b. Verify that roof waterproofing membrane has been tested to ensure that there are no leaks, and continually protected after this testing.
   c. If areas of membrane have been left exposed, waterproofing must be retested prior to installation of overburden.

B. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, other facilities, and existing exterior plants from damage caused by planting operations.

B. Provide 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.

C. Lay out tree, shrub, ground cover, and vine areas as shown in Drawings. Stake locations, outline areas, adjust locations when requested, and obtain Architect's acceptance of layout before individual plant placement. Make minor adjustments as required.

D. Place individual trees, shrubs, ground covers, and vines in approved planting areas. Architect shall review placement and direct adjustments, as needed. Obtain Architect's acceptance prior to final installation.

E. Apply anti-desiccant to trees and shrubs using power spray to provide an adequate film over trunks, branches, stems, twigs, and foliage to protect during digging, handling, and transportation.

1. If deciduous trees or shrubs are moved in full leaf, spray with anti-desiccant at nursery before moving and again two weeks after planting.

3.3 TREE AND SHRUB EXCAVATION

A. Pits and Trenches: Excavate circular pits with sides sloped inward. Leave center area raised slightly to support root ball and assist in drainage. Scarify sides of plant pit smeared or smoothed during excavation.

1. Excavate approximately three times as wide as ball diameter for balled and burlapped and container-grown stock.

2. Excavate 36” depth for trees prior to planting and 24” depth for shrubs as a baseline, or deeper if needed to accommodate rootball depth and raised center area for planting pedestal.

B. Fill excavations with water and allow to percolate away before positioning trees and shrubs. Notify the Owner, in writing, immediately of any subsurface drainage, ponding, or other soil conditions which the Contractor or Arborist considers detrimental to growth or survival of plant materials.

C. Unsatisfactory Conditions: Examine subgrade, verify elevations, observe conditions under which work is to be performed, and notify Architect of any unsatisfactory or adverse conditions such as, but not limited to:

1. Unexpected rock, utilities, or other obstructions detrimental to plant material are encountered in excavations.

2. Subsoil conditions evidence unexpected water seepage or retention in tree or shrub pits.

D. Do not proceed until unsatisfactory conditions have been corrected.

3.4 TREE AND SHRUB PLANTING
A. Due to digging techniques or improper transplanting, plants may arrive from the nursery with the root flare buried. The Landscape Contractor must take care to make sure that the original root flare is planted at the proper grade.

B. Set balled and burlapped stock plumb and in center of pit or trench with top of root ball flush with adjacent finish grades.
   1. Remove burlap and wire baskets from tops of root balls and partially from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
   2. Place planting soil mix around root ball in 6-inch lifts, tamping to settle mix and eliminate voids and air pockets. When pit is approximately one-half backfilled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed. Water again after placing and tamping final layer of planting soil mix.

C. Set container-grown stock plumb and in center of pit or trench with the original grade of the plant flush with adjacent finish grades.
   1. Carefully remove root ball from container without damaging root ball or plant.
   2. Place planting soil mix around root ball in 6-inch lifts, tamping to settle mix and eliminate voids and air pockets. When pit is approximately one-half backfilled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed. Water again after placing and tamping final layer of planting soil mix.

D. Set and support bare-root stock in center of pit with root collar or trunk flare flush with adjacent finish grade. Spread roots without tangling or turning toward surface, and carefully work backfill around roots by hand. Puddle with water until backfill layers are completely saturated. Plumb before backfilling, and maintain plumb while working backfill around roots and placing layers above roots. Tamp final layer of backfill. Remove injured roots by cutting cleanly; do not break.

E. Mulch: Apply 2-inch average thickness of organic mulch to planting bed. Feather mulch to zero inches at root collar, beginning at 4 inches from trunks or stems. In no circumstance should mulch contact exposed portions of trunk flare.

F. At Contractor’s option wrap trees of 2-inch caliper and larger with trunk-wrap tape. Start at base of trunk and spiral cover trunk to height of first branches. Overlap wrap, exposing half the width, and securely attach without causing girdling. Inspect tree trunks for injury, improper pruning, and insect infestation; take corrective measures required before wrapping.

G. Contractor to coordinate tree planting locations with Architect for Courtyard installations.

3.5 TREE AND SHRUB PRUNING
A. Prune, thin, and shape trees and shrubs according to standard horticultural practice. Prune trees to retain required height and spread. Unless otherwise indicated by Architect, do not cut tree leaders; remove only injured or dead branches from flowering trees. Prune plant material to retain natural character. Shrub sizes indicated are sizes after pruning.

3.6 GUYING AND STAKING
A. Upright Staking and Tying:
   1. For trees, anchor guys to fir deadmen buried level at least 6 inches below base of rootball. Wrap guy cable over top of 2x6x36 fir spacers placed at top of rootball, both sides. Provide turnbuckles for each guy cable and tighten securely.

3.7 GROUND COVER AND VINE PLANTING
A. Set out and space ground cover as indicated.
B. Dig holes large enough to allow spreading of roots, and backfill with planting soil.
C. Carefully remove plants from containers without injury or damage to roots.
D. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.

E. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

F. Support: Tie vine stems to a support to direct new growth toward vine trellis structure.

3.8 PLANTING BED MULCHING

A. Apply mulch within 2 days after planting and maintain at specified depth during maintenance period. Maintain mulch at a uniform thickness. Do not allow mulch to wash and cover branches and foliage of plants. Water thoroughly immediately after mulching and hose down planting area with fine spray to wash leaves of plants. Remove any mulch spilled on pavements.

3.9 CLEANUP AND PROTECTION

A. During exterior planting, keep adjacent paving and construction clean and work area in an orderly condition. Promptly remove soil and debris created by exterior planting work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Protect exterior plants from damage due to landscape operations, operations by other contractors and trades, and others. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged exterior planting.

3.10 DISPOSAL

A. Disposal: Remove surplus soil and waste material, including excess subsoil, unsuitable soil, plastic labels, materials, synthetic burlap, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 32 90 00
PART 1 - GENERAL

1.1 SUMMARY
A. The scope of work intended under this section includes furnishing all labor, materials, tools and equipment for Planting Soil manufacturing, placement, and mulching. Such work shall include but is not limited to the following:

1. Furnish and install components that make up the Soil Types.
2. Furnish and install Soil Types.
3. Furnish and install all fertility amendments.
4. Furnish and install Composted Mulch

B. Related Sections
1. Section 01 25 00 – Substitution Procedures
2. Section 01 33 00 – Submittal Procedures
3. Section 01 56 39 – Temporary Tree and Plant Protection
4. Section 32 80 00 – Irrigation
5. Section 32 90 00 – Planting
6. Section 32 92 00 – Lawns

1.2 REGULATORY REQUIREMENTS AND REFERENCES:
A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1. ASTM C136 - Sieve Analysis of Fine & Coarse Aggregates
2. ASTM D854-02 - Specific Gravity of Soil
4. ASTM D3665 - Random Sampling of Construction Materials
5. ASTM F1632 – Standard Test Method for Particle Size Analysis and Sand Shape of Golf Course Putting Green and Sports Field Root Zone Mixes
6. American Society of Agronomy (ASA) - Methods of Soil Analysis
7. Solvita Organic amendment Analysis
   a. Water Release Characterization
   b. Moisture Diffusion/Drawdown Analysis
   c. Infiltration Rate
10. ASTM C-88 – Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate


1.3 SUBMITTALS

A. Materials List:

1. Submit a complete list of materials proposed to be furnished and installed demonstrating conformance with the requirements specified. Include names and addresses of all suppliers.

B. Soil and Organic Amendment Tests:

1. Provide the following analyses of organic materials and soil amendments for approval from an accredited soils testing laboratory:
   a. Infiltration Rate
   b. An analysis of the chemical and physical characteristics including pesticides and heavy metals.
   c. A fertility analysis and recommendations for fertilizer types and application rates.
   d. pH levels of soil mixes.
   e. Submit laboratory results of all amendment analysis to Architect prior to beginning any soil amendment placement.
   f. Costs of testing will be paid for by Contractor.

C. Soil Materials:

1. Submit 0.25 cu. ft. samples of the following at least 30 days prior to beginning work for the approval of the Architect and Engineer:
   a. Planting Soil Mix 1 and 2: Planting Soil for Lawns
   b. Planting Soil Mix 3: Planting Soil for Trees, Shrubs, and Groundcovers
   c. Planting Soil Mix 4: Planting Soil with Lightweight Component

D. Fertilizers:

1. Submit manufacturer's analysis of all fertilizers for the approval of the Architect.

1.4 QUALITY ASSURANCE

A. Product information sheets shall be submitted for approval for amendments and fertilizers.

B. Furnish certificates of inspection of landscape materials to accompany shipments, as required by governmental authorities. Comply with applicable Federal, State, County, and local regulations governing landscape materials.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver packaged materials in containers showing weight, analysis and name of manufacturer. Protect materials from deterioration during delivery, and while stored at the site.

B. Bulk Materials:
1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing lawn 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 and soil amendments with appropriate certificates.

1.6 SEQUENCING AND SCHEDULING

A. The Contractor is responsible for coordinating blending, shipping, delivery and installation of soils so that the following conditions are met:
   1. Components of stockpiled mixes do not segregate or become contaminated.
   2. Placement and compaction of the soils shall be coordinated to avoid damage to other installed work, such as roof waterproofing systems, subdrainage, or irrigation systems.

1.7 GUARANTY

A. The work in this specification shall be subject to the guaranty requirements as described within Division 01.

PART 2 - PRODUCTS

2.1 MATERIALS:

A. Planting Soil Types 1 and 2 (for use at lawns): Planting Soil Types 1 and 2 shall consist of 60% Sand and 40% Organic Amendment by volume, and shall meet or exceed the following specifications:
   1. The Sand Component shall meet the following specifications within reasonable variations:

      Screen Size Percent Passing
      3/8" 100
      1/4" 95-100
      #10 85-95
      #30 60-75
      #60 50-60
      #100 20-30
      #200 <5

   2. pH range between 6.5 and 7.0
   3. The Compost (Organic Amendment) Component shall consist of 100% recycled yard waste materials or other organic waste materials that have been sorted, ground up, aerated and aged and shall be fully composted, stable and mature (non-aerobic). The composting process shall be for at least six months time and the organic amendment shall have a uniform dark, soil-like appearance. In addition, the compost shall have the following physical characteristics:
      a. Shall have Carbon to Nitrogen ration of between 20:1 and 40:1.
b. Shall be certified by the Process to Further Reduce Pathogens (PFRP) guideline for hot composting as established by the United States Environmental Protection Agency.

c. Shall be fully mature and stable before usage.

d. Shall be screened using a sieve no finer than ¼-inch and no greater than ½-inch.

e. Based on dry weight of total organic amendment sample: Must comply with the following percent by weight passing:

<table>
<thead>
<tr>
<th>Sieve Size Percent (%) Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2” (12.7mm) 100</td>
</tr>
<tr>
<td>1/4” (6.35mm) 95-100</td>
</tr>
<tr>
<td>4.76mm 90-95</td>
</tr>
<tr>
<td>2.38mm 75-90</td>
</tr>
<tr>
<td>1.00mm 45-70</td>
</tr>
<tr>
<td>500micron 0-30</td>
</tr>
</tbody>
</table>

f. Shall have heavy metal concentrations below the WSDA limits as follows:

<table>
<thead>
<tr>
<th>Metal Type WA State (Max. lb./ac.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARSENIC 0.297</td>
</tr>
<tr>
<td>CADMIUM 0.079</td>
</tr>
<tr>
<td>COBALT 0.594</td>
</tr>
<tr>
<td>LEAD 1.981</td>
</tr>
<tr>
<td>MERCURY 0.019</td>
</tr>
<tr>
<td>MOLYBDENUM 0.079</td>
</tr>
<tr>
<td>NICKEL 0.713</td>
</tr>
<tr>
<td>SELENIUM 0.055</td>
</tr>
<tr>
<td>ZINC 7.32</td>
</tr>
</tbody>
</table>

B. Planting Soil Mix Type 3 (for use at trees, shrubs, and groundcovers): Planting Soil Mix 3 shall consist of 67% sandy loam and 33% composted organic material.

1. The Sandy Loam or Loamy Sand component shall consist largely of sand, but with enough silt and clay present to give it a small amount of stability and shall meet the following sieve analysis:

<table>
<thead>
<tr>
<th>Screen Size Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8” 100</td>
</tr>
<tr>
<td>1/4” 95-100</td>
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<td>#100 10-20</td>
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2. Individual sand grains can be seen and felt readily. On squeezing in the hand when dry, it shall form a cast that will not only hold its shape when the pressure is released, but shall withstand careful handling without breaking. The mixed loam shall meet the following:

a. Shall have pH range of 6.5 – 7.0 with dolomite lime, sulfur or other amendments, added prior to delivery, as necessary to attain this range. The decomposed organic amendment component shall consist of composted organic material as described above for Planting Soil Types 1 and 2.
C. Planting Soil Mix Type 4 (for use at trees, shrubs, and groundcovers where lightweight amendment is required): Planting Soil Mix 4 shall consist of approx. 45% sand, 15% pumice, and 40% compost:

1. Shall have pH range of 6.5 – 7.0 with dolomite lime, sulfur or other amendments, added prior to delivery, as necessary to attain this range. The decomposed organic amendment component shall consist of composted organic material as described above.

2. Weight of Planting Soil Mix Type 4 to not exceed 90 lbs per cubic foot when fully saturated.

D. Composted Mulch:

1. Composted mulch shall be a well decomposed, humus-like material derived from the decomposition of organic matter. The compost shall have an earthy odor, shall be free of viable weed seeds and other plant propagules (weed seed test sample to be taken from 2” to 8” below the surface of the pile), shall have a moisture content such that there is no visible free water or dust produced when handling the material, and shall be free of contaminants. In addition, compost shall have the following physical characteristics:

2. Composted mulch:
   a. Shall have minimal weed seed or weed propagules present based on germination testing of a representative sample.
   b. Shall have less than 100 plant parasitic nematodes per 100 CC of organic matter.
   c. Shall be free of soil borne pathogens.
   d. Shall have a pH from 6.5 to 7.0.
   e. Shall have a maximum carbon to nitrogen ration of 20:1 or 40:1 for native plantings.
   f. Shall have heavy metal concentrations below the WSDA per year load limit.
   g. Shall be certified by the Process to Further Reduce Pathogens (PFRP) guideline for hot composting as established by the United States Environmental Protection Agency.
   h. Shall be produced at a permitted solid waste composting facility.

E. Fertilizers:

1. Bonemeal: Commercial, raw or steamed, finely ground. Nitrogen and phosphoric acid percentages selected to meet specified planting and soil needs.

2. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
   a. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

2.2 BASIS OF DESIGN SUPPLIERS FOR SOILS AND MULCH:

A. Red-E Topsoils
   1. www.red-e-topsoil.com; Ph: (425) 868-6500

B. Lloyd Enterprises, Inc.
   1. www.LloydEnterprises.com; Ph: (253) 874-6692

C. Sawdust Supply Company, Inc.
PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine areas to receive plants for compliance with requirements and conditions affecting installation and performance.

1. Verify that no foreign or deleterious material 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.
   a. Proceed with installation only after unsatisfactory conditions have been corrected.
   b. 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 Architect and replace with new planting soil.

3.2 WATERPROOFING MEMBRANE SYSTEM VERIFICATION

A. Where installing soils over structure obtain verification in writing that the waterproofing membrane system over structure has been installed properly per Drawings and Specifications. Verify that the manufacturer’s dampproofing, protection board, root barrier, insulation and all other waterproofing and drainage components have been installed and approved per Drawings and Specifications prior to placement of soil mixes.

3.3 SUBGRADE PREPARATION

A. Site Grading:

1. Grade subgrades of all areas designated to receive planting soil as needed and approved by Architect. Refer to Drawings for topsoil depths.

B. Subgrade Scarification:

1. Scarify all subgrades to an 8 inch depth except: Do not scarify areas within the root zones of protected trees and shrubs to remain indicated as shown on the tree protection plan. See Section 01 56 39 Tree and Plant Protection.
2. Remove all stones, wood metal or concrete debris, or other deleterious materials from the soil surface.
3.4 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.

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.

3.5 PLANTING BED ESTABLISHMENT

A. Coordinate planting soil depths, types, and locations with Drawings and Section 32 90 00 Planting.

B. Planting soil components must be mixed prior to placement in the planting bed or tree pits.

C. Loosen and scarify subgrade to a minimum depth of 8 inches. 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.
   1. Apply fertilizer directly to subgrade before loosening.
   2. Thoroughly blend planting soil mix off-site before spreading.
   3. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
   4. Mix lime with dry soil before mixing fertilizer.
   5. Spread first lift of planting soil mix to a depth of 8 inches over loosened subgrade. Mix thoroughly into top 4 inches of subgrade.
   6. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.

D. Place remaining planting soil mix in depths as indicated in Drawings in two level lifts. Refer to Drawings for overall topsoil extents. The first lift must contain 1/2 of the planter soil depth. After placing, moisten surface at a rate of 1 gallon of water per square foot. Allow water to thoroughly percolate through soil before placing next lift. Allow for settling and place additional planting soil as needed. Allow for bed preparation and amendment but place enough soil to meet finished grades within specified tolerances.

E. Soil backfill for trees will coincide with tree planting rather than preceding tree planting.

F. As plants are installed, soil shall be evenly spread, cultivated, and lightly compacted to prevent future settlement.

G. Planting Soil Depths:
   1. Refer to Drawings for soil depths.

3.6 FINISH GRADING:

A. Grade planting beds to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, ensuring that all debris is removed as specified and that the surface is smooth, free draining, contains no low or high spots, and meets specified finish grades. Limit fine grading to areas that can be planted in the immediate future.
   1. Grades will not be less than required to meet the finish grades after light rolling and natural settlement.
2. Restore planting beds if eroded or otherwise disturbed after finish grading and before planting.

3. Coordinate finish grading with installation of irrigation system as per Section 32 8000 Irrigation.

B. Before planting, obtain Architect’s acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.7 PROTECTION

A. Store excess soils and mulches in stockpiles protected from erosion and contamination by other contractors and materials with tarps.

B. Protect newly graded areas from traffic and erosion. Keep free of trash and debris.

C. Repair and reestablish grades in settled, eroded, or rutted areas to specified grades.

END OF SECTION 32 91 00
PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Sodding.

B. Related Sections include the following:
   1. Section 01 25 00 – Substitution Procedures
   2. Section 01 33 00 – Submittal Procedures
   3. Section 32 80 00 – Irrigation
   4. Section 32 91 00 – Soil Preparation
   5. Section 32 90 00 – Planting

1.2 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Manufactured Soil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

C. Planting Soil: Imported topsoil or manufactured topsoil mixed with soil amendments.

D. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill immediately beneath planting soil.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.
   1. If specified plant material is not obtainable from 5 nurseries or supply companies, submit proof of non-availability together with proposal for use of equivalent material at least 90 days prior to starting work.
   2. Manufacturer’s installation instructions.
   3. Bag labels or product data sheets for commercial fertilizer, soil amendments, mulches, and other commercial products indicating weight, analysis, and manufacturer.

B. Samples for Verification: For each of the following:
   1. Two one-cubic foot samples (bagged samples of loose products) of topsoil planting mix.
   2. 5 lb (2.2 kg) of mulch for each type required, in labeled plastic bags.

C. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name and 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 of each seed mixture for sod, identifying source, including name and telephone number of supplier.

2. Any required certificates of inspection of plant material by state or federal authorities.

D. Product Certificates: For soil amendments and fertilizers, signed by product manufacturer.

E. Qualification Data: For landscape Installer.

F. Material Test Reports: For imported topsoil.

G. Planting Schedule: Indicating anticipated planting dates for each type of planting.

H. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of lawns during a calendar year. Submit before expiration of required maintenance periods.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Firm experienced in performing planting operations similar in complexity to those required for this Project.

1. Not less than five years experience.

2. Not less than two comparable scale projects successfully completed.

3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when planting is in progress.

B. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.5 WARRANTY

A. Special Warranty: Installer agrees to repair or replace lawn installation that fails in materials, workmanship, or growth within specified warranty period.

B. Failures include, but are not limited to, the following:

1. Death and unsatisfactory growth, except for defects resulting from incidents that are beyond Contractor's control.

2. Warranty Period is 1 year from Date of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Preparation for delivery: Prepare materials for delivery in a manner to prevent damage.

1. Delivery: Coordinate delivery with planting operations.

2. Notify Architect two weeks in advance of delivery so that plant material may be inspected upon arrival at the Project Site.

3. Deliver fertilizer, and other packaged/bagged commercial products in original unopened containers bearing manufacturer's guaranteed chemical analysis, name, trade name, trademark, and in conformance with applicable laws.
4. Provide protection during delivery to prevent damage to plant materials. Plants which show transportation damage will be rejected.

5. Sod: Harvest, deliver, store, and handle sod according to requirements in TPI's "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in its "Guideline Specifications to Turfgrass Sodding."

B. Handling:
   1. Do not bind plant materials in a manner which would damage root systems.
   2. Protect materials from rough handling.

C. Storage and Protection:
   1. Store materials in a manner to prevent damage.
   2. Protect materials from damage by the elements and construction procedures.
   3. Store materials at temperatures above 40 degrees F.
   4. Store fertilizer and other similar materials in original unopened containers so that effectiveness is not impaired.

1.7 SCHEDULING

A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.
   1. Spring Planting: March 15 to June 1.
   2. Fall Planting: September 15 to November 1.

B. Perform actual planting when weather and soil conditions are suitable and in compliance with locally accepted practice. Under no circumstances will planting be permitted during freezing weather, in frozen ground, excessive moisture, drought or other unsatisfactory conditions.

1.8 LAWN MAINTENANCE

A. Begin maintenance immediately after each area is planted and continue until acceptable lawn is established, but for not less than the following periods:
   1. Sodded Lawns: 60 days from date of Substantial Completion.

B. Maintain and establish lawn by watering, fertilizing, weeding, mowing, trimming, replanting, and other operations. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth lawn.
   1. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch. Anchor as required to prevent displacement.

C. Watering: Provide and maintain temporary piping, hoses, and lawn-watering equipment to convey water from sources and to keep lawn uniformly moist to a depth of 4 inches.
   1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
   2. Water lawn at a minimum rate of 1 inch per week.
D. Mow lawn as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 40 percent of grass height. Remove no more than 40 percent of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain a 1-1/2 to 2 inch grass height.

E. Lawn Postfertilization: Apply fertilizer after initial mowing and when grass is dry.
   1. Use fertilizer that will provide actual nitrogen of at least 1 lb/1000 sq. ft. to lawn area.

PART 2 - PRODUCTS

2.1 TURFGRASS SOD
A. Turfgrass Species: Sod of grass species as follows, with not less than 95 percent germination, not less than 98 percent pure seed, not more than 0.5 percent weed seed and not more than 1.5 percent inert matter:
   1. Product: Ryegrass Fescue Blend
      a. 70 percent Perennial Ryegrass
      b. 30 percent Fescue
      c. Sod to be supplied without root zone reinforcement netting or webbing.
   2. Or approved equal.

2.2 TOPSOIL
A. Refer to Section 32 91 00 Soil Preparation:
   1. Soil Types 1 and 2 to be used for lawn planting.

2.3 FERTILIZER
A. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 4 percent nitrogen and 20 percent phosphoric acid.
B. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.
C. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
   1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.
D. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
E. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.

PART 3 - EXECUTION
3.1 EXAMINATION

A. Examine areas to receive lawns and grass for compliance with requirements and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.
   1. Verify that final grades have been established, and that foreseeable plant growth will not interfere with previously completed work, especially underground utilities.
   2. Verify plant material is free of injury and insect infestation.
   3. Verify that the soils in the areas where plant materials are to be installed have satisfactory drainage.
   4. Verify that the soils in the areas where plant materials are to be installed contain no toxic materials or construction waste.

B. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.

B. Provide 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.

3.3 LAWN PREPARATION

A. Limit lawn subgrade preparation to areas to be planted.

B. Refer to Section 32 91 00 Soil Preparation for additional requirements.

C. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 4 inches. 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.
   1. Apply fertilizer directly to subgrade before loosening.
   2. Thoroughly blend planting soil mix off-site before spreading or spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil mix.
      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.
   3. Spread planting soil mix to depths as indicated per the Drawings 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 one-half the thickness of planting soil mix over loosened subgrade. Mix thoroughly into top 2 inches of subgrade. Spread remainder of planting soil mix.
      b. Account for elevation of planting soil to allow for soil thickness of sod.
D. Prior to final grading and raking of surface to be seeded, ensure that soil profile is free draining, dry, and that the subgrade has been compacted to 85% to ensure that no soil settling will occur.

E. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch of finish elevation. Roll and rake, ensuring that all debris is removed as specified and that the surface is smooth, free draining, contains no low or high spots, and meets specified finish grades. Approved mechanical raking methods may be utilized prior to hand raking but not as a substitute. Limit fine grading to areas that can be planted in the immediate future.

F. Moisten prepared lawn areas before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil condition.

G. Restore areas if eroded or otherwise disturbed after finish grading and before planting.

3.4 SODDING

A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.

B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.

1. Lay sod across angle of slopes exceeding 1:3.

2. Anchor sod on slopes exceeding 1:6 with wood pegs or steel staples spaced as recommended by sod manufacturer but not less than 2 anchors per sod strip to prevent slippage.

C. Saturate sod with fine water spray within two hours of planting. During first week, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below sod.

3.5 SATISFACTORY LAWNS

A. Satisfactory Sodded Lawn: At end of maintenance period, a healthy, well-rooted, even-colored, viable lawn has been established, free of weeds, open joints, bare areas, and surface irregularities.

B. Reestablish lawns that do not comply with requirements and continue maintenance until lawns are satisfactory.

3.6 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by lawn work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Erect barricades and warning signs as required to protect newly planted areas from traffic. Maintain barricades throughout maintenance period and remove after lawn is established.

C. Remove erosion-control measures after grass establishment period.
3.7 DISPOSAL

A. Disposal: Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 32 92 00
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. References and standards listed herein are to be the latest edition available, unless specifically stated otherwise.

1.2 SUMMARY

A. The work includes installation of waterlines, valves, and appurtenances.

B. Related Sections:
   1. Division 01 Section "Submittals Procedures."
   2. 01 56 39 Temporary Tree and Plant Protection
   3. 31 00 00 Earthwork

1.3 SUBMITTALS

A. General: Make submittals in accordance with Division 1 Section “Submittal Procedures.”

B. All products.

1.4 QUALITY ASSURANCE

A. All work shall conform with the 2011 Standard Specifications and Standard Plans for Road, Bridge and Municipal Construction, as published by the City of Seattle (COS), unless otherwise indicated herein.

B. The Contractor shall have one copy of the Standard Specifications and Standard Plans at the job site.

C. The Standard Specifications apply only to performance and materials and how they are to be incorporated into the work. The legal/contractual relationship sections, and the measurement and payment sections do not apply to this document.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. Water distribution piping shall be ductile iron pipe. Ductile iron pipe shall be thickness Class 52 conforming to AWWA C 151. Pipe shall have a cement mortar lining conforming to AWWA C 104. Pipe shall use restrained joints unless shown otherwise on the drawings.

B. Gate valves shall conform to City of Seattle Standard Specification 9-30.3.

C. Provide valve box and operating nut extension for each gate valve shown on the Drawings. Valve boxes shall conform to City of Seattle Standard Specification 9-30.3(5).

D. Anchorages: Provide anchorages for tees, wyes, crosses, plugs, bends, valves, and hydrants. After installation, apply full coat of asphalt or other acceptable corrosion retarding material to surfaces of ferrous anchorages.
2. Joint Restraint: Per Standard Specification Section 7-11.3(6) D.

2.2 AIR/VAC VALVES

A. Air/Vacuum valves shall be combination air release/air vacuum valves designed to operate with potable water under pressure to permit discharging a surge of air from an empty line when filling and relieve the vacuum when draining the system. The valves shall also release an accumulation of air when the system is under pressure.

B. This shall be accomplished in a single valve body designed to withstand 300 psi.

C. The body and cover shall be cast iron conforming to ASTM A 48, Class 30. Floats shall be stainless steel conforming to ASTM A 240 and designed to withstand 1,000 psi.

D. Seats shall be Buna N rubber. Internal parts shall be stainless steel or bronze.

2.3 CONCRETE

A. Unreinforced concrete shall be commercial class 3000 conforming to Section 6-02.3(2)B of the COS Standard Specifications.

2.4 FIRE HYDRANTS

A. Fire hydrants shall conform with City of Seattle Standard Specification 9-30.5.

2.5 CASING PIPE

A. Casing pipe shall be new, straight seam smooth wall carbon steel pipe conforming to ASTM Specification A139, Grade B. Steel casing pipe shall have a minimum yield strength of 35,000 psi.

B. Casing pipe shall be 24-inch external diameter. Minimum pipe wall thickness shall be 0.5 inches.

C. Casing pipe joints shall be continuously welded with a butt joint.

D. Casing pipe shall be square cut.

E. Casing pipe shall have a roundness such that the difference between the major and minor outside diameters shall not exceed 1 percent of the specified nominal outside diameter or 0.25 inch, whichever is less.

F. Casing pipe outside circumference shall be within 1 percent of the nominal circumference or within 0.5 inch, whichever is less.

G. Casing pipe shall have a maximum allowable straightness deviation of 1/8 inch in any 10-foot length.

2.6 CASING SPACERS

A. Casing spacers shall be installed per manufacturer’s recommendations. Provide a minimum of two spacers per pipe length. One spacer at the joint and one mid-pipe length. Spacers shall be secured to prevent rotation during installation and pipe flotation during grouting.
2.7 CASING SEALS
   A. Casing seals shall be Link – Seal Modular Seals, Model C, as manufactured by Pipeline Seal and Insulator Inc. or approved equivalent.

2.8 IRRIGATION GATE VALVE
   A. Irrigation gate valve shall be Kennedy Valve AWWA C509 Resilient Wedge Gate Valve model KS-FW.

2.9 MEGALUG RESTRAINTS
   A. Megalug restraints shall be series 1700 Megalug Restraint Harness for ductile iron pipe.

PART 3 - EXECUTION

3.1 TRENCHES
   A. Trenches shall be excavated and backfilled, and the pipe shall be bedded in conformance with Section 7-09.3 of the COS Standard Specifications.

3.2 PIPES AND VALVES
   A. Pipes and valves shall be installed in conformance with Section 7-09.3 and 7-12.3 of the COS Standard Specifications.
   B. Provide 3-foot minimum cover over piping below finished grade.

3.3 FIRE HYDRANTS
   A. Fire hydrants shall be installed in conformance with Section 7-14.3 of the COS Standard Specifications.

3.4 TESTING AND FLUSHING
   A. Testing and flushing procedures shall be per NFPA 24.

3.5 CASING PIPE
   A. Steel casing pipe joints shall be continuously welded with butt joint per the current edition of AWS D1.1/D1.1M. The welds shall attain the full strength of the pipe and shall result in a full watertight section. The inner face of the weld seam shall be flush with the pipe to facilitate the installation and potential future removal of the carrier pipe. Coordinate visual inspection of welds by City of Seattle SPU Inspector. Casing joints shall be video inspected per Section 7-17.3(4)I of the City of Seattle Standard Specification.
   B. Casing shall be installed with Class B bedding per Section 7-10.3(9)A of the City of Seattle Standard Specifications.
   C. All voids between carrier pipe, casing, and manholes shall be sealed with Link Seal installed per the manufacturers recommendations.
3.6 CASING SPACERS

A. Casing spacers shall be installed per manufacturer’s recommendations. Provide a minimum of two spacers per pipe length. One spacer at the joint and one mid-pipe length. Spacers shall be secured to prevent rotation during installation and pipe flotation during grouting.

END OF SECTION 33 10 00
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. References and standards listed herein are to be the latest edition available, unless specifically stated otherwise.

1.2 SUMMARY

A. The work includes constructing sanitary sewer mains, side sewers, and manholes.

B. Related Sections:
   1. Division 01 Section "Submittals Procedures"
   2. 31 00 00 Earthwork
   3. 01 56 39 Temporary Tree and Plant Protection

1.3 SUBMITTALS

A. General: Make submittals in accordance with Division 1 Section “Submittal Procedures.”

B. Product Data: Submit manufacturers standard drawings and catalog cuts for the following:
   1. Casing spacers, seals
   2. Carrier pipe including joint and gasket
   3. Precast manholes
   4. Manholes hole frames and lids
   5. Pipe including joint and gasket materials

1.4 QUALITY ASSURANCE

A. All work shall conform with the 2011 Standard Specifications and Standard Plans for Road, Bridge and Municipal Construction, as published by the City of Seattle (COS), unless otherwise indicated herein.

B. The Contractor shall have one copy of the Standard Specifications and Standard Plans at the job site.

C. The Standard Specifications apply only to performance and materials and how they are to be incorporated into the work. The legal/contractual relationship sections, and the measurement and payment sections do not apply to this document.

PART 2 - PRODUCTS

2.1 PIPE

A. Sanitary sewer pipe shall have flexible, gasketed, push-on joints and be PVC (polyvinyl chloride) SDR 35 conforming to ASTM D 3034. Fittings shall be factory molded of PVC. All pipe and fittings shall be legibly and permanently marked with type and class.
B. Sanitary sewer pipe shall be ductile iron where called out on the plans. Ductile iron pipe shall conform to AWWA C151 and shall be cement mortar lined, thickness class 52, with push-on or mechanical joints. Joints shall be rubber gasketed, conforming to the requirements of AWWA C111.

2.2 CASING PIPE

A. Casing pipe shall be new, straight seam smooth wall carbon steel pipe conforming to ASTM Specification A139, Grade B. Steel casing pipe shall have a minimum yield strength of 35,000 psi.

B. Casing pipe shall be 24-inch external diameter. Minimum pipe wall thickness shall be 0.5 inches.

C. Casing pipe joints shall be continuously welded with a butt joint.

D. Casing pipe shall be square cut.

E. Casing pipe shall have a roundness such that the difference between the major and minor outside diameters shall not exceed 1 percent of the specified nominal outside diameter or 0.25 inch, whichever is less.

F. Casing pipe outside circumference shall be within 1 percent of the nominal circumference or within 0.5 inch, whichever is less.

G. Casing pipe shall have a maximum allowable straightness deviation of 1/8 inch in any 10-foot length.

2.3 CASING SPACERS

A. Casing spacers shall be Model S8G-2 stainless steel casing isolators, as manufactured by Pipeline Seal and Insulator Inc., or approved equivalent. Spacers shall be new, centered, and restrained, and shall facilitate. Spacers shall be fitted with polymer runners and be field-adjustable to maintain the design slope of the carrier pipe.

2.4 MANHOLES

A. Pre-cast manholes shall conform to City of Seattle Standard Specification Section 9-12 and Standard Plans.

2.5 CLEANOUTS

A. Cleanouts shall be of the same material as the pipe and shall conform with Section 7-19.2 of the COS Standard Specifications.

2.6 PIPE CONNECTION GASKET

A. Gasket shall be Link-Seal or approved equivalent.

2.7 GROUT

A. Grout for filling voids between sewer structures where pipe connections are made shall be non-shrink cement sand grout complying with City of Seattle Standard Specification Section 9-12.4.
PART 3 - EXECUTION

3.1 PIPE
   A. Sanitary sewer pipe shall be installed, cleaned, and tested in conformance with City of Seattle Standard Specification Section 7-17.
   B. Sanitary sewer pipe bedding shall be Class B.

3.2 CASING PIPE
   A. Steel casing pipe joints shall be continuously welded with butt joint per the current edition of AWS D1.1/D1.1M. The welds shall attain the full strength of the pipe and shall result in a full watertight section. The inner face of the weld seam shall be flush with the pipe to facilitate the installation and potential future removal of the carrier pipe. Coordinate visual inspection of welds by City of Seattle SPU Inspector. Casing joints shall be video inspected per Section 7-17.3(4)I of the City of Seattle Standard Specification.
   B. Casing shall be installed with Class B bedding per Section 7-10.3(9)A of the City of Seattle Standard Specifications.
   C. All voids between carrier pipe, casing, and manholes shall be sealed with Link Seal installed per the manufacturers recommendations.

3.3 CASING SPACERS
   A. Casing spacers shall be installed per manufacturer’s recommendations. Provide a minimum of two spacers per pipe length. One spacer at the joint and one mid-pipe length. Spacers shall be secured to prevent rotation during installation and pipe flotation during grouting.

3.4 CASING SEALS
   A. Casing seals shall be Link – Seal Modular Seals, Model C, as manufactured by Pipeline Seal and Insulator Inc. or approved equivalent.

3.5 MANHOLES
   A. Pre-cast manholes shall be installed in conformance with City of Seattle Standard Specification Section 7-05.
   B. All rigid pipes entering or leaving manholes shall be provided with flexible joints within 1 1/2 pipe diameters of the structure which shall be firmly supported by compacted bedding. All openings through which pipes enter structures shall be grouted tight in workmanlike manner to ensure a watertight connection.

3.6 CLEANOUTS
   A. Cleanouts shall be installed in conformance with Section 7-19.3 of the COS Standard Specifications.

3.7 CLEANING AND TESTING
   A. All sewers and appurtenances shall be cleaned and tested after backfilling by the low pressure air method specified in Section 7-17.3(4) of the COS Standard Specifications.
3.8 PIPE CONNECTION GASKET

A. Install per manufacturer’s specifications.

END OF SECTION 33 30 00
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. References and standards listed herein are to be the latest edition available, unless specifically stated otherwise.

1.2 SUMMARY

A. The work includes drainage pipe, drainage structures, filter fabric, drainage mat and drainage pipe fittings.

B. Related Sections:
   1. Division 01 Section "Submittals Procedures"
   2. 31 20 00 Earthwork
   3. 01 56 39 Temporary Tree and Plant Protection
   4. 32 92 00 Lawns

1.3 SUBMITTALS

A. General: Make submittals in accordance with Division 1 Section “Submittal Procedures.”

B. The following shall be submitted for review and approval prior to commencing Work:
   1. Product data, including catalog cuts and technical specifications shall be provided for the following:
      a. Precast manholes, catch basins and area drains
      b. Catch basin, manhole, and area drain frames, lids and grates
      c. Pipe including joint and gasket materials
      d. Trench Drain channels and grates

1.4 QUALITY ASSURANCE

A. All work shall conform with the 2011 Standard Specifications and Standard Plans for Road, Bridge and Municipal Construction, as published by the City of Seattle (COS), unless otherwise indicated herein.

B. The Contractor shall have one copy of the Standard Specifications and Standard Plans at the job site.

C. The Standard Specifications apply only to performance and materials and how they are to be incorporated into the work. The legal/contractual relationship sections, and the measurement and payment sections do not apply to this document.
PART 2 - PRODUCTS

2.1 PIPE

A. Drainage pipe shall have flexible, gasketed, push-on joints and be PVC (polyvinyl chloride) conforming to ASTM D 3034, SDR 35.

B. Drainage pipe shall be ductile iron where called out on the plans. Ductile iron pipe shall conform to AWWA C151 and shall be cement mortar lined, thickness class 52 with push on or mechanical joints. Joints shall be rubber gasketed conforming to the requirements of AWWA C111.

C. Perforated PVC drain pipe shall conform to the provisions of ASTM D 2729-96A. Provide two rows of 1/4-inch perforations at 4-inch on center, spaced 120-degrees apart.

2.2 CATCH BASINS AND MANHOLES

A. Pre-cast manholes, catch basins, inlets, lids, and grates shall conform to City of Seattle Standard Specification Section 9-12 and Standard Plans.

B. Metal castings shall conform to the requirements of Section 9-05.15 of the COS Standard Specifications, and be permanently marked “DRAIN” or “STORM.” Privately owned drainage structures shall have lids permanently marked “PRIVATE” as indicated on plans. Lids shall be non-locking.

2.3 GASKET FOR PIPE PENETRATIONS/CONNECTIONS TO CONCRETE STRUCTURES

A. Gasket shall be Link-Seal or approved equivalent.

2.4 CLEANOUTS

A. Cleanouts shall be of the same material as the pipe and shall conform with Section 7-19.2 of the COS Standard Specifications.

2.5 TRENCH DRAINS

A. Trench drains shall be ACO Drains model K100S.

2.6 TRENCH DRAIN GRATES/ TRENCH DRAIN COVERS

A. Trench drain grates and covers shall be 4.9-inch Flat Rainbow Trench Drain Grates from Urban Accessories.

2.7 TRENCH DRAIN IN-LINE CATCH BASINS

A. Trench Drain In-Line Catch Basins shall be ACO Drains model K900.

2.8 AREA DRAINS

A. Area drains shall be Nyloplast drain basins.

2.9 AREA DRAIN GRATES

A. Area drain grates shall be Angle grates from Urban Accessories.
2.10 DRAINAGE MAT
   A. Drainage mat shall be Miradrain 9800 or approved equal.

2.11 FILTER FABRIC
   A. Filter fabric shall be Mirafi 140N or an approved equal.

2.12 FLEXIBLE COUPLING
   A. Flexible coupling shall be Romac FJ-Restraint Flexible Ball Joint Restraint Fitting or approved equal.

PART 3 - EXECUTION

3.1 PIPE
   A. Storm drains shall be installed, cleaned, and tested in conformance with City of Seattle Standard Specification Section 7-17.
   B. Storm drain pipe bedding shall be Class B.

3.2 STRUCTURES
   A. Pre-cast catch basins and maintenance holes shall be installed in conformance with City of Seattle Standard Specification Section 7-05.
   B. All rigid pipes entering or leaving catch basins or maintenance holes shall be provided with flexible joints within 1 1/2 pipe diameters of the structure which shall be firmly supported by compacted bedding. All openings through which pipes enter structures shall be grouted tight in workmanlike manner to ensure a watertight connection.

3.3 CLEANOUTS
   A. Cleanouts shall be installed in conformance with Section 7-19.3 of the COS Standard Specifications.

3.4 PIPE CONNECTION GASKET
   A. Install per manufacturer’s specifications.

3.5 TRENCH DRAINS
   A. Install per manufacturer’s specifications.

3.6 AREA DRAINS
   A. Install per manufacturer’s specifications.
3.7 DRAINAGE MAT

A. Install per manufacturer’s specifications.

END OF SECTION 33 40 60
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Contract Drawings and General Provisions of the Contract, including General Terms and Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. Galvanized structural steel pole for the trolley overhead system, as specified and as shown on Contract Drawings.

B. Related Sections:
1. Section 31 66 05 – OCS Pole Foundations

1.3 REFERENCES

A. Definitions:
1. Joint Use Pole: A pole supporting King County trolley overhead attachments, in addition to street light(s) and/or traffic signals, signs and cables, telephone cables, power cables, and television cables.

B. Reference Standards
1. Section incorporates by reference the latest revisions of the following documents:
2. American Institute of Steel Construction:
   a. Specification for Structural Steel Buildings
   a. ASTM E709, Standard Guide for Magnetic Particle Testing
   a. AWS D1.1, Structural Welding Code, Steel (Code)
5. City of Seattle
   a. City of Seattle Street and Sidewalk Pavement Opening and Restoration Rules
   b. COS Standard Specifications for Road, Bridge and Municipal Construction 2011 (“Standard Specifications”)
      http://www.seattle.gov/util/groups/public/@spu/@engineering/documents/webcontent/01_011339.pdf
6. King County Metro (KCM)
   a. King County Metro Transit Division Trolley Overhead System Standards (“KCM Standards”)
      2) SP drawings: http://your.kingcounty.gov/kcdot/transit/dcs/standards/SP-201-1_201-16.pdf
7. Society for Protective Coatings (SSPC):
   a. SP-1 - Solvent Cleaning
   b. SP-6 - Commercial Blast Cleaning
1.4 QUALITY ASSURANCE

A. Material Testing
   1. The chemical compositions and appropriate mechanical properties shall be determined of materials used, either by obtaining manufacturer's certificates of compliance or by laboratory testing at a facility acceptable to the Owner's Representative.

B. Weld Testing
   1. Equipment, procedures and personnel for weld testing, and test reports, shall conform to the requirements of AWS D1.1.
   2. The services of an AWS Certified Welding Inspector shall be provided by the pole fabricator to perform verification inspection and to perform weld inspection as specified. Approval of the Welding Inspector shall be obtained from the Owner's Representative.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver tubular poles complete with associated fittings and accessories, properly loaded and protected against damage and loss of parts.

B. Protect from damage during storage, handling and moving from the storage facility to the installation site.

C. Handle and transport tubular poles in a manner to preclude damage to the structural steel, paint and zinc coating.

D. Deliver poles to the site complete with associated fittings and accessories, properly packed and protected against damage and loss of parts.

PART 2 - PRODUCTS

2.1 POLES

A. The following OCS pole types are indicated in Contract Drawings:
   1. Type SA-201V.
   2. Type SA-201X.
   3. Type SA-201Y (Chief Seattle base not required).
   4. Type SA-201Z.

B. Provide poles of the indicated types that comply with King County Metro Transit Division Trolley Overhead System Standards ("KCM Standards"), Drawings SA-201 and SP-201, anchor base steel pole.
   1. Furnish with bracket arm luminaire flange as shown on KCM Standards Drawing SP-201 Sheet 9 of 16.
   2. Furnish with handhole and cover as shown on KCM Standards Drawing SP-201 Sheet 6 of 16.
   3. Hot dip galvanize poles in compliance with Drawing SP-201. No other finish will be required.

2.2 OTHER MATERIALS

A. Galvanizing repair compound shall conform to Federal Specification No. DOD-O-21035; and shall be "Galvanox" as manufactured by Subox, Inc.; "Cold Galvanizing Compound" as manufactured by ZRC Chemical Products Co.; or approved equal.
B. Grout: Non-shrink cement grout complying with Standard Specifications 9-20.3(2), grout Type 2 for non-shrink applications.

2.3 SOURCE QUALITY CONTROL

A. Weld Inspection and Testing:
   1. Comply with Standard Specifications 6-03.3(25)B.
   2. Repair welds found to be unacceptable in accordance with Standard Specifications 6-03.3(25)A and retest.

B. Conduct other tests as indicated in KCM Standards Drawing SP-201.

C. Pole Deflection Testing:
   1. Demonstrate to the Owner’s Representative the deflection of each type of pole provided under this Contract.
   2. Perform at the place of manufacture at a place and time agreed by the Owner’s Representative.
   3. Testing shall be nondestructive.
   4. Parameters to be demonstrated include load at maximum deflection and deflection at maximum loading.
   5. Conduct the test on a rigid foundation that resists all translation and rotation in any axis.
   6. Under the deflection load, the tubular pole at point of loading shall not show a deflection exceeding by five percent the calculated theoretical value.
   7. After having removed the load, the pole at point of loading shall not show a permanent set exceeding ten percent of its temporary deflection under this load.

D. Inspection by the Owner’s Representative: Provisions shall be made for inspection of the fabrication and testing by the Owner’s Representative. Two weeks advance notice shall be provided. This inspection will be at the expense of Owner.

PART 3 - EXECUTION

3.1 CONSTRUCTION

A. Pole Setting
   1. Erect and rake poles in compliance with Standard Specifications 8-32.3(1)B.
   2. Joint Use Poles: Coordinate with utilities and agencies sharing pole before installing pole.
   3. Pole caps: Verify that pole caps have been installed on pole prior to setting.
   4. Pole finish: Exercise care while erecting poles to prevent damage to pole finish.
   5. Overhead utilities: During steel pole erection, prevent contact with overhead utilities.
   6. Handhole locations: Set poles with handholes oriented on the side of the pole facing away from prevailing vehicular traffic or directly behind the streetlight.
   7. Secure poles to anchor bolts in compliance with Standard Specifications 6-03.3(33)A using turn-of-nut method, as defined in that section. “Snug-tight” is defined in Standard Specifications 6-03.3(32).
   8. Grounding: Connect ground stub-up from foundation to grounding provisions inside pole. See KCM Standards Drawing SP-01 Sheet 6 of 16.

B. Grouting:
   1. Coat or wrap anchor bolt threads to protect them from grout or concrete.
   2. Comply with Standard Specifications 9-04.3(2) and Standard Plans No. 563a.

C. Sidewalk Replacement: Adjacent sidewalk concrete shall be graded to drain away from poles, to the extent possible in conformance with the Applicable Standards in this Section and in Section 31 66 05, OCS Pole Foundations.
D. Remove and dispose of existing poles indicated for removal on Contract Drawings.

3.2 FIELD REPAIR

A. Galvanizing: Repair damage to galvanized coating of delivered poles, fittings, and accessories using the specified zinc repair paint.
   1. Apply zinc paint in compliance with manufacturer's instructions and recommendations.
   2. Touch up poles, fittings, and accessories within five days after delivery.

END OF SECTION 34 23 13
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Contract Drawings and General Provisions of the Contract, including General Terms and Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES:
1. Direct embedment temporary wood poles to support trolley span wires, pull offs, temporary streetlights, etc. in a temporary route.
2. Removal of temporary wood poles after OCS is completed on the permanent route.

1.3 REFERENCE STANDARDS

A. Section incorporates by reference the latest revisions of the following documents:

B. American National Standards Institute (ANSI):
   1. ANSI 05.1 - Specifications and Dimensions for Wood Poles

C. American Wood-Preservers' Association (AWPA)
   1. AWPA P1, Standard for Creosote Preservative
   2. AWPA P8, Standard for Oil-Borne Preservatives
   3. AWPA P9, Standards for Solvents and Formulations for Organic Preservative Systems

D. City of Seattle (COS)
   1. COS Street and Sidewalk Pavement Opening and Restoration Rules.

E. King County Metro
   1. King County Department of Transportation Trolley Standards (“KCM Standard Drawings”)  
      a. SA drawings:  

1.4 SUBMITTALS

A. Product Data:
   1. Pole tags.

PART 2 - PRODUCTS

2.1 MATERIAL

A. Provide wood poles, toe, top keys and related accessories as required by KCM Standard Drawings SA-202 and SA-214.


C. Pole length: As shown on the Contract Drawings.

PART 3 - EXECUTION

3.1 CONSTRUCTION

A. Field locate poles at locations shown on Contract Drawings.
B. Install in compliance with King County Department of Transportation Trolley Standards ("KCM Standard Drawings") SA-214.

C. Underground Utilities:
   1. Contact underground utility owners to locate utilities before boring or excavating for foundations.
   2. After the utility locate, hand excavate each foundation location to a depth of four feet and to the width shown on the Drawings and Standards.
   3. If no utilities are found, and with Owner’s Representative’s approval, complete the Work in accordance with KCM Standard Drawing SA-214.
   4. If utilities are confirmed in the proposed location of the foundation, proceed as directed by Owner’s Representative.

D. Construction Sequence:
   1. Provide a hole of the proper depth and diameter according to length and diameter of pole.
   2. Set load bearing toe and top keys, as shown.
   3. Provide compacted backfill and suitable grade finishing.

E. Landscaping
   1. If trees or landscaping must be trimmed to facilitate placement of poles, work shall be performed by a licensed landscape gardener or tree surgeon as approved by the City of Seattle.
   2. The City of Seattle must also approve all trimming. Coordinate with John Peterson (206-684-5047).

F. Excavation
   1. Perform excavation such that the bearing surfaces of the excavation remain firm and intact.
   2. Caving: Where soil type causes caving of the drilled hole, provide casing or use other techniques to prevent caving.
      a. Provide adequate casings if needed to maintain hole free of loose soil and water until toe key, top key, pole, and backfill are in place.
      b. Method used shall be subject to review of the Owner’s Representative.
   3. Curbs:
      a. During excavation, exercise care to avoid disturbing existing curbs.
      b. If curbs are disturbed, the Contractor shall make restoration at no cost to Owner.
   4. Excavated material:
      a. Locate so that it will not interfere with street storm drainage.
      b. Where excavation is adjacent to loading zones or traffic areas, remove material immediately after excavation.
      c. In no case shall excavated materials remain at site of construction overnight.
   5. Coordinate so that a maximum of 48 hours is required between excavation and placement of toe and top key, pole and backfill.
   6. Protection
      a. During the interval between excavating pole foundation and placing toe key, top key, pole and backfill, cover excavated holes, provide barriers, and post proper warning signs in compliance with COS Street and Sidewalk Pavement Opening and Restoration Rules.


H. Pole Setting
   1. General
      a. Wood poles shall generally be set with the embedment depth and rake as shown in the KCM Standard Drawing SA-214. Rake for joint use poles will be less in order to maintain new poles in pole line.
b. The wood pole shall be installed, oriented as shown in KCM Standard Drawing SA-214. Direction of pole rake shall be in direct opposition to the resultant load tension away from the street.

2. Handling
   a. When handling treated poles, care shall be exercised so that the pole is not subjected to abrasion or penetration of the treated surface, particularly at the ground line.

I. Backfill
   1. Tamp backfill by means of hand shoveling and pneumatic or mechanical tampers, with all functions being performed simultaneously until backfilling has completely filled all voids.
   2. Backfill material shall be as indicated and shall be placed in accordance with KCM Standard Drawing SA-214. Surfaces in unpaved areas shall be restored in accordance with KCM Standard Drawing SA-214.

J. A pole roof shall be cut at 15 feet as shown in KCM Standard Drawing SA-202.

K. Poles shall be marked in accordance with KCM Standard Drawing SA-202.

L. Sidewalks and Pavements
   1. Opening and Restoration:
      a. All sidewalks and pavements shall be opened and restored in accordance with COS Street and Sidewalk Pavement Opening and Restoration Rules.
   2. Pavement Cutting:
      a. Existing paved surfaces to be removed shall be cut with minimum damage to adjacent surfaces, using power saws, power drills and other appliances approved by Owner’s Representative.

M. Pole Removal
   1. Wood poles indicated for removal shall be removed completely, and if possible, intact.
   2. Backfill holes in accordance with COS Street and Sidewalk Pavement Opening and Restoration Rules.
   3. Salvage and deliver wood poles to King County Metro per direction of the Owner’s representative.

N. Joint-use poles with street lights: Contract Drawings show street lights on temporary OCS wood poles. See Electrical Drawings and Specifications for street light requirements.

O. No separate payment will be made for pilot drilling or potholing and all costs shall be included in the bid prices, except in cases where an Owner approved site is found to be unsuitable for location of a pole within a 2 foot radius. Where these circumstances arise, the potholing, backfilling and restoration of the site will be paid as a change order. Owner’s Representative will identify an alternate site for the Contractor.

P. If Contractor observes situations where additional keys or sidewalk guys are required, notify Owner’s Representative to obtain approval before commencing work.

END OF SECTION 34 23 14
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Contact wire for electric trolley bus (ETB) OCS.

B. Related Sections:
   1. Section 34 23 91 – ETB OCS Testing

1.3 REFERENCE STANDARDS

A. This Section incorporates by reference the latest revisions of the following documents:

B. American society for Testing and Materials (ASTM)
   1. ASTM B47, Standard Specification for Copper Trolley Wire

1.4 SUBMITTALS

A. Procedures: Section 01 33 00, Submittal Procedures.

B. Shop Drawings: Submit for approval before manufacture of wire. Include as a minimum:
   1. Physical Characteristics and Parameters
      a. Type.
      b. Material.
      c. Cross section area.
      d. Weight per foot.
      e. Rated breaking strength.
   2. Electrical Characteristics:
      a. Rated current carrying size (AWG or kcmil).
      b. Resistance per unit length.

C. Samples: Provide samples of conductors, when requested by Owner’s Representative.

D. Provide certification from the wire manufacturer verifying that the conductors have been designed, manufactured, inspected and tested in accordance with applicable portions of these referenced standards, Specifications and the Contract Drawings.

E. Submit the manufacturer’s written procedure for factory splicing on contact wire.
F. Factory Test Reports:
   1. Submit a certified copy of the test report for each cable reel, for the specific conductors provided, before shipment. A copy of the test report shall be packed with each reel.

G. Installation:
   1. Written procedures for conductor stringing and final termination.
   2. Drawings for temporary anchorages, guying, and, if needed, a program for electrical isolations.
   3. The conductor erection tension calculation spreadsheet developed by the Contractor shall be updated and submitted to Owner’s Representative within 5 days after the installation of each conductor.

1.5 WITNESSING
   A. Owner’s Representative reserves the right to witness the manufacture and packing of conductors. See Section 34 23 91, ETB OCS Testing for witnessing of testing. Notify Owner’s Representative not less than 10 days in advance of manufacturing and testing operations.

1.6 QUALITY ASSURANCE
   A. Conductors shall have a minimum in-service life expectancy of 30 years under City of Seattle operating conditions. The normal wear of the contact wire is an acceptable reason for its replacement prior to 30 years.

1.7 DELIVERY, STORAGE AND HANDLING
   A. Delivery and Acceptance Requirements
      1. Ship conductors on wooden reels suitable for the weight of the conductors and protect from damage.
      2. The diameter of the drum shall be sufficiently large so as to avoid difficulty with waves or kinks when the conductor is strung.
      3. Conductors shall be wound on reels in even level wraps with no crossed, overlapping, or loose ends. Specify orientation of conductor wound onto reel to suit construction methods.
      4. Permanent twisting or rotation of the grooved contact wire shall be cause for rejection of the reel at the Contractor's expense.
      5. Each reel shall consist of one continuous, unspliced conductor. Each shall have the required length of conductor so that no splices are required in each tension length when installed, unless specifically identified prior to installation and approved by Owner’s Representative.
      6. Labeling: Each reel shall have a strong, weatherproof tag or marker securely fastened to it, showing the size and type of conductor as well as the ASTM designation, name and mark of the manufacturer, total reel length, and weight and manufacturer’s special instructions.
      7. Paint a stripe in any contrasting color approximately 1 inch wide across the outermost layer on each reel. Any visible conductor shift at this line, upon receipt at the job site, will be treated as indicating a relative wire movement during shipment, and is cause for reel rejection.
8. A copy of the factory test report shall be packed with each reel.

B. Storage and Handling Requirements:

1. Ensure that provided materials are suitably packaged and protected against damage during delivery and transportation.

2. Store products in accordance with the manufacturer's instructions, to ensure that material is protected from damage and exposure.

3. Handle and otherwise use the wire and cable in accordance with the manufacturer's instructions, so as to ensure that the products are not damaged or misused prior to or during installation.

4. Materials shall not be stored in direct contact with the ground, but shall be stored in a manner and location that will not cause deterioration.

5. Damage to the wire and cable shall be the Contractor's responsibility, and all repairs and replacements shall be accomplished by the Contractor in accordance with the manufacturer's instructions, at no additional cost to Owner.

1.8 WARRANTY

A. The conductors shall be unconditionally guaranteed by the manufacturer or supplier to be free from defects for a period not less than 5 years.

B. The Contractor shall be responsible for the correct installation of specified conductors, and repairs and replacements shall be made by the Contractor in accordance with the cable/wire manufacturer's instructions at no additional cost to Owner, and with the approval of Owner's Representative.

PART 2 - PRODUCTS

2.1 MATERIAL

A. Conductor materials shall be of a composition, quality and purity such that the finished product shall have the properties and characteristics described in this Specification and the referenced standards. Conductors of the same design shall be uniform size and shape.

B. The physical, mechanical and electrical properties of the conductors shall conform to the requirements of this Specification and the pertinent provisions of all Standards referenced in this Section.

C. The bare conductor particulars shall be in accordance with the parameters indicated on the Contract Drawings and as specified.

1. Contact Wire: Solid, 4/0 AWG, grooved, hard-drawn copper, complying with ASTM B47.

D. Protective Pipe: Fiber reinforced plastic (FRP) pipe, cut in half to make half-round protective cover, as shown on Contract Drawings.

2.2 SOURCE QUALITY CONTROL

A. Prior to wire drawing, factory manufactured wire joints in contact wire stock shall be marked with paint or dye. These marks shall be readily distinguishable after the wire drawing process. Such joints shall meet the minimum breaking strength requirements of the contact wire, without exception.
B. Conductors shall be subject to factory production tests as required in the applicable Standards.

C. Tests shall be performed on each reel prior to shipment.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS:

A. The following describes the installation of OCS conductors and wiring assemblies for the complete OCS system.

B. The Work includes stringing, tensioning, terminating, clipping in, registering, and adjusting the contact wire and other ancillary hardware as required, to provide a complete and fully operational OCS.

C. The Contractor shall be responsible for coordinating the OCS installation.

D. At all stages of Work, handle conductors with special care to avoid bending, kinking, twisting or other forms of damage.

3.2 TOOLS

A. Contact wire shall be strung or held in tension only by specifically designed grips that pull along the wire centerline without bending or kinking the wire.

B. Use wire grips and other installation equipment that ensure that tension is applied along the axis of the conductors, so as not to damage or kink the wire.

C. OCS components for permanent installation shall not be used as multiple use construction tools.

3.3 INSTALLATION TOLERANCES

A. The final installed OCS shall conform to the dimensional requirements shown on the Contract Drawings, and Owner’s Representative’s approved Contractor’s plans, within the following tolerances:

1. Pole rake (after loading): 1 inch off vertical at pole top.
2. Contact wire height, at support: 1 inch.
3. Contact wire height, at a bridge: 1/2 inch.
4. Contact wire stagger at registration: 1 inch.
5. Vertical separation between crossing contact wires: 4 inches.

3.4 OCS CONDUCTOR STRINGING

A. Install overhead conductors in compliance with the Contractor's procedure, as approved by Owner’s Representative.

B. Field Conditions:

1. During contact wire stringing, measure conductor temperature with a contact thermometer.
2. Determine actual erection tension for each tension length based on conductor temperature.

C. For use as a guide during the stringing process, the pavement or ground may be marked with points of alignment of the ETB contact wire.

D. Energized wires: Prevent ETB contact wire from coming into contact with existing energized wires.

E. Where ETB contact wire runs between special work assemblies is less than 5 feet, provide Universal Spacer Bar and compatible tips.

3.5 ETB CONTACT WIRE HEIGHT

A. Minimum ETB contact wire height: 18 feet-0 inches above street level.

B. Height at support point: 18 feet-9 inches above street level.

C. Height at support point exception: Where minimum ETB contact wire height cannot be obtained, height at support point may be up to 19 feet above street level.

D. Notify Owner’s Representative immediately and provide explanation if required wire height cannot be achieved.

E. Acceptance measurements:
   1. Take measurements after clipping in, to verify contact wire alignment locations and wire heights.

3.6 ETB CONTACT WIRE ALIGNMENT

A. Horizontal distance between face of curb and nearest overhead ETB contact wire support point on tangent run:
   1. Parking permitted: 12 feet, unless otherwise indicated.
   2. Parking not permitted: 9 feet, unless otherwise indicated.

B. Space between positive and negative ETB contact wire: Nominal 24 inches.

3.7 PRE-TENSIONING

A. Take precautions to reduce the effects of initial contact wire creep by using one of the following pre-tensioning methods, or a combination of both, before making final OCS adjustments. Submit a procedure for approval describing the proposed method.

   1. Method 1 - Pre-stressing: Procedure shall describe the procedure and include:
      a. Pre-stress tension.
      b. Pre-stress time period to be applied before reducing to normal tension.
      c. Verification that structures can safely carry the proposed loading.
      d. Tension shall be measured by dynamometer installed to be visible from the ground throughout the pre-stress period.
2. Method 2 - Time-lapse: Allow the initial creep to occur over a prescribed period of time by leaving the contact wire in temporary rollers or travelers for a minimum period. Procedure shall include:
   a. The time-lapse period.
   b. Necessary precautions to be taken.

B. Secure conductors at the termination assemblies after the initial creep has been removed.

3.8 TENSIONING AND ADJUSTMENT

A. After stringing and final tensioning, transfer wire from temporary supports to insulated hanger clamps.

B. Verify alignment of ETB contact wire. This may be done using a plumb bob suspended from the wire and compared with previous markings made at ground level.

C. Locate and reposition tangent hangers, including feed hangers, as necessary for correct alignment of the ETB contact wires.

D. At curves, make ETB contact wire offset adjustments by retensioning, shortening, or lengthening pull-off strands, or a combination, as required.

3.9 ETB CONTACT WIRE SPLICES

A. ETB contact wire shall be continuous between end fittings of in-line assemblies, unless otherwise specified.

B. If splicing is unavoidable, notify Owner’s Representative and obtain approval for splice.

C. Splices, where approved by Owner’s Representative, shall be located at curve segments between the curve plates and runner tips.

3.10 IN-LINE ASSEMBLIES

A. Install section insulators and other assemblies after final tensioning of the full tension length.

B. Install in compliance with KCM Standard Drawings and the manufacturer’s instructions.

C. Install in the longitudinal position shown in the Contract Drawings.

D. Minor shifts in position for optimum alignment shall be approved in the field by Owner’s Representative.

3.11 SPECIAL BRIDGE REQUIREMENTS

A. Where attaching to underside of bridge structure, provide protective cover of half-round FRP over each wire and extend 5 feet beyond end of bridge, as shown on Contract Drawings.

3.12 REPAIRS

A. Remove vertical kinks in contact wire using an adjustable contact wire de-kinking tool made for the purpose.
B. Twists in the contact wire shall be corrected.

C. Lateral kinks in the contact wire shall be removed if they affect the fit of any parts or are detrimental to ETB operation.

END OF SECTION 34 23 22
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SECTION INCLUDES:

A. Bare and PVC covered copper-clad steel wire for use as support wire.
B. Synthetic rope.

1.3 REFERENCE STANDARDS

A. This Section incorporates by reference the latest revisions of the following documents:
B. American Society for Testing and Materials (ASTM)
   1. ASTM A460, Standard Specification for Copper-Clad Steel Wire Strand
   2. ASTM B228, Standard Specification for Concentric-Lay-Stranded Copper-Clad Steel Conductors
C. King County Metro
   1. King County Department of Transportation Trolley Standards ("KCM Standard Drawings")
      a. SA drawings:  

1.4 SUBMITTALS

A. Procedures: Section 01 33 00, Submittal Procedures.
B. Manufacturer's Data:
   1. Description.
   2. Size.
   3. Type.
   5. Number of and diameter of individual wires.
   6. Overall diameter.
   7. Cross sectional area.
   8. Weight per foot.
  10. Initial and final modulus of elasticity
  11. Coefficient of thermal expansion.
13. Hardness value.

C. Shop Drawings:

D. Certification: Submit certification verifying that the proposed materials have been designed, manufactured, inspected and tested in accordance with the referenced standards and these Specifications.

E. Test Reports: Submit copies of factory test reports as required by these Specifications and referenced standards.

1.5 QUALITY ASSURANCE

A. Products shall have been manufactured within one year of date of installation.

1.6 DELIVERY, STORAGE AND HANDLING

A. Ship on reels suitable for the weight carried.

B. Each reel shall have a strong, weatherproof tag securely fastened showing the physical and mechanical properties, type designation, ASTM designation, the name and mark number of the manufacturer, and the total length and weight of the wire or synthetic rope on each reel.

C. A stripe in a contrasting color approximately one-inch wide shall be painted across the outermost layer of wire and rope on each reel. A shift in this line at time of receipt indicates relative movement of the coils during shipping and is cause for rejection.

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS

A. Copper clad steel guy wire (bare): ASTM A460.
   2. Size/Designation: 16M (KCM Standards Drawing No. SA-099, Item No. 16)
   3. Approved Manufacturer/Product: Fushi Copperweld, Type M® guy strand.
   4. Substitutions: No substitutions are permitted.

B. Copper clad steel guy wire (insulated):
   1. KCM Standards Drawing No. SA-099, Item Nos. 18 and 19.
   2. Same as bare wire but coated with 50-60 mil thickness of grey polyvinyl chloride (PVC).
   3. PVC Coating: Compound X-3676 (formerly V-131), Manner Plastics, McKinney, TX, (972) 542-6789.

C. Other Copper-Clad Wire: ASTM B228.
D. Synthetic Rope:
1. Manufactured from impregnated, continuous filament, high modulus, aramid fiber strands. Strands shall be closed right regular lay.
3. KCM Standards Drawing No. SA-099, Item No. 55
4. Approved Manufacturer/Product: Phillystran, HPTG 67001.
5. Substitutions: No substitutions are permitted.

PART 3 - EXECUTION

3.1 WIRE TYPE REQUIREMENTS

END OF SECTION 34 23 33
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SECTION INCLUDES

A. Section includes but is not limited to the following Electric Trolley Bus (ETB) OCS items:
   1. Clevis fittings
   2. Wire terminations
   3. Parallel wire and cable clamps
   4. Nuts, bolts, washers and cotter pins
   5. Dead ends
   6. Links
   7. Terminations and turnbuckles
   8. Double clevis end fittings
   9. Thimbles
  10. Strain clamps
  11. Pole bands
  12. Cable cleats and cleat supports

1.3 REFERENCE STANDARDS

A. Section incorporates by reference the latest revisions of the following documents:

B. Ferrous Metals - American Society for Testing and Materials (ASTM)
   2. ASTM A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
   3. ASTM A536, Standard Specification for Ductile Iron Castings
   4. ASTM A668/A668M, Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use
   5. ASTM A711/A711M, Standard Specification for Steel Forging Stock
   9. ASTM B248, Standard Specification for General Requirements for Wrought Copper and Copper-Alloy Plate, Sheet, Strip, and Rolled Bar
10. ASTM B249/B249M, Standard Specification for General Requirements for Wrought Copper and Copper-Alloy Rod, Bar, Shapes and Forgings


12. ASTM B584, Standard Specification for Copper Alloy Sand Castings for General Applications


C. King County Metro

1. King County Department of Transportation Trolley Standards ("KCM Standard Drawings")

1.4 SUBMITTALS

A. Procedures: Section 01 33 00, Submittal Procedures.

B. Submit for information only: Manufacturer’s written recommendations for the installation of fittings and hardware.

C. Factory production tests: Submit for tests performed.

1.5 QUALITY ASSURANCE

A. Testing:
   1. For tensile tests, a minimum of three test bars shall be poured from each lot of metal.
   2. For chemical analysis each lot of castings shall be analyzed for conformance with the chemical composition specified in the referenced American Society for Testing and Materials (ASTM) Standards.
   3. A lot consists of all castings produced from one furnace melt.
   4. All materials shall be tested as required by that material’s manufacturing standard.

1.6 DELIVERY, STORAGE AND HANDLING

A. Fittings and hardware shall be packed in accordance with the best commercial practice, adequate to ensure acceptance and safe delivery.

B. Shipping boxes, bags, or crates shall be properly marked showing the contents of each. If different materials are packaged in a single box, bag, or crate, all items of a kind shall be boxed, bagged, or crated and properly marked or tagged prior to placement in the shipping vessel.

C. OCS fittings and hardware shall be packaged and marked in a manner to allow stacking and outdoor storage until final installation with no harmful effects.
PART 2 - PRODUCTS

2.1 COMPONENT REQUIREMENTS

A. Electric trolley bus (ETB) OCS fittings and Hardware:
   1. Assemblies are identified on Contract Drawings. Provide parts shown in drawings as identified in King County Metro ETB Master Materials List, KCM Standard Drawings SA-099.

2.2 IDENTIFICATION

A. Cast the identification mark of manufacturer or foundry and the pattern number assigned by the supplier into all castings.

B. Marks and numbers shall be of a readable size, and in such a position that they will not affect the electrical or mechanical performance.

2.3 METAL CHARACTERISTICS FOR COMPONENTS AND FITTINGS

A. Malleable Iron: Grade 32510 or better conforming to ASTM A47/A47M.

B. Forged Steel: ASTM A711/A711M or A668.

C. Ductile Iron: Grade 60.40.18 or better conforming to ASTM A536.

D. Stainless Steel: ASTM A747.

E. Copper alloys: ASTM B584 and B148.

F. Copper: ASTM B248 or B249/B249M.

G. Aluminum: ASTM B26/B26M, B557 and B686/B686M.

2.4 GALVANIZING

A. Malleable iron, forged steel, and ductile iron fittings and components shall be galvanized in accordance with ASTM A153/A153M.

B. Mechanical galvanizing shall not be used.

2.5 FABRICATION

A. The designated metals shall be produced by an approved method that will meet the requirements of these Specifications.

B. Castings shall be of uniform quality and shall be made in such a manner that the material of the casting conforms to the chemical and mechanical properties prescribed in the referenced ASTM standards.

2.6 WORKMANSHP, Finish, AND APPEARANCE

A. Castings shall be free of adhering sand, voids, cracks, surface porosity, and non-uniform dimensions.
B. Material repairs shall be permitted only to the extent allowed by the referenced ASTM standards. For welding or repair of a greater magnitude, obtain approval from Owner’s Representative.

C. Malleable iron, ductile iron, forged steel and mild steel components in contact with the pole surface shall be finished to match the finish of the pole. Galvanized components shall be compatible with finish system used.

PART 3 - EXECUTION

3.1 REQUIREMENTS FOR MATERIAL USE

A. Fittings or components requiring high yield strength shall be of ductile iron.

B. Cotter, hitch, and roll pins shall be stainless steel.

3.2 INSTALLATION REQUIREMENTS

A. Installation of fittings and hardware shall be in accordance with the manufacturer’s recommendations and as shown on the Contract Drawings and KCM Standard Drawings.

B. Marks and numbers in castings shall be visible after assembly.

END OF SECTION 34 23 36
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SECTION INCLUDES

A. Installation verification, testing and pre-revenue operation of the Electric Trolley Bus Overhead Contact System (ETB OCS).

1.3 SUBMITTALS

A. Procedures: Section 01 33 00, Submittal Procedures.

B. Acceptance Test Program Plan and Procedure:
   1. Submit a detailed written Acceptance Test Program Plan and Procedure to Owner’s Representative for review at least 60 days in advance of the scheduled test.
   2. Tests covered shall include those required for testing and commissioning the ETB OCS following completion of construction, including the following:
      a. Visual Inspection of OCS/Installation Verification
      b. Acceptance and Measurements Tests
      c. Support for Pre-Revenue Trolley Tests
   3. The test procedure shall include, as a minimum:
      a. Objective and scope
      b. Equipment to be used
      c. Personnel required for the test
      d. Estimated duration of the test
      e. Pass/fail criteria
      f. Samples of report forms and data sheets showing the proposed format for test data to be used.
      g. Furnish record of weather conditions, including temperature and precipitation during actual testing, in the acceptance test documentation, for review by Owner’s Representative.

C. Safety Program
   1. Define in detail all precautions to be taken and notices, signs, and barriers to be posted concerning the safety of the public, work personnel, and equipment.
   2. Program shall define measures to be taken before, during, and following acceptance testing until normal Work is resumed.
D. Acceptance Test Reports and Data Sheets:
   1. Submit for acceptance within seven days after test is completed to Owner’s Representative’s satisfaction.
   2. Test Reports and Data Sheets shall contain all test data obtained during tests, an analysis of the data, and conclusions relating to the test pass/fail criteria outlined in the Test Procedure.
   3. A test that fails shall be repeated and any corrective action taken to pass the re-test shall be outlined in a new test report.

1.4 QUALITY ASSURANCE
   A. The Contractor shall perform the Work included in this Section in accordance with the Contractor’s Quality Control Program, as approved by Owner’s Representative.

1.5 WITNESSING OF TESTS
   A. Owner’s Representative will, at its option, witness all tests.
   B. Notify the Owner’s Representative in writing at least 30 days before each test of the date, time and location the test will be performed.
   C. If Owner’s Representative decides not to witness a test or tests, test reports shall nevertheless be submitted.
   D. The witnessing of tests shall not be considered as acceptance of test results or test reports.
   E. Test Reports and Data Sheets shall be signed by the parties responsible for performing the tests and all witnessing parties.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT
   A. Measuring tapes, poles, sticks: Non-conducting. Under no circumstances shall use of metallic or conductive measuring tapes, chains and other devices be permitted when OCS is energized.
   B. Height Measuring Gage: Insulated, telescoping.

PART 3 - EXECUTION

3.1 TEST PROCEDURES AND EQUIPMENT
   A. Acceptance measurement and test equipment will be used by the Contractor and Owner’s Representative for checking the height of the contact wire.
   B. Height Measuring Gage:
      1. Use to measure the heights of conductors and guy attachment heights, and other installed details.
      2. One height measuring gage shall be readily available for use by Owner’s Representative at any time during the construction and acceptance measurement periods.
3.2 VISUAL INSPECTION AND INSTALLATION VERIFICATION OF COMPLETED ETB OCS

A. Notice: Upon completion of all ETB OCS construction, the Contractor shall notify Owner’s Representative that the system is ready for inspection and testing.

B. Visual inspection and installation verification:
   1. At contact wire level, inspect and verify all installations for the following, at a minimum:
      a. Fit and tightness of all components.
      b. Security of supporting wires, ending fittings, split pins and locknuts.
      c. Contact wire damage including kinks, rolls, and other damage.
      d. Smooth traverse of the trolleybus harp collector through fittings.
         1) Manually hold a trolley harp against the wire as the truck traverses the route.
         2) The trolley harp assembly will be loaned from King County Transit.
   2. Correct problems, defective conditions and other deviations from the requirements of the Contract, at no additional cost, as directed by Owner’s Representative.
   3. Complete visual inspection and installation verification to Owner’s Representative’s satisfaction before starting acceptance measurements.

3.3 ACCEPTANCE MEASUREMENTS

A. Record measurements of the ETB OCS including the following, as a minimum.
   1. Height of contact wires, with respect to the roadway, at all supporting spans and at mid-span.
   2. Horizontal position of the contact wires, with respect to the curb, at all supporting spans.
   3. Heights of guy and bridle attachments, with respect to the pavement, at all supporting poles and building eye bolts.
   4. Other measurements, as directed by Owner’s Representative during the measurements test.
   5. The Contractor shall record variances to the design details and dimensions shown in the Contract Drawings, for submittal to Owner’s Representative.

B. Owner’s Representative will evaluate Acceptance Measurements to determine compliance with the design and will inform Contractor of necessary corrections.

C. Perform corrections at no additional cost to Owner.

D. After corrections, re-measure and record affected data and submit for review.

E. Complete acceptance measurements to Owner’s Representative’s satisfaction before starting pre-revenue trolley bus operation tests.

3.4 PRE-REVENUE TROLLEY BUS OPERATION TESTS

A. Coordinate with and support Owner’s Representative to energize the system and perform trolley bus operating test.
B. This test will require that a bus make six to eight runs, as a minimum, along the route, operating through all switches and over the route at varying distances from the wire centerline.

1. Objective: Check alignment of contact wire for the following:
   a. Locate dewirement-prone locations requiring further adjustment.
   b. Locate rough special work, as indicated by excessive noise, requiring further adjustment.
   c. Verify positive operation of switch control equipment.

C. Based on the results of this test, Owner’s Representative will inform Contractor of final adjustments to the alignment of contact wires and special work and adjustment of the lead on pole position switch contactors, to optimize the trolley pole operations.

D. The Contractor shall execute corrections at no additional cost to Owner.

E. After execution of corrections, re-measure and record affected data and submit for review.

F. Incorporate the final measurements in the Contractors “as-built” record documents and submit.

G. The Work of this Section will not be complete or accepted until corrections are completed and accepted by Owner’s Representative.

END OF SECTION 34 23 91