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CAST-IN-PLACE CONCRETE

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 cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.
- B. Related Requirements:
 - 1. Division 31 Section "Earth Moving" for drainage fill under slabs-on-grade.

1.3 **DEFINITIONS**

- A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.
- B. W/C Ratio: The ratio by weight of water to cementitious materials.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 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 concrete to attend, including the following:
 - a. Contractor's superintendent.
 - b. Owner's Independent testing agency.
 - c. Ready-mix concrete manufacturer responsible for concrete design mixtures..
 - d. Concrete Subcontractor.
 - e. Contractor/subcontractor's quality control supervisor.
 - f. Architect/Structural Engineer representative.
 - g. Owner's representative.
 - h. Special concrete finish Subcontractor.
 - 2. 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, vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, methods for achieving specified floor and slab flatness and levelness floor and slab flatness and levelness measurement, concrete repair procedures, and concrete protection.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. 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. Indicate amounts of mixing water to be withheld for later addition at Project site.
- C. Steel Reinforcement Shop Drawings: Placing Drawings that detail fabrication, bending, and placement in sufficient detail without reference to contract documents. Drawing shall include as a minimum the 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. The Drawings should clearly identify column grid locations, dimensions, and section cuts in sufficient detail to locate bar placement.
- D. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.
 - 1. Location of construction joints is subject to approval of the Architect.
 - 2. Contractor shall submit drawings showing construction and expansion joints for review by the Architect and design teams.
- E. Samples:
 - 1. Waterstops
 - 2. Vapor retarder.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data:
 - 1. Installer
 - 2. Manufacturer
 - 3. Testing agency.
- B. Welding certificates.
- C. Material Certificates: For each of the following, signed by manufacturers:
 - 1. Cementitious materials.
 - 2. Admixtures.
 - 3. Form materials and form-release agents.
 - 4. Steel reinforcement and accessories.
 - 5. Waterstops.
 - 6. Curing compounds.

- 7. Floor and slab treatments.
- 8. Bonding agents.
- 9. Adhesives.
- 10. Vapor retarders.
- 11. Semirigid joint filler.
- 12. Joint-filler strips.
- 13. Repair materials.
- D. Material Test Reports: For the following, from a qualified testing agency:
 - 1. Aggregates.
- E. Floor surface flatness and levelness measurements indicating compliance with specified tolerances.
- F. Field quality-control reports.
- G. Minutes of preinstallation conference.

1.7 QUALITY ASSURANCE

- A. 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.
 - 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
- B. Testing Agency Qualifications: An independent agency, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
- C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4/D 1.4M.

1.8 **PRECONSTRUCTION TESTING**

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on concrete mixtures if required.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.
- B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

1.10 FIELD CONDITIONS

- A. 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 (4.4 deg C) for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301 (ACI 301M).
 - 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.
- B. Hot-Weather Placement: Comply with ACI 301 (ACI 301M) and as follows:
 - 1. Maintain concrete temperature below 90 deg F (32 deg C) 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.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

- A. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
 - 1. ACI 301 (ACI 301M).
 - 2. ACI 117 (ACI 117M).

2.2 FORM-FACING MATERIALS

- A. Smooth-Formed Finished Concrete: Form-facing panels that provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
 - 1. Plywood, metal, or other approved panel materials.
 - 2. 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. Medium-density overlay, Class 1 or better; mill-release agent treated and edge sealed.
 - c. Structural 1, B-B or better; mill oiled and edge sealed.
 - d. B-B (Concrete Form), Class 1 or better; mill oiled and edge sealed.
 - 3. Overlaid Finnish birch plywood.

- 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. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.
- D. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation.
- E. Void Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.
- F. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch (19 by 19 mm), minimum.
- G. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.
- H. Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.
 - 1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
- I. Form Ties: Factory-fabricated, removable or snap-off glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

2.3 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.
- B. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.
- C. Steel Bar Mats: ASTM A 184/A 184M, fabricated from ASTM A 615/A 615M, Grade 60 (Grade 420), deformed bars, assembled with clips.
- D. Plain-Steel Wire: ASTM A 1064/A 1064M,.
- E. Deformed-Steel Wire: ASTM A 1064/A 1064M.
- F. Plain-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, plain, fabricated from asdrawn steel wire into flat sheets.
- G. Deformed-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, flat sheet.

2.4 REINFORCEMENT ACCESSORIES

A. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), plain-steel bars, cut true to length with ends square and free of burrs.

- B. 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, where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.

2.5 CONCRETE MATERIALS

- A. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.
- B. Cementitious Materials:
 - 1. Portland Cement: ASTM C 150/C 150M, Type I/II,.
 - 2. Fly Ash: ASTM C 618, Class C or Class F.
 - 3. Slag Cement: ASTM C 989/C 989M, Grade 100 or 120.
 - 4. Silica Fume: ASTM C 1240, amorphous silica.
- C. Normal-Weight Aggregates: ASTM C 33/C 33M, coarse aggregate or better, graded. Provide aggregates from a single source.
 - 1. Maximum Coarse-Aggregate Size: 3/4 inch (19 mm) nominal.
 - 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- D. Air-Entraining Admixture: ASTM C 260/C 260M.
- E. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and that do 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.
 - 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.
 - 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.
- F. Water: ASTM C 94/C 94M and potable.

2.6 FIBER REINFORCEMENT

A. Synthetic Macro-Fiber: Polyolefin macro-fibers engineered and designed for use in concrete, complying with ASTM C116/C 116M, Type III, 1 to 2 14 inches (25 to 57 mm long). Minimum addition rate shall be 5.0 lbs/yd3. Use of this produce shall be pre-approved by the SEOR and accepted by the GC. Explicit location for its use shall be identified.

2.7 WATERSTOPS

- A. Flexible Rubber Waterstops: CE CRD-C 513, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.
 - 1. Profile: Ribbed with center bulb.
 - 2. Dimensions: 4 inches by 3/16 inch thick (100 mm by 4.75 mm thick); nontapered.
- B. 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. Profile: Ribbed with center bulb.
 - 2. Dimensions: 4 inches by 3/16 inch thick (100 mm by 4.75 mm thick); nontapered.
- C. Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 by 1 inch (19 by 25 mm).
- D. Self-Expanding Rubber Strip Waterstops: Manufactured rectangular or trapezoidal strip, bentonite-free hydrophilic polymer-modified chloroprene rubber, for adhesive bonding to concrete, 3/8 by 3/4 inch (10 by 19 mm).

2.8 VAPOR RETARDERS

- A. Sheet Vapor Retarder: ASTM E 1745, Class A
 - 1. Water vapor permeance (ASTM E96) = 0.3 Perms
 - 2. Tensile strength (ASTM D828 or D882) = 45.0 lbf/in.
 - 3. Puncture resistance (ASTM D1709) = 5lb
 - 4. Minimum thickness = 15 mils
 - 5. Include manufacturer's recommended adhesive or pressure-sensitive tape.

2.9 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) when dry.
- C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- D. Water: Potable.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.
- F. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, nondissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering.
- G. Clear, Solvent-Borne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.

H. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.

2.10 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips:
 - 1. ASTM D 1751, asphalt-saturated cellulosic fiber
 - 2. ASTM D 1752, cork or self-expanding cork.
- B. Bonding Agent: ASTM C 1059/C 1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.
- C. 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.

2.11 REPAIR MATERIALS

- A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch (3.2 mm) and that can be feathered at edges to match adjacent floor elevations.
 - 1. Cement Binder: ASTM C 150/C 150M, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
 - 2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
 - 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch (3.2 to 6 mm) or coarse sand as recommended by underlayment manufacturer.
 - 4. Compressive Strength: Not less than 4000 psi (27.6 MPa) at 28 days when tested according to ASTM C 109/C 109M.
- B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch (6.4 mm) and that can be filled in over a scarified surface to match adjacent floor elevations.
 - 1. Cement Binder: ASTM C 150/C 150M, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
 - 2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
 - 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch (3.2 to 6 mm) or coarse sand as recommended by topping manufacturer.
 - 4. Compressive Strength: Not less than 5000 psi (34.5 MPa) at 28 days when tested according to ASTM C 109/C 109M.

2.12 CONCRETE MIXTURES, GENERAL

- A. 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 (ACI 301M).
 - 1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.
- B. Cementitious Materials: Use fly ash, pozzolan, slag cement, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 15 percent.
- C. Limit water-soluble, chloride-ion content in hardened concrete to 0.30 percent by weight of cement.
- D. 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 required to be watertight, and concrete with a w/c ratio below 0.50.
 - 4. Use corrosion-inhibiting admixture in concrete mixtures where indicated.
- E. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

2.13 CONCRETE MIXTURES FOR BUILDING ELEMENTS

- A. Footings, Tie Beams, Stem Walls, Grade Beams, Interior Concrete Walls: Normal-weight concrete.
 - 1. Minimum Compressive Strength: 4000 psi (27.6 MPa) at 28 days.
 - 2. Maximum W/C Ratio: 0.45.
 - 3. Minimum Cementitious Materials Content: 550 lb/cu. yd. (326 kg/cu. m).
 - 4. Slump Limit: 4 inches (100 mm) or 8 inches (200 mm) for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch (25 mm).
 - 5. Air Content: 6 percent, plus or minus 1.0 percent at point of delivery for 3/4-inch (19-mm) nominal maximum aggregate size.
- B. Interior Slabs-on-Grade: Normal-weight concrete.
 - 1. Minimum Compressive Strength: 4000 psi (27.6 MPa) at 28 days.
 - 2. Maximum W/C Ratio: 0.45.
 - 3. Minimum Cementitious Materials Content: 550 lb/cu. yd. (326 kg/cu. m).
 - 4. Slump Limit: 4 inches (100 mm), plus or minus 1 inch (25 mm).
 - 5. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.
- C. Concrete over steel deck: Normal-weight concrete.

- 1. Minimum Compressive Strength: 4000 psi (27.6 MPa) at 28 days.
- 2. Maximum W/C Ratio: 0.45.
- 3. Minimum Cementitious Materials Content: 550 lb/cu. yd. (326 kg/cu. m).
- 4. Slump Limit: 4 inches (100 mm) or 8 inches (200 mm) for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch (25 mm).
- 5. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.
- D. All other concrete: Normal-weight concrete.
 - 1. Minimum Compressive Strength: 4000 psi (27.6 MPa) at 28 days.
 - 2. Maximum W/C Ratio: 0.45.
 - 3. Slump Limit: 4 inches (100 mm) or 8 inches (200 mm) for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch (25 mm).
 - 4. Air Content: 6 percent, plus or minus 1.0 percent at point of delivery for 3/4-inch (19-mm) nominal maximum aggregate size.

2.14 FABRICATING REINFORCEMENT

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

2.15 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and ASTM C 1116/C 1116M, and furnish batch ticket information.
 - 1. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 FORMWORK INSTALLATION

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301 (ACI 301M), 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 (ACI 117M).
- C. Limit concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:
 - 1. Class A, 1/8 inch (3.2 mm) for smooth-formed finished surfaces.
 - 2. Class C, 1/2 inch (13 mm) for rough-formed finished surfaces.

- D. Construct forms tight enough to prevent loss of concrete mortar.
- E. Construct 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.
- F. 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.
- G. 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.
- H. Chamfer exterior corners and edges of permanently exposed concrete.
- I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
- J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 EMBEDDED ITEM INSTALLATION

- 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 303.
 - 2. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
 - 3. Install dovetail anchor slots in concrete structures as indicated.

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 (10 deg C) for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations, and curing and protection operations need to be maintained.

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

3.4 VAPOR-RETARDER INSTALLATION

- A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E 1643 and manufacturer's written instructions.
 - 1. Lap joints 6 inches (150 mm) and seal with manufacturer's recommended tape.

3.5 STEEL REINFORCEMENT INSTALLATION

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting 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 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.
 - 1. Weld reinforcing bars according to AWS D1.4/D 1.4M, where indicated.
- 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.

3.6 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 approved by Structural Engineer.

- 1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated.
- 2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete.
- 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.
- C. Control Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct control joints for a depth equal to at least one-fourth of concrete thickness as follows:
 - 1. Grooved Joints: Form control joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch (3.2 mm). Repeat grooving of control joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
 - 2. Sawed Joints: Form control joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3.2-mm-) wide joints into concrete when cutting action does 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 (13 mm) or more than 1 inch (25 mm) below finished concrete surface where joint sealantsare 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.

3.7 WATERSTOP INSTALLATION

- 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.
- B. Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated, according to manufacturer's written instructions, adhesive bonding, mechanically fastening, and firmly pressing into place. Install in longest lengths practicable.

3.8 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections are completed.
- B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect.
- C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301 (ACI 301M).
 - 1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is 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 or approved by structural engineer. Deposit concrete to avoid segregation.
 - 1. Deposit concrete in horizontal layers of depth not to 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 (ACI 301M).
 - 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 (150 mm) 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.
- E. 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.
 - 2. Maintain reinforcement in position on chairs during concrete placement.
 - 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.

3.9 FINISHING FORMED SURFACES

- A. 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.

- B. 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, to receive a rubbed finish, or to be covered with a coating or covering material applied directly to concrete.
- C. Rubbed Finish: Apply the following to smooth-formed-finished as-cast concrete where indicated:
 - 1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
 - 2. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix 1 part portland cement to 1-1/2 parts fine sand with a 1:1 mixture of bonding admixture and water. Add white portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.
 - 3. Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix 1 part portland cement and 1 part fine sand with a 1:1 mixture of bonding agent and water. Add white portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.
- D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.10 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. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch (6 mm) in one direction.
 - 1. Apply scratch finish to surfaces indicated and to receive concrete floor toppings.
- C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.
 - 1. Apply float finish to surfaces indicated to receive trowel finish and to be covered with fluidapplied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.
- D. 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 indicated or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
- 2. Finish surfaces to the following tolerances, according to ASTM E 1155 (ASTM E 1155M), for a randomly trafficked floor surface:
 - a. Specified overall values of flatness, F(F) 25; and of levelness, F(L) 20; with minimum local values of flatness, F(F) 17; and of levelness, F(L) 15.
 - b. 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.
 - c. Specified overall values of flatness, F(F) 25; with minimum local values of flatness, F(F) 17; for elevated concrete over steel deck.
- E. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces indicated where ceramic or quarry tile is to be installed by either thickset or thinset method. While concrete is still plastic, slightly scarify surface with a fine broom.
 - 1. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.
- F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and elsewhere as indicated.
 - 1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiberbristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.
- G. Slip-Resistive Finish: Before final floating, apply slip-resistive aggregate finish where indicated and to concrete stair treads, platforms, and ramps. Apply according to manufacturer's written instructions and as follows:
 - 1. Uniformly spread 25 lb/100 sq. ft. (12 kg/10 sq. m) of dampened slip-resistive aggregate over surface in one or two applications. Tamp aggregate flush with surface, but do not force below surface.
 - 2. After broadcasting and tamping, apply float finish.
 - 3. After curing, lightly work surface with a steel wire brush or an abrasive stone and water to expose slip-resistive aggregate.
- H. Dry-Shake Floor Hardener Finish: After initial floating, apply dry-shake floor hardener to surfaces according to manufacturer's written instructions and as follows:
 - 1. Uniformly apply dry-shake floor hardener at a rate of 100 lb/100 sq. ft. (49 kg/10 sq. m) unless greater amount is recommended by manufacturer.
 - 2. Uniformly distribute approximately two-thirds of dry-shake floor hardener over surface by hand or with mechanical spreader, and embed by power floating. Follow power floating with a second dry-shake floor hardener application, uniformly distributing remainder of material, and embed by power floating.
 - 3. After final floating, apply a trowel finish. Cure concrete with curing compound recommended by dry-shake floor hardener manufacturer and apply immediately after final finishing.

3.11 MISCELLANEOUS CONCRETE ITEM INSTALLATION

- A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. 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.
- C. Equipment Bases and Foundations:
 - 1. Coordinate sizes and locations of concrete bases with actual equipment provided.
 - Construct concrete bases 4 inches (100 mm) high unless otherwise indicated, and extend base not less than 6 inches (150 mm) in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated or unless required for seismic anchor support.
 - 3. Minimum Compressive Strength: 4000 psi (27.6 MPa) at 28 days.
 - 4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 12-inch (305-mm) centers around the full perimeter of concrete base.
 - 5. Prior to pouring concrete, place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 6. Cast anchor-bolt insert into bases. Install anchor bolts to elevations required for proper attachment to supported equipment.
- D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel finish concrete surfaces.

3.12 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 (ACI 301M) 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 (1 kg/sq. m 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 remainder of 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 (300-mm) 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 (300 mm), 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 does 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.
 - a. Removal: If curing compounds are used on surfaces (exterior or interior, formed or unformed) that are scheduled or specified to receive surface-adhered treatment (including but not limited to cementitious toppings/overlays, adhesive applied carpet, resilient flooring, terrazzo, thin-set ceramic tile/stone, wood, coatings, paint, waterproofing, membranes, athletic flooring, epoxy overlay/adhesive, hardeners, sealers, water repellents, or other covering system adhered with water-based adhesive), then the following requirements apply:
 - 1) Remove curing compound no later than 7 days after end of curing period by mechanical bead blast process acceptable to Architect.
 - 2) Allow sufficient additional time after curing compound removal to achieve proper concrete moisture and/or water vapor limitation for successful application of subsequent surface treatment as specified in appropriate surface treatment specification Section.
 - b. Do not use curing compounds at concrete surfaces that are to receive the following finishes:
 - 1) Penetrating liquid floor hardener and sealer.
 - 2) Polished concrete.
 - 3) Chemical stain.
- 4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a 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. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.13 LIQUID FLOOR TREATMENT APPLICATION

- A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment according to manufacturer's written instructions.
 - 1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
 - 2. Do not apply to concrete that is less than seven days' old.
 - 3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing. Rinse with water; remove excess material until surface is dry. Apply a second coat in a similar manner if surface is rough or porous.
- B. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller according to manufacturer's written instructions.

3.14 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(s). 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 joints clean and dry.
- C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches (50 mm) deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.15 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.
- B. Patching Mortar: Mix dry-pack patching mortar, consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing a No. 16 (1.18-mm) 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.
 - Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch (13 mm) in any dimension to solid concrete. Limit cut depth to 3/4 inch (19 mm). Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat 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 matches 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 Architect.
- 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 (0.25 mm) 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 receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
 - 5. 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 (6 mm) 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.
 - 6. Repair defective areas, except random cracks and single holes 1 inch (25 mm) 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 (19-mm) 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.
 - 7. Repair random cracks and single holes 1 inch (25 mm) 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 Architect's approval, using epoxy adhesive and patching mortar.
- F. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.16 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Inspections:
 - 1. As indicated on contract documents.
- C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172/C 172M 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. (4 cu. m), but less than 25 cu. yd. (19 cu. m), plus one set for each additional 50 cu. yd. (38 cu. m) or fraction thereof.
 - 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/C 231M, 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 (4.4 deg C) and below or 80 deg F (27 deg C) and above, and one test for each composite sample.
 - 5. Compression Test Specimens: ASTM C 31/C 31M.
 - a. Cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
 - b. Cast and field cure one set of three standard cylinder specimens for each mix per day.
 - 6. Compressive-Strength Tests: ASTM C 39/C 39M; test one of three laboratory-cured specimens at 7 days and one of two specimens at 28 days. Retain the third specimen for low breaks and evaluation if other specimens fail.
 - 7. 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 (3.4 MPa).
 - 8. Test results shall be reported in writing to Architect, 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 or as directed.
 - 9. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
 - 10. 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 Architect/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 Architect/Engineer.

- 11. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements. If the contractor chooses to request additional specimens to test for early breaks, the cost shall be paid by the contractor requesting the additional tests.
- 12. The contractor shall correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents at no additional cost to the owner.
- D. Measure floor and slab flatness and levelness according to ASTM E 1155 (ASTM E 1155M) within 72 hours of finishing.

3.17 PROTECTION OF LIQUID FLOOR TREATMENTS

A. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.

END OF SECTION 03 3000

SECTION 03 30 00.01 CAST-IN-PLACE CONCRETE FOR LANDSCAPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Cast-in-place concrete footings and foundations.
- B. Control, expansion and contraction joint devices associated with concrete work, including joint sealants.

1.2 RELATED SECTIONS

- A. SECTION 03 35 19 Decorative Concrete Paving
- B. SECTION 03 45 01 Site Structures Precast Concrete

1.3 REFERENCES

- A. American Concrete Institute (ACI):
- 1. 301 Structural Concrete for Buildings.
- 2. 302 Guide for Concrete Floor and Slab Construction.
- 3. 304 Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.
- 4. 305R Hot Weather Concreting.
- 5. 306R Cold Weather Concreting.
- 6. 308 Standard Practice for Curing Concrete.
- 7. 318 Building Code Requirements for Reinforced Concrete.
 - B. American Society for Testing and Materials (ASTM):
- 1. D 994 Preformed Expansion Joint Filler for Concrete (Bituminous Type).
- 2. D 1190 Concrete Joint Sealer, Hot-Poured Elastic Type.
- 3. D 1751 Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types).
- 4. D 1752 Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
- 5. B 221 Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes.
- 6. C 33 Concrete Aggregates.
- 7. C 94 Ready-Mixed Concrete.
- 8. C 150 Portland Cement.
- 9. C 260 Air Entraining Admixtures for Concrete.
- 10. C 330 Light Weight Aggregates For Structural Concrete.
- 11. C 494 Chemicals Admixtures for Concrete.
- 12. C 618 Fly Ash and Raw or Calcinated Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.

1.4 SUBMITTALS

- A. Product Data: Provide data on joint devices, attachment accessories and admixtures.
- B. Manufacturer's Installation Instructions: Indicate installation procedures and interface required with adjacent Work.
- 1. Accepted sample becomes the standard of acceptance of the work.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with ACI 301.
- B. Acquire cement and aggregate from same source for all work.
- C. Conform to ACI 305R when concreting during hot weather.
- D. Conform to ACI 306R when concreting during cold weather.

1.6 COORDINATION

- A. Coordinate work with other work proposed on site.
- B. Coordinate the placement of joint devices with erection of concrete form work and placement of form accessories.

PART 2 - PRODUCTS

1.1 CONCRETE MATERIALS

- A. Cement: ASTM C 150, Type I, II or III for general work.
- B. Aggregates: ASTM C 33.
- 1. Odot Type 'A' Aggregate.
 - 2. Coarse Aggregate: General Work: Size No. 57 (1" to No. 4).
 - 3. Fine Aggregate: ASTM C 33; dune, bank-run and manufactured sands not acceptable.
 - C. Water: Clean and not detrimental to concrete.

1.2 ADMIXTURES

- A. Air Entrainment: ASTM C 260.
- B. Chemical: ASTM C 494, Type C Accelerating
- C. Water-Reducing: ASTM C 494, Type A (water reducing) or Type D Water Reducing and Retarding.

1.3 FORM MATERIALS

- A. STRIP FORMS:
 - 1. Approved type plywood, metal, metal framed plywood, plastic overlaid plywood, wood or other type panel materials of maximum panel size and strength to resist movement during concrete placement, to retain horizontal and vertical alignment until removed, and to minimize number of joints.
 - a. Plywood: PS 1-83; APA B-B plyform Class I; factory sanded faces; factory mill-oiled and edge sealed.
 - b. Plastic Overlaid Plywood: PS 1; APA High Density Overlaid Plyform Class I; factory sealed edges; both faces factory sanded and coated with hard, smooth, semi-opaque surface of thermosetting, resin impregnated material forming durable, continuous bond with plywood.
 - c. Metal-Framed Plywood: Matched, tight fitting type approved prior to use or purchase.
 - d. Steel: Minimum 16 gage sheet well matched, tight fitting, stiffened to support concrete weight without deflection detrimental to tolerances and appearance of finished surfaces.

B. Form Accessories:

1. Form Coating: Commercial formulated type that will not bond with, stain, nor adversely affect concrete surfaces, which will not impair subsequent treatment of concrete surfaces requiring bond or adhesion, nor impede wetting of surfaces to be cured with water or curing compounds.

1.4 CONCRETE PROPORTIONING AND DESIGN MIXES

03 30 00.01 - 2

- A. General
- 1. Proportion materials by weight or volume. Use measuring methods that are adjustable, controlled and easily checked.
 - a. Cement: Measure by weight on scale or weight hopper separate and distinct from those used for other materials.
 - b. Coarse and Fine Aggregate: Measure by weight. Include weight of dry material plus total weight of absorbed and surface moisture contained in aggregate.
 - c. Mixing Water: Measure by Weight or volume. Include water contained in aggregate, water introduced in form of admixtures, and water added to batch.
 - d. Admixtures: measure powdered admixtures by weight, and paste or liquid admixtures by weight or volume.
 - B. Normal Weight Portland Cement Concrete
- 1. Min. 28 Day Compressive Strength: 3,500 psi.
- 2. Slump Range (In Inches): 2 to 4.
- 3. Admixture Required: As required and approved.
- 4. Min. Sacks Cement per Cu. Yd.: 5
 - C. Use accelerating admixtures in cold weather only when approved by Landscape Architect. Use of admixtures will not relax cold weather placement requirements.
 - D. Use set retarding admixtures during hot weather only when approved by Landscape Architect.
 - E. Add air entraining agent to normal weight concrete mix for work exposed to exterior.

PART 3 - EXECUTION

1.1 PLACING CONCRETE

- A. Place concrete in accordance with ACI 304.
- B. Notify Landscape Architect a minimum 24 hours prior to commencement of operations.
- C. Vibrate concrete into seatwall forms.

1.2 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed in accordance with ACI 301.
- B. Provide free access to Work and cooperate with appointed firm.
- C. Submit proposed mix design to and testing firm for review prior to commencement of Work.
- D. Tests of cement and aggregates may be performed to ensure conformance with specified requirements.

END OF SECTION

SECTION 03 35 19 DECORATIVE CONCRETE PAVING

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

- A. This section includes the complete installation of colored concrete paving and coping as indicated on the Drawings including:
 - 1. Materials: Forming materials, reinforcement, concrete, dryshake color hardener, curing compound, release agent, and sealer.
 - 2. Special imprinting and texturing tools.
 - 3. Concrete placement and finish.
 - 4. Color hardener and release agent placement.
 - 5. Pressure washing to remove excess release agent.
 - 6. Curing compound application.
 - 7. Sealer application.

1.02 RELATED SECTIONS

- A. SECTION 32 91 19 Landscape Grading: Excavation of subsoil and backfill of over excavated or fill areas.
- B. SECTION 03 30 00 Cast-In-Place Concrete for Landscaping

1.03 REFERENCES AND STANDARDS

- A. AMERICAN CONCRETE INSTITUTE (ACI):
 - 1. 301 Structural Concrete for Buildings
 - 2. 304 Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.

B. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM):

- 1. A615 Deformed and Plain Billet Steel Bars for Concrete Reinforcement.
- 2. C33 Concrete Aggregates.
- 3. C94 Ready Mix Concrete.
- 4. C143 Slump of Hydraulic Cement Concrete.
- 5. C150 Portland Cement.
- 6. C171 Sheet Materials for Curing Concrete.
- 7. C172 Sampling Fresh Concrete.
- 8. C173 Air Content of Freshly Mixed Concrete by Volumetric Method.
- 9. C231 Air content of Freshly mixed Concrete by the Pressure Method.
- 10. C260 Air-Entraining Admixtures for Concrete.
- 11. C309 Liquid Membrane-Forming Compounds for Curing Concrete.
- 12. C494 Chemical Admixtures for Concrete.
- 13. C509 Elastomeric Cellular Preformed Gasket and Sealing Material.
- 14. D698 Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, Using 5.5 lb. (2.49 Kg) Rammer and 12 inch (304.8 mm) Drop.
- 15. D1556 Test Method for Density of Soil in Place by the Sand-Cone Method.
- 16. D1557 Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10 lb (4.54 Kg) Rammer and 18 inch (457 mm) Drop.
- 17. D1751 Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction.
- 18. D2922 Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
- 19. D3017 Test Methods for Moisture Content of Soil and Soil-Aggregate Mixtures.

1.04 QUALITY ASSURANCE

- A. Criteria: The work shall include all labor, material, equipment and transportation required to install surface colored concrete paving. The Contractor shall have more than 7 years experienced in the construction of shake applied colored and textured concrete paving. The Contractor shall is required to provide a foreman or supervisor who has done at least three similar installations of high quality.
- B. Work shall be performed according to the American Concrete Institutes standards and practices.

- C. Perform work in accordance with ACI 301 requirements of SECTION: Cast-in-Place Concrete.
- D. Obtain cementitious materials from same source throughout.
- E. Pre qualified contractors include the following"1. Bomanite of Oklahoma, Oklahoma City, OK 405.842.6262.

1.05 SUBMITTALS

- A. Submit as guided in the Front end specifications and SECTION: Submittals
- B. Product Data: Provide data on joint filler, bond breaker, joint sealant, admixtures, color hardener, release agent, and seamless texture.
 - 1. Concrete type "1": Colored Concrete Sandscape texture, by Bomanite Corporation, Madera, CA, (559) 673-2411.
 - 2. Concrete type "2": Colored Concrete Reveal by Bomanite Corporation, Madera, CA, (559) 673-2411.
 - 3. Concrete type "3": Colored Concrete Reveal by Bomanite Corporation, Madera, CA, (559) 673-2411.
 - 4. Concrete type "4" Colored Concrete Reveal by Bomanite Corporation, Madera, CA, (559) 673-2411.
 - 5. Decorative paving types, colors, and textures to match existing paving at the adjacent Outpatient Building on site.
- C. Samples:
 - 1. Colored Concrete Paving: Provide two samples of colored concrete for "A", "B", "C". The Owner and Landscape Architect shall determine which panel shall be used as the standard. Two color samples , "A", "B", "C", "D" shall be as follows:
 - a. "1" –Sandscape Color Blend EX-SSR-110-112-14 and EX-SSR-112-13: TBD by Landscape Architect Neutral Earth Tone to Match Building.
 - b. "2" –Color Reveal EX-RV-080211-05: TBD by Landscape Architect Neutral Earth Tone to Match Building.
 - c. "3" –Color Reveal EX-RV-080211-16: TBD by Landscape Architect Neutral Earth Tone to Match Building.
 - d. "4" –Color Reveal EX-RV-080211-18 TBD by Landscape Architect –Neutral Earth Tone to Match Building.
- e. Test Results: Submit test results within five calendar days of receipt.

1.06 ENVIRONMENTAL REQUIREMENTS

A. Placing During Cold Weather: Concrete placement shall be discontinued when the air temperature reaches 40 degrees F. and is falling. Placement may begin when air temperature reaches 35 degrees F. and is rising. Provisions shall be made to protect the concrete from freezing during the specified curing period. If necessary to place concrete when the temperature of the air, aggregates, or water is below 35 degrees, F., placement shall be approved in writing. Approval shall be contingent upon full conformance with the following provisions. The underlying material shall be prepared and protected so that it is entirely free of frost when the concrete is deposited. Mixing water and aggregates shall be heated as necessary to result in the temperature of the in-place concrete being between 50 and 85-degree F. Method and equipment for heating shall be approved. The aggregates shall be free of ice, snow, and frozen lumps before entering the mixer. Covering and other means shall be provided for maintaining the concrete at a temperature of at least 50 degrees F. for not less than 72 hours after placing, and at a temperature above freezing for the remainder of the curing period.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Concrete: The concrete shall have a minimum compressive strength of 3,500 psi. Portland cement shall conform to ASTM C150, Type I. Aggregates shall conform to ASTM C33. Sand shall comply with ASTM C33. Mixing water shall be fresh, clean and potable. An air-entraining agent complying with ASTM C260 shall be used to achieve entrained air content for the particular concrete mix used in accordance with the published recommendations of the Portland Cement Association and the American Concrete Institute. A normal-set or retarded-set water reducing admixture complying with ASTM C494 may be used. Nothing containing calcium chloride is permitted in the mix. High range water reducing admixture shall comply with C494.
- B. Color Hardener and Release Agent: The color hardener and release agent shall match the approved submittal samples.
- C. Form Materials
 - 1. Form Materials: Conform to ACI 301 as specified in SECTION: Cast-In-Place Concrete.
 - 2. Formwork shall be designed and constructed to insure that the finished concrete will conform accurately to the indicated dimensions, lines, and elevations, and within the tolerances specified. Forms shall be of wood or steel, straight, of sufficient strength to resist springing during depositing and consolidating concrete. Wood forms shall be surfaced plank, straight and free from warp, twist, loose knots, splits or other defects. Steel forms shall be channel formed sections with a flat top surface and with welded braces at each end and at not less than two intermediate points. Ends of steel forms shall include be interlocking and self-aligning. Steel forms shall include flexible forms for radius forming, corner forms, form spreaders, and fillers.
 - 3. Sidewalk forms shall be of a height equal to the full depth of the finished sidewalk.
- D. Reinforcing Steel:
 - 1. ASTM A615; 40 ksi (276 MPa) yield grade; deformed billet steel bars; unfinished.
 - 2. Dowels: ASTM A615; 40 ksi (276 MPa) yield grade, plain smooth steel, unfinished galvanized finish, greased with a metal cap.
- E. Crusher Run: Coarse Screenings: 703.04 Cover for Pipe Underdrains Coarse cover aggregate, screenings, gravel or crushed stone.
- F. Joint Filler Materials Preformed Expansion Joint Filler: Filler shall consist of 3/8-inch thick preformed strips made of cane or other suitable fibers of a cellular nature securely bound together and then uniformly saturated with asphalts. Filler shall conform to ASTM D1751.
- G. Joint Sealers:
 - 1. A two-part polysulfide or two-part urethane self leveling type cold applied compound.
 - 2. Joint sealer shall match color of adjacent concrete.
- H. Bond Breakers
 - Blocking Media Compressible, non-shrinkable, nonreactive with joint sealant and nonabsorption type such as plastic rod or neoprene-grade closed cellular cord, free of oils or bitumens. Blocking media shall have water absorption of not more than 5 percent by weight when tested in accordance with ASTM C509. Blocking media shall be consistent with joint seal manufacturer's installation instructions and be at least 25 percent larger in diameter than width of joints.
 - 2. Separating Tape Pressure sensitive aluminum foil, polyethylene or polyester tape, 3 mil minimum thickness, or masking tape, nonreactive, nonabsorptive, adhesive back tape, width equal to width of joints. Separating tape shall be consistent with joint seal manufacturer's installation instructions.

2.02 CONCRETE MIX

A. Mix and deliver concrete in accordance with ASTM C94.

- 1. Mix and deliver concrete in accordance with ASTM C94-94.
- 2. Provide concrete to the following mix design:

<u>Unit</u> Compressive Strength (28 day) ASTM Stone Size Water/cement ratio Slump Range Air Entrained <u>Measurement</u> 3,500 psi #67 0.51 3-6inches 5-7 percent

- B. Refer to paragraph 2.01.B for Color Hardener and Release Agent.
- C. Use accelerating admixtures in cold weather only when approved by the Landscape Architect. Use of admixtures will not relax cold weather placement requirements.
- D. Use set retarding admixtures during hot weather only when approved by Landscape Architect.

2.03 SOURCE QUALITY CONTROL AND TESTS

- A. SECTION: Quality Control.
- B. Submit proposed mix design for sidewalks before commencement of work.
- C. Tests on cement and aggregates will be performed to ensure conformance with specified requirements.
- D. Test samples in accordance with ACI 301.

PART 3 - EXECUTION

- 3.01 EXAMINATION
 - A. Examine installation areas. Report unsatisfactory conditions in writing to Landscape Architect. Do not continue until unsatisfactory conditions have been corrected.
 - B. Starting installation constitutes acceptance of condition or satisfactory for installation of stamped colored concrete by Contractor, who shall correct damage and defects or unsatisfactory work at no additional cost.
- 3.02 BACKFILLING
 - A. Employ a placement method that does not disturb or damage other work.
 - B. Maintain optimum moisture content of backfill materials to attain required compaction density.
 - C. Make gradual grade changes. Blend the slope into level areas.
 - D. Remove surplus aggregate backfill material from the site.
 - E. Leave fill material stockpile areas free of excess fill materials.
 - F. Subgrade shall be maintained in a smooth, compacted condition. Moisten base to minimize absorption of water from fresh concrete.
 - G. Coat surfaces of manholes and valve box frames with oil to prevent bond with concrete pavement.
 - H. Compact the subgrade to a 95% compaction density. Receive test results prior to placement of concrete.
 - I. Notify the Landscape Architect a minimum 24 hours before commencement of concreting operations.

3.03 AGGREGATE PLACEMENT

- A. Spread aggregate over a prepared substrate to a total compacted thickness as shown on Drawings.
- B. Place aggregate to a compacted depth of 2 or 4 inches as shown in the Contract Documents and roller compact to 95% density.
- C. Level and contour surfaces to elevations and gradients indicated.

- D. Add fine aggregate to coarse aggregate as appropriate to assist compaction.
- E. Add water to assist compaction. If excess water is apparent, remove aggregate and aerate to reduce moisture content.
- F. Use mechanical tamping equipment in areas inaccessible to compaction equipment.
- G. Provide density test for each 800 square feet of area

3.04 FORMING

- A. Forms shall be carefully set to the indicated alignment, grade and dimensions. Forms shall be held rigidly in place. Corners and deep sections shall have additional stakes and braces, as required. Clamps, spreaders, and braces shall be used where required to insure rigidity in the forms. Forms shall be removed without injuring the concrete. Bars or heavy tools shall not be used against the concrete in removing the forms. Any concrete found defective after form removal shall be promptly and satisfactorily repaired.
- B. Forms shall be cleaned and coated with form oil each time before concrete is placed. Wood forms may, instead, be thoroughly wetted with water before concrete is placed, except that with probable freezing temperatures, oiling is mandatory.
- C. Forms for sidewalks shall be set with the upper edge true to line and grade with an allowable tolerance of 1/8-inch in any 10-foot long section. After forms are set, grade and alignment shall be checked with a 10-foot straight edge. Forms shall have transverse slope as indicated per foot with the low side next to the street. Side forms shall not be removed for 12 hours after finishing has been completed.
- D. Place joint filler vertical in position, in straight lines. Secure to formwork during concrete placement.

3.05 REINFORCEMENT

- A. Support reinforcement with plastic chairs so reinforcement will remain in the center of the pavement section. Chairs shall be placed at the sides and in the center of the reinforcement grid. Reinforcement shall be in the center of the concrete paving section.
- B. Interrupt reinforcement at expansion joints.
- C. Place dowels to achieve pavement and curb alignment as detailed.
- D. Provide doweled joints at spacing shown on Drawings, at expansion joints with one end of dowel greased and capped to allow longitudinal movement.

3.06 PLACING CONCRETE

- A. Concrete Work:
 - 1. Place concrete as specified in SECTION: Cast-In-Place Concrete.
 - 2. Ensure reinforcement, inserts, embedded parts, and formed joints are not disturbed during concrete placement.
 - 3. Place concrete continuously over the full width of the panel and between predetermined construction joints. Do not break or interrupt successive pours such that cold joints occur.
 - 4. Apply color hardener evenly to the surface of the fresh concrete by the dry-shake method using a minimum of 60 pounds per 100 square feet. It shall be applied in two or more shakes, floated after each shake and troweled only after the final floating.
 - 5. The release agent shall be applied evenly to the troweled surface prior to imprinting
 - 6. While the concrete is still in its plastic stage of set apply imprinting tools to the concrete surface.

3.07 FINISHING

A. Paved Areas:

- 1. Colored Concrete Paving shall be buffed to provide a light nonslip texture.
- 2. Direction of texturing as directed by the Landscape Architect.

- B. Edge Finishing: All slab edges, including those at formed joints shall be finished with an edger having a radius of 1/4-inch.
- C. Unacceptable finishes which do not match the integrity of the approved examples at the median areas and corners or edges that have crumbled and areas with lack sufficient concrete shall be replaced in their entirety to the closest expansion joint.

3.08 JOINTS

- A. Saw Joints: Joint layout is as shown on Drawings. Depth shall be 1-inch.
- B. Expansion Joints: Expansion joint layout is shown on Drawings. Expansion joints shall be formed about all structures and features which project through or into the sidewalk pavement, using joint filler of the type, thickness and width indicated on the Drawings.
 - 1. Separate poured in place concrete pavements with 3/8-inch thick joint filler.
 - 2. Place joint filler in pavement pattern placement sequence. Set top to required elevations. Secure to resist movement by wet concrete.
 - 3. Extend joint filler from bottom of pavement to the distance required for bond breaker. Bond break shall be continuous and a minimum of 1/2-inch between top of bond breaker and walk surface.
 - 4. Place 3/8"-inch continuous bead of joint surface sealant to 1/2-inch below walk surface.

3.09 CURING

A. General Requirements: Concrete shall be protected against loss of moisture and rapid temperature changes for at least 7 days from the beginning of the curing operation. Unhardened concrete shall be protected form rain and flowing water. All equipment needed for adequate curing and protection of the concrete shall be on hand and ready for use before actual concrete placement begins. Protection shall be provided as necessary to prevent cracking of the pavement due to temperature changes during the curing period. Cure concrete by the mat method, impervious sheeting method or membrane curing method according to ACI guidelines.

3.10 PROTECTION

- A. Immediately after placement, protect pavement from premature drying, excessive hot or cold temperatures, graffiti and mechanical injury.
- B. Do not permit pedestrian traffic over pavement until 75 percent design strength of concrete has been achieved.

3.11 CLEAN UP

A. Clean all concrete surfaces in the project area from construction debris and stains.

3.12 FINAL ACCEPTANCE

A. Concrete surfaces shall be reviewed by the Landscape Architect to verify compliance with the approved sample and any deficiencies in appearance will be identified. Areas that exhibit excessive cracking, discoloration, form marks, graffiti or tool marks or which are otherwise inconsistent with the overall appearance of the work and not matching the finish of the approved sample shall be removed and replaced.

3.13 TOLERANCES

- A. Refer to SECTION Quality Assurance.
- B. Top Surface of Backfilling Under Paved Areas: Plus or minus 1-inch from required elevations.
- C. Top Surface of General Backfilling: Plus or minus 1-inch from required elevations.
 - 1. Verify compacted Subgrade aggregate base course is acceptable and ready to support paving and imposed loads.
 - 2. Verify gradients and elevations of base are correct. Subgrade shall be tested for grade and cross section with a template extending the full width of the sidewalk and supported between side forms.

- D. Course Aggregate Fill:
 - 1. Flatness: Maximum variation of 1/4-inch measured with 10 foot straight edge.
 - 2. Scheduled Compacted Thickness: Within 1/4-inch.
 - 3. Variation From Design Elevation: Within 1/4-inch.
- E. Concrete Paving Tolerances:
 - 1. Maximum Variation of Surface Flatness: 5/16-inch in 10 feet.
 - 2. Maximum Variation from True Position: 1/4-inch.
 - 3. Maximum Variation in Section Thickness: 1/4-inch.

3.14 FIELD QUALITY CONTROL

- A. SECTION: Quality Assurance: Field inspection and testing.
- B. General Requirements: Perform the inspection and tests described and meet the specified requirements for inspection details and frequency of testing. Based upon the results of these inspections and tests, the proper action shall be taken and reports submitted as required and additional tests performed to insure the requirements of this specification is met.
- C. Fill and Backfill Material Testing: Perform one of each of the following tests for each material used. Provide additional tests for each source change.
 - 1. Fill and Backfill Material Testing: Test moisture density relations in accordance with ASTM D698 or ASTM D1557.
 - 2. Density Tests: Test density in accordance with ASTM D1556 or ASTM D2922 and ASTM D3017. When ASTM D2922 and ASTM D3017 density tests are used, verify density test results by performing an ASTM D1556 density test at a location already ASTM D2922 and ASTM D3017 tested as specified herein. Perform an ASTM D1556 density test at the start of the job, and for every ASTM D2922 and ASTM D3017 density test thereafter, test each lift at randomly selected locations every 600 square feet of existing grade in fills for concrete slabs.
 - 3. If tests indicate Work does not meet specified requirements, remove Work, replace and retest.
- D. Concrete Testing
 - Strength Testing: Provide molded concrete specimens for strength tests. Samples of concrete placed each day shall be taken not less than once a day or less than once for every 250 cubic yards of concrete. The samples for strength shall be taken in accordance with ASTM C172. Cylinders for acceptance shall be molded in conformance with ASTM C31. Each strength test result shall be the average of two test cylinders from the same concrete sample tested at 28 days, unless otherwise specified or approved. Concrete specified on the basis of compressive strength will be considered satisfactory if the averages of all sets of three consecutive strength test results equal or exceed the specified strength, and no individual strength test result falls below the specified strength by more than 200 psi.
 - 2. Air Content: Air content shall be determined in accordance with ASTM C173 Tow tests for air content shall be made on randomly selected batches of each class of concrete placed during each shift. Additional tests shall be made when excessive variation in concrete workability occurs. If results of the tests are out of tolerance, the air content shall be corrected at the concrete plant. Additional tests for air content will be performed on each truckload of material until such time as the air content is within the tolerances specified.
 - Slump Test: Two slump tests shall be made on randomly selected batches of each class of concrete for every 250 cubic yards, or fraction thereof, of concrete placed during each shift. Additional tests will be performed when excessive variation in the workability of the concrete is noted.
 - 4. Maintain records of placed concrete items. Record date, location of pour, quantity, air temperature, and test samples taken.
- E. Thickness Evaluation: The thickness evaluation of the concrete shall be determined before placement by passing a template through the formed section.
- F. Surface Evaluation: The finished surface of each category of the completed work shall be uniform in color, free of blemishes form or tool marks and match the integrity of the sample panels.

- A. Subgrade: To coarse aggregate fill, compacted to 95 percent.
- B. Crusher Run Aggregate: Compacted to 95 percent.
- C. Stamped Colored Concrete Paving: 3,500 psi 28 day concrete, 5-7 inches thick, match color and texture of the approved samples.

END OF SECTION 03 35 19
SECTION 03 45 01 SITE STRUCTURES PRECAST CONCRETE

PART 1 – GENERAL

1.1 SUMMARY

- A. This section includes the performance criteria, materials, design, production, and erection of architectural precast concrete for wall caps and exterior site walls only. The work performed under this Section includes all labor, material, equipment, related services, and supervision required for the manufacture and erection of the architectural precast concrete work shown on the Contract Drawings.
- B. This Section includes the following:
 - 1. Architectural precast concrete walls, wall caps, planters, stair treads, and site furnishings.
- C. Related Sections include the following:
 - 1. Section 03 30 00.01: Cast-in-Place Concrete for Landscaping.
 - 2. Section 04 20 00: Unit Masonry for Landscaping
 - 3. Section 12 93 00: Site Furnishings

1.2 REFERENCES

- A. American Society for Testing and Materials (ASTM)
 - 1. ASTM C-150
 - 2. ASTM C-33
 - 3. ASTM C-260
 - 4. ASTM C-494
 - 5. ASTM C-128
 - 6. ASTM C-31
- B. Precast Concrete Institute (PCI)
- C. American Concrete Institute ACI-318

1.3 DEFINITION

A. Design Reference Sample: Sample of approved architectural precast concrete color, finish and texture, preapproved by Landscape Architect.

1.4 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide architectural precast concrete units and connections capable of withstanding the following design loads within limits and under conditions indicated:
 - 1. Dead Loads: Self weight and weights of attached elements.
 - 2. Live Loads: refer to general structural notes.
 - 3. Wind Loads: refer to general structural notes.
 - 4. Seismic Loads: refer to general structural notes.
 - 5. Thermal Movements: Provide for in-plane thermal movements resulting from annual ambient temperature changes of 80 °F.

1.5 SUBMITTALS

- A. Shop Drawings:
 - 1. Submit shop drawings of all precast concrete items showing detail sections and profile for all precast items. Details shall show all reinforcing and special hardware required for fastening.
- B. Samples:
 - 1. Submit 3 samples, 6" x 6" size for each color.
 - a. Color to be selected from Wausau Tile Site Furnishings color chart.
 - b. Sample to be submitted for color and texture.
 - c. Match existing or architect's sample
 - 2. Submit copy of Quality Assurance and Procedure Program.
- C. Performance Requirements
 - 1. Compressive Strength 5000 psi.
 - 2. Air Content 6-8%
 - 3. Water-Cement Ratio 45:1

1.6 QUALITY ASSURANCE

- A. Quality-Control Testing: Test and inspect precast concrete according to PCI MNL 117 requirements. If using self-consolidating concrete also test and inspect according to PCI TR-6 "Interim Guidelines for the Use of Self-Consolidating Concrete" and ASTM C 1611/C 1611M, ASTM C 1712, ASTM C 1610/1610M, and ASTM C 1621/C 1621M.
- B. Precast manufacturing plant shall be certified, category AT Architectural Trim, by the Precast Concrete Institute (PCI) at the time of bidding.
- C. Manufacturer's Instructions: In addition to specified requirements, comply with precast concrete manufacturer's instructions and recommendations for substrate preparation, material storage, mixing and application, finishing and curing.
- D. Qualifications: Precast Concrete Manufacturer and Trade contractor must have a minimum of 5 years of successful experience on projects of similar magnitude and complexity to that indicated project. Manufacturer and contractor to be prequalified by architect prior to bidding. Fail to prequalify will void bid.
- E. Manufacturer to supply a written Quality Assurance Program and Procedure Manual.
- F. Testing Agency Qualifications: An independent accredited testing agency acceptable to authorities having jurisdiction, qualified according to ASTM C 1077, ASTM E 329 and ASTM E 543 to conduct the testing indicated.
- G. Design Standards: Comply with ACI 318 (ACI 318M) and design recommendations of PCI MNL 120, PCI Design Handbook Precast and Prestressed Concrete, applicable to types of architectural precast concrete units indicated.
- H. Quality-Control Standard: For manufacturing procedures and testing requirements, qualitycontrol 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.
- I. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code Steel"; AWS D1.4/D1.4M, "Structural Welding Code Reinforcing Steel" and AWS D1.6/D1.6M Structural Welding Code-Stainless".
- J. Mockups: Mockups to be representative of the finished work including exterior site walls, stair treads, site furnishings and architectural precast concrete complete with anchors, connections, flashings, and joint fillers as accepted on the final Shop Drawings. Build mockups to comply with the following requirements, using materials indicated for the completed work:

- 1. Build mockups in the location and of the size indicated in Contract Documents or, if not indicated, as directed by Architect.
- 2. Notify Architect in advance of dates and times when mockups will be constructed.
- K. Preinstallation Conference: Conduct conference at Project Site.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Packaging and Shipping: Precast concrete to be palletized and shrink wrapped, delivered in original unopened packaging with legible manufacturer identification, including size, piece number, quantities, manufacture date, and inspectors initials.
- B. Storage and Protection: Precast concrete to be stored in secure area in original packaging. Protect from damage by other trades.

1.8 SEQUENCING

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

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable manufacturer or approved equal prior to bidding:
 - 1. Wausau Tile, Inc. PO Box 1520 Wausau, WI 54402-1520 (715)359-3121

2.2 MOLD MATERIALS

- A. Molds: Rigid, dimensionally stable, non-absorptive material, warp and buckle free, that will provide continuous and true precast concrete surfaces within fabrication tolerances indicated; nonreactive with concrete and suitable for producing required finishes.
 - 1. Form-Release Agent: Commercially produced form-release agent that will not bond with, stain, or affect hardening of precast concrete surfaces and will not impair subsequent surface or joint treatments of precast concrete.
- B. Surface Retarder: Chemical set retarder, capable of temporarily delaying final hardening of newly placed concrete to depth of reveal specified.

2.3 REINFORCING MATERIALS

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.
- B. Epoxy-Coated Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420) or (ASTM A 706/A 706M], deformed bars, ASTM A 775/A 775M or ASTM A 934/A 934M epoxy coated.
- C. Steel Bar Mats: ASTM A 184/A 184M, fabricated from ASTM A 615/A 615M, Grade 60 deformed bars, assembled with clips.
- D. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, fabricated from galvanized or chromate wash treated steel wire into flat sheets.
- E. Deformed Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.
- F. Epoxy Coated-Steel Welded Wire Reinforcement: ASTM A 884/A 884M Class A coated, plain or deformed, flat sheet, Type 1 bendable or 2 non-bendable coating.

G. Supports: Suspend reinforcement from back of mold or use bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place according to PCI MNL 117.

2.5 CONCRETE MATERIALS

- A. Portland Cement: ASTM C150, Type I or III.
 - 1. For surfaces exposed to view in finished structure, use white, of same type, brand, and mill source throughout the precast concrete production.
 - 2. Standard gray portland cement may be used for non-exposed backup concrete.
- C. Aggregates: All aggregates to meet ASTM C-33 specifications, cleaned and properly graded to size. Aggregates shall be blended to meet individual project requirements.
 - 1. Face-Mixture Coarse Aggregates: Selected, hard, and durable; free of material that reacts with cement or causes staining; to match selected finish sample.
 - a. Gradation: To match design reference sample.
 - 2. Face-Mixture Fine Aggregates: Selected, natural, or manufactured sand of a material compatible with coarse aggregate to match selected Sample finish.
 - 3. Backup Concrete Aggregates: ASTM C 33 or C 330.
- D. Coloring Admixture: ASTM C 979, synthetic or natural mineral-oxide pigments or colored waterreducing admixtures, temperature stable, and nonfading. Pigments shall be inorganic, resistant to alkalinity and used per manufacturers recommendations.
- E. 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.

2.6 STEEL CONNECTION MATERIALS

- A. Carbon-Steel Shapes and Plates: ASTM A 36/A 36M.
- B. Carbon-Steel Headed Studs: ASTM A 108, Grades 1010 through 1020, cold finished, AWS D1.1/ D1.1 M, Type A or B, with arc shields and with minimum mechanical properties of PCI MNL 117, Table 3.2.3.
- C. Carbon-Steel Plate: ASTM A 283/A 283M, Grade C.
- D. Malleable Iron Castings: ASTM A 47/A 47M, Grade 32510 or 35028.
- E. Carbon-Steel Castings: ASTM A 27/A 27M, Grade 60-30 (Grade 415-205).
- F. High-Strength, Low-Alloy Structural Steel: ASTM A 572/A 572M.
- G. Carbon-Steel Structural Tubing: ASTM A 500/A 500M, Grade B or C.
- H. Wrought Carbon-Steel Bars: ASTM A 675/A 675M, Grade 65 (Grade 450).
- I. Deformed-Steel Wire or Bar Anchors: ASTM A 496/A 496 M or ASTM A 706/A 706M.
- J. Carbon-Steel Bolts and Studs: ASTM A 307, Grade A or C (ASTM F 568M, Property Class 4.6) carbon-steel, hex-head bolts and studs; carbon-steel nuts (ASTM A 563/A 563M, Grade A); and flat, unhardened steel washers, ASTM F 844.

2.7 GROUT MATERIALS

- A. Sand-Cement Grout: Portland cement, ASTM C 150, Type I, and clean, natural sand, ASTM C 144 or ASTM C 404. Mix at ratio of 1 part cement to 2¹/₂ to 3 parts sand, by volume, with minimum water required for placement and hydration. Water-soluble chloride ion content of grout with less than 0.06 percent chloride ion by weight of cement when tested in accordance with ASTM C 1218/C 1218M.
- B. Nonmetallic, Nonshrink Grout: Premixed, prepackaged non-ferrous aggregate, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating

agents, plasticizing and water-reducing admixtures, complying with ASTM C 1107, Grade A for drypack and Grades B and C for flowable grout and of consistency suitable for application within a 30-minute working time. Water-soluble chloride ion content of grout with less than 0.06 percent chloride ion by weight of cement when tested in accordance with ASTM C 1218/C 1218M.

C. Epoxy-Resin Grout: Two-component, mineral-filled epoxy-resin: ASTM C 881/C 881M of type, grade, and class to suit requirements.

2.8 MOLD FABRICATION

- A. Molds: Accurately construct molds, mortar tight, of sufficient strength to withstand pressures due to concrete placement and vibration operations and temperature changes, and for prestressing and detensioning operations. Coat contact surfaces of molds with release agent before reinforcement is placed. Avoid contamination of reinforcement and prestressing tendons by release agent.
- B. Maintain molds to provide completed architectural precast concrete units of shapes, lines, and dimensions indicated in Contract Documents, within fabrication tolerances specified.
 - 1. Form joints are not permitted on faces exposed to view in the finished work.
 - 2. Edge and Corner Treatment: All exposed edges to have minimum 1/8" chamfer to prevent chipping.
 - 3. Finished surfaces to match approved control sample.
 - 4. All precast concrete finished surfaces to be sealed with a sealer approved by manufacturer.

2.9 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.
 - 1. Weld headed studs and deformed bar anchors used for anchorage according to AWS D1.1/D1.1M and AWS C5.4, "Recommended Practices for Stud Welding."
- B. Furnish loose hardware items including steel plates, clip angles, seat angles, anchors, dowels, cramps, hangers, and other hardware shapes for securing architectural precast concrete units to supporting and adjacent construction.
- C. Cast in reglets, slots, holes, and other accessories in architectural precast concrete units as indicated on Contract Drawings.
- D. Cast in openings larger than 10 in. (250 mm) in any dimension. Do not drill or cut openings or prestressing strand without Architect's approval.
- E. Reinforcement: Comply with recommendations in PCI MNL 117 for fabrication, 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. When damage to epoxy-coated reinforcing exceeds limits specified in ASTM A 775/A 775M, repair with patching material compatible with coating material and epoxy coat bar ends after cutting.
 - 2. Accurately position, support, and secure reinforcement against displacement during concrete- placement and consolidation operations. Completely conceal plastic tipped or corrosion resistant metal or plastic chair support devices to prevent exposure on finished surfaces.
 - 3. Place reinforcing steel and prestressing tendon to maintain at least 3/4 in. (19 mm) minimum concrete cover. Increase cover requirements for reinforcing steel to 11/2 in. (38 mm) when units are exposed to corrosive environment or severe exposure conditions. 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 reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh spacing and wire tie laps, where required by design. Offset laps of adjoining widths to prevent continuous laps in either direction.
- F. Reinforce architectural precast concrete units to resist handling, transportation and erection stresses, and specified in-place loads, whichever governs.
- G. Comply with requirements in PCI MNL 117 and requirements in this Section for measuring, mixing, transporting, and placing concrete. After concrete batching, no additional water may be added.
- H. Coordinate all step lighting features, connections, and conduit routing prior to fabrication.

2.10 FABRICATION TOLERANCES

- A. Fabricate architectural precast concrete units of shapes, lines and dimensions indicated, so each finished unit complies with PCI MNL 117 product tolerances as well as position tolerances for cast-in items.
- B. All units to conform to shop drawings, with a 1/8" tolerance in dimensions.

2.11 FINISHES

- A. Exposed faces shall be free of joint marks, grain, and other obvious defects. Corners, including false joints shall be uniform and straight. Finish exposed-face surfaces of architectural precast concrete units to match approved design reference samples and as follows:
 - 1. Design Reference Sample:
 - a. All design references provided by Tectura Designs.
 - i. Acid washed A26 (Stair Treads and Seat Wall at base of the Beacon of Hope)
 - ii. Ground and Polish G30(Wall Caps)
 - 2. PCI's Architectural Precast Concrete Color and Texture Selection Guide, of plate numbers indicated.
 - 3. As-Cast Surface Finish: Provide surfaces to match accepted sample or mockup units for acceptable surface air voids, sand streaks, and honeycombs.
 - 4. Textured-Surface Finish: To match accepted sample or mockup units for acceptable surface air voids, sand streaks, and honeycombs, with uniform color and texture.
 - 5. Bushhammer Finish: Use power or hand tools to remove matrix and fracture coarse aggregates to match accepted sample or mockup units.
 - 6. Exposed Aggregate Finish: Use chemical retarding agents applied to molds, and washing and brushing procedures, to expose aggregate and surrounding matrix surfaces after form removal to match accepted sample or mockup units.
 - 7. Abrasive-Blast Finish: Use abrasive grit, equipment, application techniques, and cleaning procedures to expose aggregate and surrounding matrix surfaces to match accepted sample or mockup units.
 - 8. Acid-Etched Finish: Use acid and hot-water solution, equipment, application techniques, and cleaning procedures to expose aggregate and surrounding matrix surfaces to match accepted sample or mockup units. Protect hardware, connections, and insulation from acid attack.
 - 9. Honed Finish: Use continuous mechanical abrasion with fine grit, followed by filling and rubbing procedures to match accepted sample or mockup units.
 - 10. Polished Finish: Use continuous mechanical abrasion with fine grit, followed by filling and rubbing procedures to match accepted sample or mockup units.
 - 11. Sand-Embedment Finish: Use selected stones placed in a sand bed in bottom of mold, with sand removed after curing to match accepted sample or mockup units.

- B. Finish exposed surfaces of architectural precast concrete units to match face-surface finish.
- C. Finish unexposed surfaces of architectural precast concrete units with as-cast finish.
- D. Finish top and back surfaces of architectural precast concrete units by steel-trowel finish.

2.12 CAULKS AND SEALANTS

- A. Polyurethane or acrylic sealant
- B. Color to be selected by architect from standard color pallet

2.13 SEALER

A. Colorless, pure acrylic water-repellent penetrating sealer. Sealer to maintain natural look of concrete surface with no glaze or gloss, darkening or color change.

PART 3 – EXECUTION

3.1 PREPARATION

A. Furnish anchorage devices for precast concrete units to be embedded in or attached to the foundation before start of such Work. Provide locations, setting diagrams, templates and instructions for the proper installation of each anchorage device.

3.2 EXAMINATION

- A. Examine supporting structural frame or foundation and conditions for compliance with requirements for installation tolerances, bearing surface tolerances, and other conditions affecting precast concrete performance.
- B. Proceed with precast concrete installation only after unsatisfactory conditions have been corrected.
- C. Contractor shall notify precast concrete erector that supporting cast-in-place concrete foundation and building structural framing has attained minimum allowable design compressive strength or supporting steel or other structure is structurally ready to receive loads from precast concrete units prior to proceeding with installation.

3.3 INSTALLATION

- A. Install loose clips, hangers, bearing pads, and other accessories required for connecting architectural precast concrete units to supporting members and backup materials
- B. Structural steel fabricator to supply and install miscellaneous steel preweld connection hardware in the shop.
- C. Precaster or erector to supply and install miscellaneous steel preweld connection hardware in the field.
- D. Erect architectural precast concrete level, plumb, and square within the specified allowable erection tolerances. Provide temporary supports and bracing as required to maintain position, stability, and alignment of units until permanent connections are completed.
 - 1. Install temporary steel or plastic spacing shims as precast concrete units are being erected. Surface weld steel shims to each other to prevent shims from separating.
 - 2. Maintain horizontal and vertical joint alignment and uniform joint width as erection progresses.
 - 3. Remove projecting lifting devices and use sand-cement grout to fill voids within recessed lifting devices flush with surface of adjacent precast concrete surfaces when recess is exposed.

- E. After each unit has been set, all joints shall be raked to a depth of 3/4-inch from the face for pointing. The face of each stone shall then be sponged off to remove any splashed mortar or mortar smears.
- F. Connect architectural precast concrete units in position by bolting, welding, grouting, or as otherwise indicated on Shop (Erection) Drawings. Remove temporary shims, wedges, and spacers as soon as practical after connecting and/or grouting are completed.
- F. Welding: Comply with applicable AWS D1.1/D1.1M, AWS D1.4/D1.4M and D1.6/D1.6M requirements for welding, welding electrodes, appearance of welds, quality of welds, and methods used in correcting welding work.
 - 1. Protect architectural precast concrete units and bearing pads from damage during field welding or cutting operations and provide noncombustible shields as required.
 - 2. Welds not specified shall be continuous fillet welds, using not less than the minimum fillet as specified by AWS D 1.1/D 1.1M, D 1.4/D 1.4M or D1.6/D1.6M.
 - 3. Clean weld- affected metal surfaces with chipping hammer followed by brushing or power tool cleaning and then reprime damaged painted surfaces in accordance with paint manufacturer's recommendations.
- G. At bolted connections, use upset threads, thread locking compound or other approved means to prevent loosening of nuts after final adjustment.
 - 1. Where slotted connections are used, verify bolt position and tightness at installation. For sliding connections, properly secure bolt but allow bolt to move within connection slot.
 - 2. For slip critical connections, one of the following methods shall be used to assure proper bolt pretension:
 - a. Turn-of-Nut in accordance with AISC.
 - b. Calibrated Wrench in accordance with AISC.
 - c. Twist-off Tension Control Bolt meeting ASTM F 1852.
 - d. Direct-Tension Control Bolt meeting ASTM F 1852.
 - 3. For slip critical connections, the method to be used and the inspection procedure to be used shall be approved by the Architect and coordinated with the inspection agency.
- H. Grouting or Dry-Packing Connections and Joints: Indicate joints to be grouted and any critical grouting sequences on Shop (Erection) Drawings. Grout connections where required or indicated on Shop (Erection) Drawings. Retain flowable grout in place until it gains sufficient strength to support itself. Alternatively pack spaces with stiff dry pack grout material, tamping until voids are completely filled. Place grout and finish smooth, level, and plumb with adjacent concrete surfaces. Promptly remove grout material from exposed surfaces before it affects finishes or hardens. Keep grouted joints damp for at least 24 hours after initial set.

3.6 REPAIRS

- A. Repairs will be permitted provided structural adequacy of units and appearance are not impaired.
- B. Repair damaged units to meet acceptability requirements of PCI MNL 117.
- C. Mix patching materials and repair units so cured patches blend with color, texture, and uniformity of adjacent exposed surfaces and show no apparent line of demarcation between original and repaired work, when viewed in typical daylight illumination from a distance of 20 ft (6 m).

3.7 POINTING AND CAULKING

A. When ready for pointing, the joints shall be dampened and carefully pointed to a slight concave unless otherwise specified by the Landscape Architect. No pointing shall be done in freezing weather not in locations exposed to hot sun, unless properly protected. Coloring pigments may be added as required. The Landscape Architect shall approve color of mortar and sealant before proceeding with pointing.

B. Head joints and bed joints in precast caps shall be caulked with a joint sealant used in accordance with the Manufacturer's instructions.

3.8 CLEANING

- C. Clean all surfaces of precast concrete to be exposed to view, as necessary, prior to shipping.
- D. Clean mortar, plaster, fireproofing, weld slag, and any other deleterious material from concrete surfaces and adjacent materials immediately.
- E. Clean exposed surfaces of precast concrete units after erection and completion of joint treatment to remove weld marks, dirt, stains and other markings.
 - Perform cleaning procedures, if necessary, according to precast concrete fabricator's recommendations. Protect adjacent 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 or damage adjacent materials.
- F. All product to be sealed with approved sealer.

END OF SECTION 03 45 01

SECTION 04 20 01 UNIT MASONRY FOR LANDSCAPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

1.2 Provide all labor, materials, equipment, services necessary for and incidental to the installation of all masonry construction as indicated on the Drawings and specified herein.

1.3 RELATED SECTIONS

A. SECTION 03 30 00.01 - Cast-In-Place Concrete for Landscaping

1.4 REFERENCES

- A. American Concrete Institute (ACI): Reference sections as follows:
 - 1. ACI 530 Building Code Requirements for Masonry Structures.
 - 2. ACI 530.1 Specifications for Masonry Structures.

B. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM):

- 1. ASTM C5 Quicklime for Structural Purposes.
- 2. ASTM C91 Masonry Cement.
- 3. ASTM C94 Ready-Mixed Concrete.
- 4. ASTM C144 Aggregate for Masonry Mortar.
- 5. ASTM C150 Portland Cement.
- 6. ASTM C199 Test Method for Pier Test for Refractory Mortar.
- 7. ASTM C207 Hydrated Lime for Masonry Purposes.
- 8. ASTM C270 Mortar for Unit Masonry.
- 9. ASTM C387 Packaged, Dry, Combined Materials, for Mortar and Concrete.
- 10. ASTM C404 Aggregates for Masonry Grout.
- 11. ASTM C476 Grout for Masonry.
- 12. ASTM C595 Blended Hydraulic Cement.
- 13. ASTM C780 Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
- 14. ASTM C1019 Method of Sampling and Testing Grout.
- 15. STM C1072 Method for Measurement of Masonry Flexural Bond Strength.
- 16. ASTM C1142 Ready-Mixed Mortar for Unit Masonry.
- 17. ASTM E447 Test Methods for Compressive Strength of Masonry Prisms.
- 18. ASTM E518 Test Method for Flexural Bond Strength of Masonry.
- C. IMIAC (International Masonry Industry All-Weather Council) Recommended Practices and Guide Specifications for Cold Weather Masonry Construction.

1.5 SUBMITTALS

- A. Samples: Submit (3) samples of each type of masonry and each accessory item required. Provide certification of pull out strength of all masonry ties and anchors. Submit certification of compliance with required standards.
- B. Mortar and Grout: Include design mix, indicate whether the Proportion or Property specification of ASTM C270 is to be used, required environmental conditions, and admixture limitations.
 - 1. Samples: Submit two samples of mortar, illustrating mortar color and color range.

- C. Reports: Submit reports on mortar indicating conformance of mortar to property requirements of ASTM C270 and test and evaluation reports to ASTM C780.
- D. Reports: Submit reports on grout indicating conformance of component grout materials to requirements of ASTM C476 and test and evaluation reports to ASTM C1019.
- E. Manufacturer's Certificate: Certify that products meets or exceed specified requirements.

1.6 QUALITY ASSURANCE

- A. Perform Work according to ACI 530 and ACI 530.1.
- B. Maintain one copy of each document on site.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver masonry units to job site in undamaged condition. Deliver and handle units to prevent chipping, breaking or other damage.
- B. Storage: Store masonry units off ground and protected from wetting by capillary action, rain or snow, and protected from mud, dust, or other materials and contaminants likely to cause staining or defects.
- C. Maintain packaged materials clean, dry, and protected against dampness, freezing, and foreign matter.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Cold Weather Requirements: IMIAC Recommended Practices and Guide Specifications for Cold Weather Masonry Construction.
- B. Maintain materials and surrounding air temperature to maximum 90 degrees F (32 degrees C) before, during, and forty-eight hours after completion of masonry work.
- C. Coverings: Masonry material shall be kept dry by covering at the end of each day and when work is not in progress with a strong, weather-resistant material extended a minimum of 2-feet down each side and held securely in place.
- D. Protection: Prevent grout or mortar from staining the face of masonry to be left exposed. Remove immediately and grout or mortar in contact with face of masonry.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers for the following shall consist as follows:
 - 1. Facing Brick:
 - a. B-1 to match building brick.
 - 2. Do not exceed variations in color and texture of specified brick.

2.2 MATERIALS

- A. Portland Cement: ASTM C150, Type I gray color.
- B. Lime: Hydrated lime, ASTM C207, Type S.
- C. Sand : ASTM C144.
- D. Aggregate: ASTM C404.
- E. Water: Mixing water must be clean and free of harmful amounts of acids, alkalis, organic materials, or other substances that would adversely affect the quality or appearance of the mortar or the masonry units.

- F. Reinforcement: Steel reinforcing shall conform to the following ASTM Specifications:
 - 1. Billet steel deformed bars, ASTM A615; 40 ksi (276 Mpa) yield grade; unfinished.
- G. Anchors and Ties
 - 1. All anchors and ties shall be coated or corrosion-resistant metal meeting or exceeding the following ASTM Specifications:
 - a. Zinc coating of wire, ASTM A116, Class 3.
 - 2. Joint reinforcement: Prefabricated welded joint reinforcement, longitudinal cross tie wire minimum 9-gauge spaced 16-inches on center; ladder or truss-type design.
- H. Cleaning agents:
 - 1. Use cleaning agents as recommended by the brick and mortar manufacturer.

2.3 MIXES

- A. Materials:
 - 1. Portland Cement: ASTM C150, Type I; nonstaining type. Masonry cement is unacceptable.
 - 2. Masonry Sand: ASTM C144, natural sand only. Manufactured sand is unacceptable.
 - 3. Gradation: Comply with referenced standard for 3/8" joints, except grade with 100% passing No. 16 sieve for joints 1/4" or less.
 - 4. Color: Natural.
 - 5. Hydrated Lime: ASTM C207, Type "S". Type "NA" (air entraining) is unacceptable.
 - 6. Quicklime: ASTM C5. Slake quicklime and age lime putty as recommended by manufacturer.
 - 7. Water: Clean, fresh, potable.
- B. Mortar Proportions, Including Mixing:
 - 1. General:
 - a. Thoroughly mechanically mix in quantity needed for immediate use.
 - a. Do not use antifreeze compounds.
 - b. Do not permit mortar to stand more than 1 hour without remixing.
 - c. Discard mortar that has begun to set, or is not used within 2-1/2 hours after initial mixing. Retemper mortar which has stiffened due to evaporation to restore its workability.
 - 2. Portland Cement Lime Mortar
 - a. Proportion following by volume, according to requirements of ASTM C270-92a (masonry cement mortar not acceptable).
 - b. Type "M".
- C. Grout Mixes: Grout for reinforced masonry shall meet the minimum requirements for Type XX, ASTM C476.
 - 1. Mix grout according to ASTM C94.
- D. Admixtures:
 - 1. No air-entraining admixtures or materials containing air entraining admixtures shall be used. Air content of mortar and grout shall be limited to 12%.
 - 2. No antifreeze compounds or other substances shall be added to mortar or grout. No calcium chloride shall be included in mortar or grout in which metal reinforcing or accessories will be embedded.
 - 3. Mortar colors shall consist of inorganic compounds not to exceed 15% of the weight of the cement except that carbon block shall not exceed 3% of the weight of the cement. If mortar colors are used in reinforced masonry, prism tests shall determine the ultimate compressive strength of the masonry.

PART 3 - EXECUTION

3.1 PREPARATION

A. Observation: Observe surfaces that are to support masonry work to assure completion to proper lines and grades free of all dirt and other deleterious material. Do not begin work until surfaces have been properly prepared to the Landscape Architects approval.

3.2 INSTALLING MASONRY

- A. Preparation:
 - 1. Verify that initial absorption rate of clay brick is less than 0.024 oz./sq. inch per minute. Brick with absorption rates greater than this amount shall be wetted with clean water 24 hours before placement until the unit is nearly saturated, and shall be surface dry when laid. During freezing, weather units that require wetting shall be sprinkled with warm or hot water just before laying.

B. Installation:

- 1. Do not install cracked, broken or chipped masonry units exceeding ASTM allowances. Use masonry saw to cut and fit exposed units. Lay brick plumb, true to line, and with level courses accurately spaced within allowable tolerances.
- 2. Unless otherwise shown on the drawings, install masonry work using one-half running bond and soldier course. Stop horizontal runs at the end of workday by racking back in each course; toothing will not be permitted.
- 3. Adjust units to final position while mortar is soft and plastic. If units are displaced after mortar has stiffened, remove, clean joints and units of mortar, and relay with fresh mortar. Adjust shelf angles to keep work level and at proper elevation.
- 4. When joining fresh masonry to set or partially set masonry. Remove loose unit and mortar, and clean and lightly wet exposed surfaces of set masonry before laying fresh masonry.
- 5. Place all accessories and reinforcement in the masonry as the job progresses. Place horizontal joint reinforcement in first bed joint and each successive third joint o concrete masonry walls to prevent cracking.
- 6. Cooperate with other trades to assure proper location of anchors, inserts, penetrations, etc.

C. Joints:

- 1. Provide a nominal joint thickness of 3/8-inch for concrete unit masonry, 3/8-inch for brick masonry. Do not furrow bed joints for solid masonry units.
- 2. Provide face-shell bedding for concrete unit masonry except at grouted cells and base course, where full mortar bedding is required. Construct uniform joints.
- 3. Provide full head and bed joints, shoved tight to prevent penetration of moisture. Provide weatherproof, concave, tooled joints in exposed surfaces when mortar is thumbprint hard, using round jointing tool.
- 4. Strike joints flush in surfaces to be covered with other material or surface-applied finish other than paint. Concave tool exterior joints below grade. Remove mortar protruding into cells or cavities of multi-wythe walls or to block weep holes. Fill with mortar all horizontal joints between top of masonry partitions and underside of concrete beams.
- 5.
- 6. Keep movement joints clean of all mortar and debris. For tuckpointing, rake mortar joints to a depth of 1/2 to 3/4-inch, saturate with clean water, fill solidly with pointing mortar and tool to match existing joints.

D. Weep Holes: 1. P

Provide weep holes in head joints in first course immediately above all flashing. Leave head joint free and clean of mortar or install weep hole tube in head joint.

- 2. Space weep holes 24-inches on center maximum for brick masonry, and 32-inches on center maximum for concrete unit masonry. Keep weep holes and area above flashing free of mortar droppings.
- 3. For backfill material behind retaining walls, and for loose fill insulation in walls, screen cavity side of weep hole against clogging before fill material is placed.
- E. Masonry Bonding:
 - 1. Bond facing and backing of multi-wythe walls as shown on the Drawings with masonry headers extended a minimum of 3-inches into backing. If a single header does not extend through a wall, overlap headers from opposite sides of wall at least 3-inches. Provide minimum number of wall headers equal to 4% of wall surface, spaced maximum distance of 24-inches on center either vertically or horizontally.
- F. Metal-tie Bonding:
 - Provide metal ties for bonding of multi-wythe walls. Stagger ties in alternate courses, and provide minimum of one tie for each 4.5-square foot of wall surface. Maximum distance between adjacent ties not to exceed 18-inches vertically or 36-inches horizontally. Embed ties in horizontal joints of facing and backing. Provide additional ties within 12-inches of openings, spaced maximum 36-inches around the perimeter.
 - 2. Instead of metal ties, a continuous prefabricated metal joint reinforcement as specified, spaced no more than 16-inches on center vertically may be used.
 - 3. Anchor nonbearing partitions abutting or intersecting other walls or partitions with cavity wall ties at vertical spacing not to exceed 4-feet.
- G. Anchoring Brick Veneer:
 - 1. Attach brick veneer to backing with metal veneer ties spaced maximum 16-inches on center vertically and horizontally with a minimum of one tie for each 2 square feet of wall area. Embed ties at least 2-inches in horizontal joint of facing. Provide additional ties within 12-inches of openings, spaced maximum 36-inches around the perimeter.
- H. Expansion and Contraction:
 - 1. Provide vertical movement joints at intervals of not more than 20-feet on centers, and at all offsets, return, openings, and intersections with dissimilar materials. Provide continuous bond break at steel columns and members. Provide pressure-relieving joints by placing a continuous 1/8-inch neoprene pad below shelf angles.

3.3 REINFORCED MASONRY

- A. Masonry Strength: Provide a minimum ultimate compressive strength of 8,000 psi.
- B. Reinforcement: 1. Hol
 - Hold vertical reinforcement firmly in place by means of frames or other suitable devices. Place horizontal reinforcement as masonry work progress. Provide minimum clear distance between longitudinal bars equal to nominal diameter of the bar. Provide minimum clear distance between bars in columns equal to 1-1/2-times bar diameter. Minimum thickness of mortar or grout between masonry and reinforcement shall be 1/4-inch, except than 1/4-inch bars may be laid in 1/2-inch horizontal mortar joints, and 6-gauge or smaller wires may be laid in 3/8-inch mortar joints. Collar joints containing both horizontal and vertical reinforcement shall have a minimum width 1/2-inch larger than the sum of the diameters of the horizontal and vertical reinforcement.
- C. Low-lift Grouting:
 - 1. For grout spaces less than 2-inches width, place grout at maximum 24-inches intervals in lifts of 6 to 8 inches as the wall is built. Assure that grout core is clean of mortar, mortar droppings, and debris. Agitate grout during and after placement to assure complete filling and coverage of reinforcement. If work is to be stopped for 1-hour or more, hold grout 1-1/2-inch below top of masonry. Continue

grouting to top of finished wall.

- D. High-lift Grouting:
 - 1. For grout spaces 2-inches or more in width, grout may be placed in lifts not to exceed 4-feet. For running bond, provide one metal tie for each 3-square feet of wall with a maximum spacing of 16-inches vertically and 24 or 32-inches horizontally for brick and concrete block, respectively.
 - 2. For a stack bond, provide one metal tie for each 2 square feet of wall with a maximum spacing 12-inches vertically and 24-inches horizontally for brick, or 16-inches vertically and horizontally for a concrete block.
 - 3. Keep grout core clean. Provide cleanout holes in bottom course as required for inspection and cleaning. Replace cleanout plugs only after area to be grouted has been accepted. Do not place grout until the entire wall has been in place a minimum of 3 days. Place horizontal grout barriers at convenient intervals. If work is to be stopped for 1 hour or more, hold grout 1-1/2-inch below top of masonry. Continue grouting to top of finished wall.
- E. Forms and Shoring:
 - 1. Provide substantial and tight forms to prevent leakage of mortar or grout. Brace or shore forms to maintain position and shape. Do not remove forms or shoring until masonry has hardened sufficiently to carry its own weight and any other temporary loads that may be placed on it during construction (10 days for girders and beams, 7 days for masonry slabs).

3.4 POINTING AND CLEANING

1.

1.

- A. Pointing:
 - At final completion of masonry work, cut out any defective joints or holes in exposed masonry and repoint with mortar, tooling to match adjacent joints.

B. Cleaning:

- Dry brush masonry surface after mortar has set at end of each workday and after final pointing. Clean exposed, unglazed masonry with stiff brush and clean water. Cleaning agents may be used only with written approval of Landscape Architect. Cleaning agent must be tested on sample wall area of 20 square feet. Protect adjacent materials from damage due to cleaning operations. Remove efflorescence in accordance with the Brick Manufacturer's recommendations.
- 2. Leave work area and surrounding surfaces clean and free of mortar spots, droppings, and broken masonry.

3.5 FIELD QUALITY CONTROL

A. Mortar and Grout: Mix mortar and grout according to the proportion requirements of ASTM C270, and ASTM C476 as applicable. Control batching procedure to ensure proper proportions by measuring materials by volume. Mortar consistency shall be controlled. Re tempering will be permitted only within the first 2-1/2 hours of the initial mix. Any mortar or grout that has partially set shall be discarded.

3.6

END OF SECTION 04 20 01

SECTION 12 93 00 SITE FURNISHINGS

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the production and installation of site furnishings that include benches, planters, litter receptacles, chairs, tables, and fixed stainless steel bollards.

1.2 RELATED SECTIONS

A. SECTION 03 35 19 Decorative Concrete Paving

1.3 REFERENCES

- A. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM):
- B. ALUMINUM ASSOCIATION (AA).
- C. AMERICANS WITH DISABILITIES ACT ACCESSIBILITY GUIDELINES (ADAAG) for Accessible Public Rights-of-Way, Section R302 Detectable Warning Surfaces
- D. AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATIONS (AAMA) 605.2 Voluntary specification for high Performance Organic Coatings on Architectural Aluminum Extrusions and Panels.
- E. ASTM Testing Standards:
 - 1.ASTM B 117 Standard Practice for Operating Salt Spray (Fog) Apparatus.
 - 2.ASTM D 522 Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings.
 - 3.ASTM D 523 Standard Test Method for Specular Gloss.
 - 4.ASTM D 2247 Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity.
 - 5.ASTM D 3359 Standard Test Methods for Measuring Adhesion by Tape Test.
 - 6.ASTM D 3363 Standard Test Method for Film Hardness by Pencil Test.
 - 7.ASTM G 155 Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials.
- F. ISO Testing Standards:
 1.ISO 1520 Paints and Varnishes Cupping Test.
 2.ISO 2815 Paints and Varnishes Buchholz Indentation Test.

1.4 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Manufacturer regularly engaged in manufacture of site furnishings since 1969.
- B. Provide 5 similar reference projects with direct contact information.
- C. Product Support: Products are supported with complete engineering drawings.
- D. Base Worth: An installed base of products worth in excess of four hundred million dollars.
- E. Assets: Excess of twenty million dollars in assets.
- F. Insurance: Liability insurance coverage of two million dollars

- G. Manufacturing Lead Time: Manufacturing lead time will be determined at time of order.
- H. Facility Operator: Welders and machine operators are certified for all AWS & ASTM standards that apply.

1.5 SUBMITTALS

- A. General: Comply with requirements of SECTION SUBMITTALS.
- B. Literature: Technical data and installation instructions.
- C. Samples:

1. Chairs, tables, benches, litter receptacles: Samples of color and finish.

- D. Maintenance and clean up: Instructions for maintenance and clean up.
- E. Shop (Erection) Drawings for custom benches.
 - 1. Detail fabrication and installation of architectural wooded benches and there connection to the precast concrete units.
 - 2. Indicate locations, plan views, elevations, dimensions, shapes, and cross-sections of each bench unit.
 - 3. Indicate aesthetic intent including joints, drips, chamfers, rustications or reveals, and extent and location of each surface finish.
 - 4. Indicate details at planter and wall corners.
 - 5. Indicate welded connections by AWS standard symbols and show size, length, and type of each weld.
 - 6. Indicate locations, tolerances, and details of anchorage devices to be embedded in or attached to structure or other construction.
 - 7. Indicate plan views and elevations showing unit location and dimensions, erection sequences, and bracing plan for special conditions.
 - 8. Indicate relationship of wooden bench attachments to architectural precast concrete and other adjacent materials.
 - 9. Indicate locations and details of joint widths.
 - 10. Coordinate and indicate openings and inserts required by other trades.
 - Design Modifications: If design modifications are proposed to meet performance requirements and field conditions, notify the Architect and submit design Shop Drawings. Do not adversely affect the appearance, durability, or strength of units when modifying details or materials and maintain the general design concept.
 - 12. Mockup Mockup a full scale copy of furnishings and submit photographs of all joints, welds, seams and finishes prior to fabrication.
 - 13. Shop Drawings must be submitted prior to mockup and or fabrication.
 - 14. Qualification Data: For Installer, Fabricator, Testing agency, and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include list of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

1.6 DELIVERY AND STORAGE

A. Site furnishings shall be delivered to the project site in a timely manner in their original unopened containers bearing labels clearly identifying the manufacturer's name. Storage of materials shall be subject to approval and shall afford easy access for inspection.

1.7 JOB CONDITIONS

CN – Replacement Hospital HFSD

- A. Existing Conditions: Examine work in place that this work is dependent. Defects that may influence satisfactory completion and performance of this work shall be corrected by the requirements of the applicable section of work before commencement of the work. Commencement shall be construed as work in place being acceptable for satisfying the requirements of this section.
- B. Protection: Protect site furnishings and adjacent work against damage during construction of the project.
- PART 2 PRODUCTS

2.1 MANUFACTURERS:

- A. LANDSCAPE FORMS-1-800-430-6209
- B. ATKORE CALPIPE -1-877-277-8518
- C. PLANTERS UNLIMITED-1-888320-0626
- D. APPROVED EQUAL

2.2 SITE FURNISHINGS

- A. Bench– Plan/Schedule Reference:
 - Manufacturer: LANDSCAPE FORMS
 Melville Bench with Back Arm Option: Arms
 Color: Powdercoat Metal, Color: Stone with Jarrah Wood
- B. Table and Chairs Plan/Schedule Reference:
 - 1.Manufacturer: LANDSCAPE FORMS
 - 2. Chipman Style Round Table and Armless Chairs
 - 3. Size: 45 Inch Round
 - 4.Height: Dining Table, 29.25 inch
 - 5.Umbrella Hole: No umbrella hole
 - 6.Mounting option: Surface Mount
 - 7.Finish/Color: Powercoat Metal (Metallic) Color: Stone
- C. Litter Receptacle Plan/Schedule Reference:
 - 1.Manufacturer: LANDSCAPE FORMS
 - 2. Poe Litter Receptacle with Side Opening
 - 3. Diameter: 29"
 - 4. Height: 44"
 - 5. Finish/Color: Powdercoat Metal (Metallic) Color: Stone
 - 6. Surface Mounted

D. Bicycle Rack – Plan/Schedule Reference:

- 1. Manufacturer: LANDSCAPE FORMS
- 2. Ride Bicycle Rack
- 3.Size: 4" x 28" x 26"
- 4. Finish/Color: Powdercoat Metal (Metallic) Color: Stone
- 5. Surface Mounted
- E. Illuminated Fixed Bollard Plan/Schedule Reference:
 - 1.Manufacturer: ATKORE CALPIPE
 - 2. Stainless Steel LED Globe Style 23
 - 3.Size: 3' H x 8" W
 - 4. Finish/Color: Stainless Steel
 - 5. Embedded Concrete Footing

- F. Fixed Bollard Plan/Schedule Reference:
 - 1. Manufacturer: ATKORE CALPIPE
 - 2. Stainless Steel Fixed Security Bollard SSF080
 - 3.Size: 3' H x 8" W
 - 4. Finish/Color: Stainless Steel
 - 5. Embedded Concrete Footing
- G. Planters-Plan/Schedule Reference:
 - 1. Manufacturer: PLANTERS UNLIMITED
 - 2. Modern Round Planter
 - 3.Size: 24" DIA.
 - 4.Material: Fiberglass
 - 5. Finish/Color: Matte finish, Color Chaps Brown
 - 6. Surface Mounted
- H. Planters-Plan/Schedule Reference:
 - 1. Manufacturer: PLANTERS UNLIMITED
 - 2. Modern Square Planter
 - 3. Size: 72" L x 36" W x 36" H. DIA.
 - 4. Material: Fiberglass
 - 5. Finish/Color: Matte finish, Color Chaps Brown
 - 6. Surface Mounted
- I. Planters-Plan/Schedule Reference:
 - 1.Manufacturer: PLANTERS UNLIMITED
 - 2. Modern Round Planter
 - 3.Size: 84" L x 30W x 30" H
 - 4. Material: Fiberglass
 - 5. Finish/Color: Matte finish, Color Chaps Brown
- 6. Surface Mounted

2.3 RECYCLED CONTENT

- A. Product:
- 1. Recycled Material Content: Minimum 65 percent.
- 2. Post-Consumer Material Content: Minimum 50 percent.
- 3. Pre-Consumer Material Content: Minimum 15 percent.
- 4.Recyclable: 100 percent.

2.4 FINISHES

- A. Table, Chairs,
 - 1. Finish on Metal: Landscape Forms, Inc. "Pangard II".
 - a.Primer: Rust inhibitor.
 - b.Topcoat: Thermosetting TGIC polyester powder coat. UV, chip, and flake resistant.
 - c. 3Test Results: "Pangard II".
 - d.Gloss Consistency, Gardner 60 Degrees, ASTM D 523: Plus or minus 5 percent from standard.
 - e.UV Resistance, Color and Gloss, ASTM G 155, Cycle 7: Delta E less than 2 at 2.0 mils and less than 20 percent loss.
 - f. Cross-Hatch Adhesion, ASTM D 3359, Method B: 100 percent pass.
 - g.Flexibility Test, Mandrel, ASTM D 522: 3 mm at 2 mils.
 - h.Erichsen Cupping, ISO 1520: 8 mm.
 - i. Impression Hardness, Buchholz, ISO 2815: 95.
 - j. Impact Test, ASTM D 2794: 60 inch-pounds at 2.5 mils.
 - k. Pencil Hardness, ASTM D 3363: 2H minimum.
 - I. Corrosion Resistance, 1,500-Hour Test, ASTM B 117: Max undercutting 1 mm.

m. Humidity Resistance, 1,500-Hour Test, ASTM D 2247: Max blisters 1 mm.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine installation areas. Field verify the location of all site furnishings in the field and receive Landscape Architect's approval prior to construction. Report unsatisfactory conditions in writing to Landscape Architect. Do not proceed until unsatisfactory conditions have been corrected.
- B. Starting installation constitutes acceptance of condition or satisfactory for installation of site furnishings by Contractor, who shall correct damage and defects or unsatisfactory work at no additional cost.

3.2 INSTALLATION

- A. General:
 - 1.Install components plumb and level, accurately in location, alignment, and elevation, measured from established lines and levels and free from rack, distortion or defects detrimental to installed appearance and performance.
 - Contractor shall be responsible for providing all necessary connections, supports, brackets, hardware, and anchors, whether shown or not shown on the drawings, as required for a full and complete installation and execution of the Bollard scope of work.
 Fit expressed compactions accurately together to form tight begins into
 - 3. Fit exposed connections accurately together to form tight hairline joints.
- B. Chair and Tables: Install as manufacturer's instructions and approved final shop drawings.
- C. Benches: Install as manufacturer's instructions and approved final shop drawings.
- D. Litter Receptacles: Install as manufacturer's instructions and approved shop drawings.
- E. Bike Rack: Install as per manufacturer's instructions and approved shop drawings.
- F. Bollard Cover: Contractor shall be responsible for providing all necessary connections, supports, brackets, hardware, and anchors, whether shown or not shown on the drawings, as required for a full and complete installation and execution of the Bollard scope of work.

3.3 **PROTECTION**

- A. Protect all site furnishings from construction activities with temporary protective coverings approved by the units manufacturer. Remove protective covering at time of Substantial Completion.
- B. Restore finishes damaged during installation and construction period so that no evidence remains of correction work. Return items that cannot be refinished in field to shop; make required alteration and refinish entire unit or provide new units.

3.4 CLEAN-UP

A. Clean-up site furnishings as required and in accordance with manufacturer's recommendation.

END OF SECTION 12 93 00

SECTION 31 36 00 GABIONS

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. The work under this section of the Specifications includes all labor, materials, equipment, and services necessary for GABIONS as shown on the Drawings and herein specified and in accordance with the Contract Documents. All costs for labor, materials, equipment, and services necessary for GABIONS shall be included in the bid prices for the work.

1.3 SECTION INCLUDES

A. Galvanized steel double twisted woven wire mesh gabion baskets filled with stone and used for various applications including but not limited to retaining walls, mechanically stabilized soil retaining structures, stream bank protection, slope paving, outfall structures, weirs, and drop structures.

1.4 RELATED SECTIONS

- A. 31 10 00 Site Clearing
- B. 31 22 00 Grading
- C. 31 23 00 Excavation and Fill
- D. 01 8113 Sustainable Design Requirements: Action and Informational Submittals
 - 1. This project is pursuing LEED Healthcare v4: Silver Certification. Refer to this section for additional, required LEED submittals not included in this specification section.

1.5 DEFINITIONS

- A. AHJ Authority Having Jurisdiction
 - 1. City of Tahlequah
- B. Gabions
 - 1. Gabions are defined as double twisted woven wire mesh box shaped baskets, of various sizes and dimensions.
 - 2. The selvedges of the gabion baskets are the thicker perimeter and edge wires to which the wire mesh is secured as to withstand sudden or gradual stress from any direction.
 - 3. Reinforcing wires are the thicker wires incorporated into the netting during
 - 4. fabrication.
 - 5. The internal diaphragms are the internal wire mesh partitions which divide the gabions into cells.
 - 6. Lacing or tie wire is used to assemble and join the gabion units.
 - 7. Connecting wires are the internal wire used to prevent the gabions from bulging.
 - 8. Alternative wire fasteners are ASTM approved wire fasteners used in lieu of lacing wire.

1.6 ACTION SUBMITTALS

- A. STONE
 - 1. Submit photographs of existing gabion walls showing the stone proposed for the project.

1.7 INFORMATIONAL SUBMITTALS 1.8 DELIVERY, STORAGE, AND HANDLING

1.9 QUALITY ASSURANCE

- A. PRECONSTRUCTION CONFERENCE
 - 1. Conduct a preconstruction conference. Subcontractors that will be performing the work shall attend the preconstruction conference. Notify ENGINEER one week (7 days) prior to the date of the meeting.
- B. REGULATORY REQUIREMENTS
 - 1. All materials and methods shall comply with the requirements of the AHJ.

1.10 PERMITS

A. CONSTRUCTION MANAGER shall make application; pay permit fees; provide payment and performance bonds required of the CONSTRUCTION MANAGER by the AHJ.

1.11 TOPOGRAPHIC SURVEY

A. OWNER has or will perform a survey of the site, stake the property limits, and provide a reference benchmark elevation. CONSTRUCTION MANAGER shall be responsible for any additional offset staking or layout survey required to locate improvements and control grade of improvements. Be responsible for the proper location and level of the work and for the maintenance of reference lines and benchmarks. Any re-staking requested by the CONSTRUCTION MANAGER shall be done at his expense.

1.12 UNDERGROUND UTILITIES

- A. CONSTRUCTION MANAGER shall contact OKIE (811 or 1-800-522-OKIE) prior to construction for locating existing utilities.
- B. The underground utilities shown on the Drawings have been located from field survey surface information and existing drawings. ENGINEER and Surveyor make no guarantee that the underground utilities shown comprise all such utilities in the area, either in service or abandoned. The underground utilities are located as accurately as possible from information available; however, ENGINEER and Surveyor further do not guarantee that the underground utilities shown are in the exact location indicated either vertically or horizontally. ENGINEER and Surveyor have not physically located the underground utilities by probing, excavating, hydrovac, or by any other means.
- C. CONSTRUCTION MANAGER shall notify all utility companies and governmental agencies who may have utility lines on or about the premises or who may be affected by the construction. Notice shall be given no less than twenty-four hours prior to any work that may interfere with a utility.
- D. All existing structures, improvement and utilities designated to remain shall be adequately protected from damage that might otherwise occur due to construction operations. Where construction comes in close proximity to existing structures, utilities or appurtenances, or if it becomes necessary to move services, poles, guy wires, pipelines or other obstructions, CONSTRUCTION MANAGER shall notify and cooperate with the owner of the utility, structure, or appurtenance. The utility lines and other existing structures shown on the plans are for information only and are not guaranteed to be complete or accurate as to location and/or depth. CONSTRUCTION MANAGER shall be liable for damage to any utilities resulting from the CONSTRUCTION MANAGER's operations. During construction, all fire hydrants, valve boxes, fire or police call boxes and other existing utility controls shall be left intact, unobstructed and accessible unless noted on the plan.
- E. CONSTRUCTION MANAGER shall satisfy themselves as to the actual existing subsurface conditions, including but not limited to the depth, location and sizes of pipe or conduits of various kinds in place prior to beginning work. Where the exact depth of any utility or obstruction is not shown on a plan, excavation shall be made prior to reaching the obstruction in order to determine adjustments in grade if needed to prevent interference. Redesign to eliminate conflicts may be necessary.

1.13 CONSTRUCTION CONTROL

- A. Do not commence work until temporary erosion and sedimentation control measures are in place.
- B. CONSTRUCTION MANAGER shall be responsible for properly laying out the work, and for lines and measurements for the work executed under the Contract Documents. Verify the figures shown on the Drawings before ordering any materials and laying out the work, and report errors or inaccuracies in writing to the ENGINEER before commencing work. The ENGINEER or his representative will in no case assume the responsibility for laying out the work.
- C. Existing survey points other than those shown on the Drawings shall not be considered as acceptable control points unless approved by the ENGINEER. If approval is secured, CONSTRUCTION MANAGER remains responsible for maintaining them and for their accuracy. Be responsible for preserving all existing iron or metal, and all concrete survey points or monuments for the construction period.

1.14 PROJECT CONDTIONS

- A. TRAFFIC
 - 1. Obtain any required Work Zone Permits from the AHJ at least two (2) working days prior to the start of work and/or placing or removing any barricades or modifying existing traffic control devices.
 - CONSTRUCTION MANAGER shall be responsible for erecting and maintaining barricades and other traffic warning devices as necessary around the perimeter of construction and adjacent to any open trenches. Provide and maintain adequate detours around the work under construction. Provide sufficient lights, warning signs, and watchmen for the safety of the public.

- 3. Any temporary street closure shall be coordinated with and approved by the AHJ. CONSTRUCTION MANAGER shall establish all detour routes while streets are closed during construction. CONSTRUCTION MANAGER shall notify Fire, Police, and EMSA headquarters when any street is temporarily closed.
- 4. CONSTRUCTION MANAGER is responsible for the prompt replacement and/or repair of all traffic control devices and appurtenances damaged or disturbed due to construction. Any existing traffic signals, signal loops, conduits, cables, and other traffic control devices affected by the work shall be reset or replaced according to AHJ's specifications. Coordinate the work with the AHJ's traffic department.
- B. UTILITY INTERRUPTIONS
 - Do not interrupt any utility serving facilities occupied by Owner or others unless permitted by OWNER and the owner(s) of the utility. Temporary utility service shall be provided for any interruption. Notify OWNER and ENGINEER one week (7 days) in advance of proposed interruption of utility.
- C. SUBSURFACE CONDITIONS
 - 1. 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. Owner will not be responsible for interpretations or conclusions drawn from the data.
- D. EXCAVATION AND TRENCH SAFETY SYSTEMS
 - CONSTRUCTION MANAGER shall be responsible for complying with State laws and Federal regulations relating to excavation and trench safety, including those which may be enacted during the performance under this Contract. CONSTRUCTION MANAGER is advised that Federal Regulations 29 C.F.R. 1926.650-1926.652 have been, in their most recent version as amended, in effect since January 2, 1990. CONSTRUCTION MANAGER shall fully comply with the U.S. Department of Labor Occupational Safety and Health Administration (OSHA) regulations pertaining to excavations, trenching, and shoring and shall provide and familiarize its employees involved in excavation and trenching with the provisions in OSHA Pamphlet Number 2226, Excavating and Trenching Operations.

1.15 HAZARDOUS CONDITIONS

A. If CONSTRUCTION MANAGER encounters a Hazardous Environmental Condition or if CONSTRUCTION MANAGER or anyone for whom CONSTRUCTION MANAGER is responsible creates a Hazardous Environmental Condition, CONSTRUCTION MANAGER shall immediately: (i) secure or otherwise isolate such condition; (ii) stop all Work in connection with such condition and in any area affected thereby (except in an emergency); and (iii) notify OWNER and ENGINEER (and promptly thereafter confirm such notice in writing). OWNER shall promptly consult with ENGINEER concerning the necessity for OWNER to retain a qualified expert to evaluate such condition or take corrective action, if any.

PART 2 - PRODUCTS

2.1 GABIONS

- A. Gabions shall be double twisted hexagonal steel wire mesh galvanized gabions. Gabions shall be fabricated in such a manner that the sides, ends, lid and diaphragms can be assembled at the construction site into rectangular baskets of the sizes specified and shown in the drawings. Gabions shall be of single unit construction: the base, lid, ends, and sides shall be either woven into a single unit or edge of these members connected to the base section of the gabion in such a manner that strength and flexibility at the connecting point does not compromise the engineered structural design of the gabion. Where the length of the gabion exceeds on and one half its horizontal width, the gabion shall be divided by diaphragms of the same mesh and gauge as the body of the gabion, into cells whose length does not exceed the horizontal width. The gabion shall be furnished with the necessary diaphragms secured in proper position on the base in such a manner that no additional tying is required at this juncture.
- B. Mesh Formation
 - 1. The double twisted hexagonal wire mesh shall have deformability sufficient to permit minimum of mesh elongation equivalent to 10% of the unstretched length of the mesh test section without reducing the gauge or the tensile strength of the individual wire strands to values less than those for similar wire, one gauge smaller in diameter.
- C. Non-Raveling

- 1. The double twisted hexagonal wire mesh is to be fabricated in such a manner as to be non-raveling. This is defined as the ability to resist pulling apart at any of the twists or connections forming the mesh when a single wire strand in a section of mesh is cut or broken.
- D. Gabion fill
 - 1. The stone fill material used for filling the gabion units shall be clean, hard stone with pieces ranging from 4 to 8 inches on the greatest dimensions. Stone filling shall not exceed 18-inch vertical drop above the gabion basket. All effort shall be made to ensure that the stone fill material utilized in the design of the structure match the stone fill used in constructing the gabion structure.
- E. Wire Mesh
 - 1. Diameter of mesh wire: 0.120 inches
 - 2. Diameter of selvedge wire: 0.153 inches
 - 3. Diameter of lacing wire: 0.091 inches
 - 4. Coating of wire: finish 5 class 3 zinc coating- ASTM A-641 tested in accordance with ASTM A370-92.
 - 5. Tensile of wire: soft temper in accordance with ASTM A641-92
 - 6. Weight of zinc coating of wire: shall be determined by ASTM A-90
 - 7. Wire diameter of 0.120 inches shall have a weight of zinc coating of: 0.85 oz/sf
 - 8. Wire diameter of 0.153 inches shall have a weight of zinc coating of: 0.90 oz/sf
 - 9. Wire diameter of 0.091 inches shall have a weight of zinc coating of: 0.80 oz/sf
 - 10. Grade of zinc coating of wire: high grade or special high grade in accordance with ASTM B-6, Table 1.
 - 11. Uniformity of coating: shall be determined by ASTM A-239
 - 12. Elongation: not less than 12% in accordance with ASTM A370-92.
 - 13. All of the above wire diameters are subject to a tolerance limit of 0.004 in accordance with ASTM A-641.
- F. Manufactured according to ASTM A975-97 guidelines for Double Twisted Hexagonal Mesh Gabions.

2.2 MANUFACTURERS

A. Terra Aqua Gabions, Inc. 1415 N 32nd Street, Fort Smith, Arkansas 72904, 479-785-5344

PART 3 - EXECUTION

3.1 FOUNDATION PREPARATION

- A. The foundation on which the gabions are to be placed shall be cut or filled and graded to the lines and grades shown on the drawings. Surface irregularities, loose material, vegetation, and all foreign matter shall be removed from foundation surface area. When fill is required, it shall consist of materials conforming to 31 23 00 Excavation and Fill. Gabions and bedding shall not be placed until the foundation preparation is completed and the subgrade surface have been inspected, tested, and approved.
- B. Compaction of bedding or filter material shall be made per 31 23 00 Excavation and Fill. The surface of the finished material shall be to grade and free of mounds, dips or windrows. Extra care shall be taken with foundation preparation in order to ensure a level and smooth surface. Geotextile shall be installed in accordance with 31 23 00 Excavation and Fill.

3.2 ASSEMBLY AND PLACEMENT

- A. Each gabion unit shall be assembled by tying or fastening all connecting seams. The binding wire shall be tightly looped around every other mesh opening along the seams in such a manner that single and double loops are alternated. Alternative wire fasteners may be used in lieu of lacing wire. The alternative wire fasteners shall be applied at approximately 4" 6" intervals on all vertical and horizontal seams. No less than 3 fasteners per one foot on any given seam.
- B. A line of empty gabions, shall be placed into position according to the contract drawings. Binding wire or alternative wire fasteners shall be used to secure each unit to the adjoining one along the vertical reinforced edges and the top selvedges. An approved corner closure tool shall be used to adjoin adjacent gabions to insure a tight, neat seam and minimize gabion wired or fastened to the latter at front and back. The lid shall be secured with an approved closure tool to insure proper closure without excessive mesh deformation.
- C. To achieve optimum alignment and finish for retaining walls, a minimum amount of stretching may be required.
- D. Connecting wire shall be inserted during the filling operation as follows: The connecting wires shall be installed according to manufacturer's instructions every 1' vertical lift of the gabion unit.

3.3 FILLING OPERATION

- A. Empty gabion baskets shall be assembled individually and placed on the approved surface to the lines and grades as shown or as directed, with the position of all creases and that the tops of all sides are level. All gabion baskets shall be properly staggered horizontally and vertically as shown in the construction drawings. Finished gabion structures shall have no gaps along the perimeter of the contact surfaces between adjoining units. All adjoining empty gabion units shall be connected along the perimeter of their contact surfaces in order to obtain a monolithic structure. All lacing wire terminals shall be securely fastened. All joining shall be made through selvedge-selvedge or selvedge-edge wire connection; meshmesh wire connection is prohibited except in the case where baskets are offset or stacked and selvedge-mesh or mesh-mesh wire connection would be necessary. As a minimum, a fastener shall be installed at each mesh opening at the location where mesh wire meets selvedge or edge wire.
 - 1. The initial line of gabion basket units shall be placed on the prepared filter layer surface and adjoining empty baskets set to line and grade, and common sides with adjacent units thoroughly laced or fastened. They shall be placed in a manner to remove any kinks or bends in the mesh and to uniform alignment. The basket units then shall be partially filled to provide anchorage against deformation and displacement during the filling operation. The stone shall be placed in the units as specified or directed by the manufacturer.
 - 2. Deformation and bulging of the gabion units, especially on the wall face, shall be corrected prior to additional stone filling. Care shall be taken, when placing the stone by hand or machine, to assure that the PVC coating on the gabions will not be damaged if PVC is utilized. All stone on the exposed face shall be hand placed to ensure a neat compact appearance.
 - 3. Gabions shall be uniformly overfilled by about 1-3 inches to account for future structural settlements and for additional layers. Gabions can be filled by any kind of earth filling equipment. The maximum height from which the stones may be dropped into the baskets shall be 3'.
- B. Stone Placement
 - 1. When excavation and foundation preparation are completed, the pre-assembled gabions shall be placed in their proper location according to the plans provided. Gabions shall then be connected together and aligned prior to filling with stone. The stone fill shall have a gradation as listed or specified within the contract specifications or as listed within this specification. The stone fill shall be placed into the gabion units in 1' lifts. Cells shall be filled to a depth not exceeding 1' at a time. The fill layer should never be more than 1' higher than any adjoining cell. Connecting wires shall be installed from the front to back and side to side of the individual cells at each 1' vertical interval for gabions with a depth of 3'. The voids shall be minimized by using well graded stone fill and by hand placement of the facing in order to achieve a dense, compact stone fill. All corners shall be securely connected to the adjoining basket of the same layer before filing the units. When more than one layer of gabions is required, in order for the individual units to become incorporated into one continuous structure, the next layer of gabions shall be uniformly overfilled by about 1-2 inches to account for structural settlement.
- C. Lid Closing
 - The lids of the gabion units shall be tightly secured along all edges, ends and diaphragms in the same manner as described for assembling. Adjacent lids may be securely attached at the same time. The panel edges shall be pulled to be connected using the appropriate closing tools where necessary. Single point leverage tools, such as crowbars will not be acceptable. All end wire shall then be turned in.

END OF SECTION

SECTION 316329 – DRILLED CONCRETE PIERS AND SHAFTS

PART 1 - GENERAL

1.1 SUMMMARY

A. Section Includes:

1. Dry-installed drilled piers

1.2 UNIT PRICES

- A. Drilled Piers: Actual net volume of drilled piers in place and approved. Actual length may vary to coincide with elevations where satisfactory bearing strata are encountered. These dimensions may also vary with actual bearing value of bearing strata determined by an independent testing and inspecting agency. Adjustments are made on net variation of total quantities, based on design dimensions for shafts.
- 1. Base bids on indicated number of drilled piers and, for each pier, the design length from top elevation to bottom of shaft.
- 2. Unit prices include labor, materials, tools, equipment, and incidentals required for excavation, trimming, shoring, casings, dewatering, reinforcement, concrete fill, testing and inspecting, and other items for complete drilled-pier installation.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at agreed upon location.
- 1. Review methods and procedures related to drilled piers including, but not limited to, the following:
 - a. Review geotechnical report.
 - b. Discuss existing utilities and subsurface conditions.
 - c. Review coordination with temporary controls and protections.
 - d. Review measurement and payment of unit prices.
 - e. Review concrete delivery method.

1.4 ACTION SUBMITTALS

A. Shop Drawings: For concrete reinforcement, detailing fabricating, bending, supporting, and placing.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer that has specialized in drilled-pier work.

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Experience shall be relevant to anticipated subsurface materials, water conditions, shaft sizes and special techniques required.

- B. Testing Agency Qualifications: Qualified according to ASTM C1077, ASTM D3740, and ASTM E329 for testing indicated.
- C. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code Steel."
 - 2. AWS D1.4/D1.4M, "Structural Welding Code Reinforcing Steel."

1.7 FIELD 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. Interruption of Existing Utilities: Do not interrupt any utility to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:
 - 1. Notify Owner no fewer than two days in advance of proposed interruption of utility.
 - 2. Do not proceed with interruption of utility without Owner's written permission.
- C. 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, Owner is not responsible for interpretations or conclusions drawn front this data.
 - 1. Make additional test borings and conduct other exploratory operations necessary for drilled piers.
 - 2. The geotechnical report is referenced elsewhere in the Project Manual.
- D. 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 indicate on record Drawings. Cooperate with Owner's testing and inspecting agency to provide data for required reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Drilled-Pier Standard: Comply with ACI 336.1 except as modified in this Section.

2.2 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A61 5/A6 1 5M, Grade 60, deformed.
- B. Low-Alloy Steel Reinforcing Bars: ASTM 706/A706M, deformed.
- C. Galvanized Reinforcing Bars: ASTM 615/A615M, Grade 60, deformed bars, ASTM A767/A767M, Class I zinc coated after fabrication and bending.
- D. Epoxy-Coated Reinforcing Bars: ASTM 615/A615M, Grade 60, deformed bars, ASTM A775/A775M or ASTM A934/A934M, epoxy coated with less than 2 percent damaged coating in each 12-inch bar length.
- E. Plain-Steel Wire: ASTM A82/A82M, as drawn.
- F. Deformed-Steel Wire: ASTM A496/A496M.
- G. Joint-Dowel Bars: ASTM A615/A615M, Grade 60, plain. Cut bars true to length with ends square and free of burrs.

2.3 CONCRETE MATERIALS

A. Reference Specification Section 033000 "Cast-In-Place Concrete" for concrete mix design requirements.

2.4 CONCRETE MIXTURES

- A. Reference Specification Section 033000 "Cast-In-Place Concrete" for concrete mix design requirements.
- 2.5 REINFORCEMENT FABRICATION
 - A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

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.
 - 1. Contractor shall maintain a separate independent Pier Log. Record the following information for each pier.

- a. Identification mark
- b. Shaft diameter
- c. Bottom of pier elevation
- d. Steel reinforcing cage length, number and size of vertical bars and tie size and spacing
- e. Top of pier elevation
- f. Date and time of drilling is complete
- g. Date and time concrete placement is begun and is completed
- h. Plumbness variation
- i. Condition of drilled hole before placement of concrete
- j. Elevation of proper bearing stratum
- k. Embedment into bearing stratum
- 1. Water depth for bottom of pier at time of concrete placement

3.2 EXCAVATION

- A. Unclassified Excavation. Excavate to bearing elevations regardless of character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions.
 - 1. Obstructions: Unclassified excavated materials may include removal of unanticipated boulders, concrete, masonry, or other subsurface obstructions.
 - 2. Payment for removing obstructions that cannot be removed by conventional augers fitted with soil or rock teeth, drilling buckets, or underreaming tools attached to drilling equipment of size, power, torque, and downthrust necessary for the Work is according to Contract provisions for changes in the Work.
- B. Classified Excavation: Excavation is classified as standard excavation, special excavation, and obstruction removal and includes excavation to bearing elevations as follows:
 - 1. Standard excavation includes excavation accomplished with conventional augers fitted with soil or rock teeth, drilling buckets, or underreaming tools attached to drilling equipment of size, power, torque, and downthrust necessary for the Work.
 - 2. Special excavation includes excavation that requires special equipment or procedures where drilled-pier excavation equipment used in standard excavation, operating at maximum power, torque, and downthrust, cannot advance the shaft.
 - a. Special excavation requires use of special rock augers, core barrels, air tools, blasting, or other methods of hand excavation.
 - b. Earth seams, rock fragments, and voids included in rock excavation area are considered rock for full volume of shaft from initial contact with rock.
 - 3. Obstructions: Payment for removing unanticipated boulders, concrete, masonry, or other subsurface obstructions that cannot be removed by conventional augers fitted with soil or rock teeth, drilling buckets, or underreaming tools attached to drilling equipment of size, power, torque, and downthrust necessary for the Work is according to Contract provisions for changes in the Work.
- C. Prevent surface water from entering excavated shafts. Conduct water to site drainage facilities.

- D. Excavate shafts for drilled piers to indicated elevations. Remove loose material from bottom of excavation.
 - 1. Excavate bottom of drilled piers to level plane within 1:12 tolerance.
 - 2. Remove water from excavated shafts before concreting.
 - 3. Excavate rock sockets of dimensions indicated.
- E. Notify and allow testing and inspecting agency to test and inspect bottom of excavation. If unsuitable bearing stratum is encountered, make adjustments to drilled piers as determined by Architect.
 - 1. Do not excavate shafts deeper than elevations indicated unless approved by Architect.
 - 2. Payment for additional authorized excavation is according to Contract provisions for changes in the Work.
- F. Slurry Displacement Method: Stabilize excavation with slurry maintained a minimum of 60 inches above ground-water 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, or redrill, clean, and test slurry in excavation before concreting.
- G. 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. Remove temporary casings, maintained in plumb position, during concrete placement and before initial set of concrete.
- H. Tolerances: Construct drilled piers to remain within ACI 336.1 tolerances.
 - 1. If location or out-of-plumb tolerances are exceeded, provide corrective construction. Submit corrective construction proposals to Architect for review before proceeding.

3.3 STEEL REINFORCEMENT INSTALLATION

- 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 over 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.

3.4 CONCRETE PLACEMENT

- A. Place concrete in continuous operation and without segregation immediately after inspection and approval of shaft by a qualified testing agency.
- B. Dry Method: Place concrete to fall vertically down the center of drilled pier without striking sides of shaft or steel reinforcement.
 - 1. Where concrete cannot be directed down shaft without striking reinforcement, place concrete with chutes, tremies, or pumps.
 - 2. Vibrate top 60 inches of concrete.
- C. Coordinate withdrawal of temporary casings with concrete placement to maintain at least a 60-inch head of concrete above bottom of casing.
 - 1. Vibrate top 60 inches of concrete after withdrawal of temporary casing.
- D. 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.
- E. 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.
- F. If 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 more than 90 deg F.

3.5 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
 - 1. Drilled piers.
 - 2. Excavation.

- 3. Concrete
- 4. Steel reinforcement welding.
- B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- C. Drilled-Pier Tests and Inspections: For each drilled pier, before concrete placement.
 - 1. 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 are determined by testing and inspecting agency. Final evaluations and approval of data are determined by EOR.
- D. Concrete Tests and Inspections: Follow same requirements as given in Specification Section 033000, subsection "Field Quality Control".

3.6 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

END OF SECTION

SECTION 32 3223 SEGMENTAL RETAINING WALLS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Work shall consist of furnishing and construction of a Segmental Retaining Wall System or equal in accordance with these specifications and in reasonably close conformity with the lines, grades, design, and dimensions shown on the plans.
- B. Work includes preparing foundation soil, furnishing and installing leveling pad, unit drainage fill and backfill to the lines and grades shown on the construction drawings.
- C. Work includes furnishing and installing geogrid soil reinforcement of the type, size, location, and lengths designated on the construction drawings.

1.02 RELATED SECTIONS

A. Section 31 23 00 – Excavation and Fill

1.03 REFERENCE DOCUMENTS

A. American Society for Testing and Materials (ASTM)

	1.	ASTM C140	Sampling and Testing Concrete Masonry Units
	2.	ASTM C1372	Specification for Dry-Cast Segmental Retaining Wall Units
	3.	ASTM D422	Particle-Size Analysis of Soils
	4.	ASTM D698	Laboratory Compaction Characteristics of Soil -Standard Effort
	5.	ASTM D1557	Laboratory Compaction Characteristics of Soil -Modified Effort
	6.	ASTM D3034	Polyvinyl Chloride Pipe (PVC)
	7.	ASTM D4318	Liquid Limit, Plastic Limit and Plasticity Index of Soils
	8.	ASTM D4475	Horizontal Shear Strength of Pultruded Reinforced Plastic Rods
	9.	ASTM D4476	Flexural Properties of Fiber Reinforced Pultruded Plastic Rods
	10.	ASTM D4595	Tensile Properties of Geotextiles - Wide Width Strip
	11.	ASTM D5262	Unconfined Tension Creep Behavior of Geosynthetics
	12.	ASTM D5818	Evaluate Installation Damage of Geosynthetics
	13.	ASTM D6637	Tensile Properties of Geogrids – Single or Multi-Rib
	14.	ASTM D6638	Connection Strength - Reinforcement/Segmental Units
	15.	ASTM D6706	Geosynthetic Pullout Resistance in Soil
	16.	ASTM D6916	Shear Strength Between Segmental Concrete Units
В.	Ame	erican Association	of State Highway and Transportation Officials (AASHTO)

- 1. AASHTO M 252 Corrugated Polyethylene Drainage Pipe
- C. Geosynthetic Research Institute (GRI)
 - 1. GRI-GG4 Determination of Long Term Design Strength of Geogrids
 - 2. GRI-GG5 Determination of Geogrid (soil) Pullout
- D. National Concrete Masonry Association (NCMA)
 - 1. NCMA SRWU-1 Test Method for Determining Connection Strength of SRW
 - 2. NCMA SRWU-2 Test Method for Determining Shear Strength of SRW

1.04 DELIVERY, STORAGE AND HANDLING

- A. Contractor shall check all materials upon delivery to assure that the proper type, grade, color, and certification has been received.
- B. Contractor shall protect all materials from damage due to jobsite conditions and in accordance with manufacturer's recommendations. Damaged materials shall not be incorporated into the work.

PART 2 - PRODUCTS

2.01 DEFINITIONS

- A. Modular Unit a concrete retaining wall element machine made from Portland cement, water, and aggregates.
- B. Structural Geogrid a structural element formed by a regular network of integrally connected tensile elements with apertures of sufficient size to allow interlocking with surrounding soil, rock, or earth and function primarily as reinforcement.
- C. Unit Drainage Fill drainage aggregate, which is placed within and immediately behind the modular concrete units.
- D. Reinforced Backfill compacted soil, which is placed within the reinforced soil volume as outlined on the plans.

2.02 MODULAR CONCRETE RETAINING WALL UNITS

- A. Modular concrete units shall conform to the following architectural requirements:
 - 1. Face color concrete gray, unless otherwise specified. The Owner may specify standard manufacturers' color.
 - 2. Face finish sculptured rock face in angular tri-planer configuration. Other face finishes will not be allowed without written approval of Owner.
 - 3. Bond configuration running with bonds nominally located at midpoint vertically adjacent units, in both straight and curved alignments.
 - 4. Exposed surfaces of units shall be free of chips, cracks or other imperfections when viewed from a distance of 10 feet under diffused lighting.
- B. Modular concrete materials shall conform to the requirements of ASTM C1372 Standard Specifications for Segmental Retaining Wall Units.
- C. Modular concrete units shall conform to the following structural and geometric requirements measured in accordance with ASTM C140 Sampling and Testing Concrete Masonry Units:
 - 1. Compressive strength: \geq 3000 psi (21 MPa);
 - 2. Absorption: 8 % (6% in northern states) for standard weight aggregates;
 - 3. Dimensional tolerances: ± 1/8" (3 mm) from nominal unit dimensions not including rough split face, ±1/16" (1.5 mm) unit height top and bottom planes;
 - 4. Unit size: 8" (203 mm) (H) x 18" (457 mm)(W) x 18" (457 mm)(D) minimum;
 - 5. Unit weight: 100 lbs/unit (45 kg) minimum for standard weight aggregates.
- D. Modular concrete units shall conform to the following performance testing:
 - 1. Inter -unit shear strength in accordance with ASTM D6916 (NCMA SRWU-2): 1500 plf (21 kN/m) minimum at 2 psi (13 MPa) normal pressure;
 - 2. Geogrid/unit peak connection strength in accordance with ASTM D6638 (NCMA SRWU-1): 900 plf (13 kN/m) minimum at 2-psi (13 MPa) normal force.
- E. Modular concrete units shall conform to the following constructability requirements:
 - 1. Vertical setback: 1/8" (3 mm) ± per course (near vertical) or 1" (25 mm) + per course per the design;
 - 2. Alignment and grid positioning mechanism fiberglass pins, two per unit minimum;
 - 3. Maximum horizontal gap between erected units shall be $\leq 1/2$ inch (13 mm).

2.03 SHEAR CONNECTORS

- A. Shear connectors shall be 1/2-inch (12 mm) diameter thermoset isopthalic polyester resin-pultruded fiberglass reinforcement rods or equivalent to provide connection between vertically and horizontally adjacent units with the following requirements:
 - 1. Flexural Strength in accordance with ASTM D4476: 128,000 psi (882 MPa) minimum;
 - 2. Short Beam Shear in accordance with ASTM D4475: 6,400 psi (44 MPa) minimum.
- B. Shear connectors shall be capable of holding the geogrid in the proper design position during

grid pre-tensioning and backfilling.

2.04 BASE LEVELING PAD MATERIAL

A. Material shall consist of a compacted crushed stone base or non-reinforced concrete as shown on the construction drawings.

2.05 UNIT DRAINAGE FILL

A. Unit drainage fill shall consist of clean 1" (25 mm) minus crushed stone or crushed gravel meeting the following gradation tested in accordance with ASTM D-422:

Sieve Size	Percent Passing
1 inch (25 mm)	100
3/4-inch (19 mm)	75-100
No. 4	0 - 10
No. 50	0 - 5

B. One cubic foot (0.028 m3), minimum, of drainage fill shall be used for each square foot (0.093 m2) of wall face. Drainage fill shall be placed within cores of, between, and behind units to meet this requirement.

2.06 REINFORCED BACKFILL

A. Reinforced backfill shall be free of debris and meet the following gradation tested in accordance with ASTM D-422:

Percent Passing
100
100-75
0-60
0-35

Plasticity Index (PI) <15 and Liquid Limit <40 per ASTM D-4318.

- B. The maximum aggregate size shall be limited to 3/4 inch (19 mm) unless field tests have been performed to evaluate potential strength reductions to the geogrid design due to damage during construction.
- C. Material can be site-excavated soils where the above requirements can be met. Unsuitable soils for backfill (high plastic clays or organic soils) shall not be used in the backfill or in the reinforced soil mass.
- D. Contractor shall submit reinforced fill sample and laboratory test results to the Architect/Engineer for approval prior to the use of any proposed reinforced fill material.

2.07 GEOGRID SOIL REINFORCEMENT

- A. Geosynthetic reinforcement shall consist of geogrids manufactured specifically for soil reinforcement applications and shall be manufactured from high tenacity polyester yarn or highdensity polyethylene. Polyester geogrid shall be knitted from high tenacity polyester filament yarn with a molecular weight exceeding 25,000 Meg/m and a carboxyl end group values less than 30. Polyester geogrid shall be coated with an impregnated PVC coating that resists peeling, cracking, and stripping.
- B. Ta, Long Term Allowable Tensile Design Load, of the geogrid material shall be determined as follows:

Ta = Tult / (RFcr*RFd*RFid*FS)

Ta shall be evaluated based on a 75-year design life.

1. Tult, Short Term Ultimate Tensile Strength shall be determined in accordance with ASTM D4595 or ASTM D6637.

Tult is based on the minimum average roll values (MARV).

2. RFcr, Reduction Factor for Long Term Tension Creep

RFcr shall be determined from 10,000-hour creep testing performed in accordance with ASTM D5262. Reduction value = 1.45 minimum.

3. RFd, Reduction Factor for Durability

RFd shall be determined from polymer specific durability testing covering the range of expected soil environments. RFd = 1.10 minimum.

4. RFid, Reduction Factor for Installation Damage

RFid shall be determined from product specific construction damage testing performed in accordance with ASTM D5818 (GRI-GG4). Test results shall be provided for each product to be used with project specific or more severe soil type. RFid = 1.05 minimum.

5. FS, Overall Design Factor of Safety

FS shall be 1.5 unless otherwise noted for the maximum allowable working stress calculation.

- C. The maximum design tensile load of the geogrid shall not exceed the laboratory tested ultimate strength of the geogrid/facing unit connection as limited by the "Hinge Height" divided by a factor of safety of 1.5. The connection strength testing and computation procedures shall be in accordance with ASTM D6638 Connection Strength between Geosynthetic Reinforcement and Segmental Concrete Units (NCMA SRWU-1).
- D. Soil Interaction Coefficient, Ci

Ci values shall be determined per ASTM D6706 (GRI:GG5) at a maximum 0.75-inch (19 mm) displacement.

E. Manufacturing Quality Control

The geogrid manufacturer shall have a manufacturing quality control program that includes QC testing by an independent laboratory.

The QC testing shall include:

Tensile Strength Testing Melt Flow Index (HDPE) Molecular Weight (Polyester)

2.08 DRAINAGE PIPE

A. If required, the drainage pipe shall be perforated or slotted PVC pipe manufactured in accordance with ASTM D-3034 or corrugated HDPE pipe manufactured in accordance with AASHTO M252.

2.09 GEOTEXTILE FILTER FABRIC

A. When required, Geotextile filter fabric shall be 4.0 oz/sy, polypropylene, needlepunched nonwoven fabric.

PART 3 - EXECUTION

3.01 EXCAVATION

- A. Contractor shall excavate to the lines and grades shown on the construction drawings. Owner's representative shall inspect the excavation and approve prior to placement of leveling material or fill soils. Proof roll foundation area as directed to determine if remedial work is required.
- B. Over-excavation and replacement of unsuitable foundation soils and replacement with approved compacted fill will be compensated as agreed upon with the Owner.

3.02 BASE LEVELING PAD

A. Leveling pad material shall be placed to the lines and grades shown on the construction drawings, to a minimum thickness of 6 inches and extend laterally a minimum of 6" in front and
behind the modular wall unit.

- B. Soil leveling pad materials shall be compacted to a minimum of 95 % Standard Proctor density per ASTM D-698 or 92% Modified Proctor Density per ASTM D1557.
- C. Leveling pad shall be prepared to insure full contact to the base surface of the concrete units.

3.03 MODULAR UNIT INSTALLATION

- A. First course of units shall be placed on the leveling pad at the appropriate line and grade. Alignment and level shall be checked in all directions and insure that all units are in full contact with the base and properly seated.
- B. Place the front of units side-by-side. Do not leave gaps between adjacent units. Layout of corners and curves shall be in accordance with manufacturer's recommendations.
- C. Install shear/connecting devices per manufacturer's recommendations.
- D. Place and compact drainage fill within and behind wall units. Place and compact backfill soil behind drainage fill. Follow wall erection and drainage fill closely with structure backfill.
- E. Maximum stacked vertical height of wall units, prior to unit drainage fill and backfill placement and compaction, shall not exceed two courses.

3.04 STRUCTURAL GEOGRID INSTALLATION

- A. Geogrid shall be oriented with the highest strength axis perpendicular to the wall alignment.
- B. Geogrid reinforcement shall be placed at the strengths, lengths, and elevations shown on the construction design drawings or as directed by the Engineer.
- C. The geogrid shall be laid horizontally on compacted backfill and attached to the modular wall units. Place the next course of modular concrete units over the geogrid. The geogrid shall be pulled taut, and anchored prior to backfill placement on the geogrid.
- D. Geogrid reinforcements shall be continuous throughout their embedment lengths and placed side-by-side to provide 100% coverage at each level. Spliced connections between shorter pieces of geogrid or gaps between adjacent pieces of geogrid are not permitted.

3.05 REINFORCED BACKFILL PLACEMENT

- A. Reinforced backfill shall be placed, spread, and compacted in such a manner that minimizes the development of slack in the geogrid and installation damage.
- B. Reinforced backfill shall be placed and compacted in lifts not to exceed 6 inches where hand compaction is used, or 8 to 10 inches where heavy compaction equipment is used. Lift thickness shall be decreased to achieve the required density as required.
- C. Reinforced backfill shall be compacted to a minimum of 95 % Standard Proctor density per ASTM D-698 or 92% Modified Proctor Density per ASTM D1557. The moisture content of the backfill material prior to and during compaction shall be uniformly distributed throughout each layer and shall be dry of optimum, + 0%, - 3%.
- D. Only lightweight hand-operated equipment shall be allowed within 3 feet (1m) from the tail of the modular concrete unit.
- E. Tracked construction equipment shall not be operated directly upon the geogrid reinforcement. A minimum fill thickness of 6 inches is required prior to operation of tracked vehicles over the geogrid. Tracked vehicle turning should be kept to a minimum to prevent tracks from displacing the fill and damaging the geogrid.
- F. Rubber tired equipment may pass over geogrid reinforcement at slow speeds, less than 10 MPH (15 KPH). Sudden braking and sharp turning shall be avoided.
- G. At the end of each day's operation, the Contractor shall slope the last lift of reinforced backfill away from the wall units to direct runoff away from wall face. The Contractor shall not allow surface runoff from adjacent areas to enter the wall construction site.

3.06 CAP INSTALLATION

A. Cap units shall be glued to underlying units with an all-weather adhesive recommended by the manufacturer.

3.07 AS-BUILT CONSTRUCTION TOLERANCES

A. Vertical alignment: ± 1.5" over any 10' distance.

- B. Wall Batter: within 2 degrees of design batter.
- C. Horizontal alignment: ± 1.5" over any 10' distance.
- D. Corners, bends & curves: ± 1 ft to theoretical location.
- E. Maximum horizontal gap between erected units shall be $\leq 1/2$ inch

3.08 FIELD QUALITY CONTROL

- A. Quality assurance should include foundation soil inspection. Verification of geotechnical design parameters, and verification that the contractor's quality control testing is adequate as a minimum. Quality assurance shall also include observation of construction for general compliance with design drawings and project specifications. Quality assurance is best performed by the site geotechnical engineer.
- B. Quality Control The Contractor shall engage inspection and testing services to perform the minimum quality control testing described in the retaining wall design plans and specifications. Only qualified and experienced technicians and engineers shall perform testing and inspection services.
- C. Quality control testing shall include soil and backfill testing to verify soil types and compaction and verification that the retaining wall is being constructed in accordance with the design plans and project specifications.

END OF SECTION