NORTHWESTERN UNIVERSITY

MASTER SPECIFICATIONS

Division 32 – EXTERIOR IMPROVEMENTS

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Comply with most current edition of the Northwestern University Design Standards.

1.2 SUMMARY

A. Provide all labor, materials and equipment as necessary to complete all work as indicated on the Drawings and specified herein.

B. This Section includes:

1. Cold milling of existing hot-mix asphalt pavement.
2. Hot-mix asphalt patching.
3. Hot-mix asphalt paving.
4. Hot-mix asphalt paving overlay.
5. Asphalt surface treatments.

C. Related Sections:

1. Division 31 Section "Earth Moving" for aggregate subbase and base courses and for aggregate pavement shoulders.
2. Division 32 Sections for other paving installed as part of crosswalks in asphalt pavement areas.

1.3 DEFINITIONS

A. Hot-Mix Asphalt Paving Terminology: Refer to ASTM D 8 for definitions of terms.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.

1. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.

B. Qualification Data: For qualified manufacturer and Installer.
C. Material Certificates: For each paving material, from manufacturer.

D. Material Test Reports: For each paving material.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by authorities having jurisdiction or the Illinois DOT

B. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated.

C. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of the City of [Evanston / Chicago] for asphalt paving work.

1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

1.6 Project Conditions:

A. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of IDOT for asphalt paving work.

B. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:

1. HMA Temperature: Delivered between 250 deg F and 350 deg F
2. Prime Coat: Minimum surface temperature of 60 deg F
4. Asphalt Base Course: Minimum surface temperature of 40 deg F in the shade and rising at time of placement.
5. Asphalt Surface Course: Minimum surface temperature of 45 deg F in the shade at time of placement and rising at time of placement.

C. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 55 deg F for water-based materials, and not exceeding 95 deg F. When more restrictive, manufacturer limits shall be adhered to.

D. Imprinted Asphalt Paving: Proceed with coating imprinted pavement only when air temperature is at least 50 deg F and rising and will not drop below 50 deg F within 8 hours of coating application. Proceed only if no precipitation is expected.

PART 2 - PRODUCTS

A. Aggregates:

1. General: Use materials and gradations that have performed satisfactorily in previous installations.
3. Fine Aggregate: ASTM D 1073, sharp-edged natural sand or sand prepared from stone, gravel, or combinations thereof.
4. For hot-mix asphalt, limit natural sand to a maximum of 20 percent by weight of the total aggregate mass.
5. Mineral Filler: ASTM D 242, rock or slag dust, hydraulic cement, or other inert material.

B. Asphalt Materials:
2. Prime Coat: ASTM D 2027, medium-curing cutback asphalt matching IDOT MC-30 per Section 1032 of the Standard Specifications for Road and Bridge construction.
3. Tack Coat: IDOT SS-1, SS-1hP, CSS-1, CSS-1hP, emulsified asphalt or cationic emulsified asphalt, slow curing, diluted in water, per Section 1032 of the Standard Specifications for Road and Bridge Construction and of suitable grade and consistency for application.
4. Tack Coat: Where Paving Geotextile as an interlayer is used; Performance Grade asphalt binder of the same grade as the overlaying pavement.
5. Fog Seal: AASHTO M 140, emulsified asphalt, or AASHTO M 208 cationic emulsified asphalt, slow curing, factory diluted in water, of suitable grade and consistency for application.

C. Herbicide: Commercial chemical for weed control, registered by the EPA. Provide in granular, liquid, or wettable powder form.

D. Sand: AASHTO M 29 Grade Nos. 2 or 3.

E. Paving Geotextile (Reflective Crack Control): AASHTO M 288-06, nonwoven polypropylene; resistant to chemical attack, rot, and mildew; and specifically designed for paving applications.
2. Grab Tensile Strength: ASTM D4632, minimum 101 lbs
3. Asphalt Retention: ASTM 6140, minimum 0.20 gal/sq. yd.

F. Joint Sealant: ASTM D 6690 or AASHTO M 324 Type II or III Type II Type IV, hot-applied, single-component, polymer-modified bituminous sealant.

G. Pavement-Marking Paint Type 1: Alkyd-resin type, lead and chromate free, ready mixed, complying with AASHTO M 248, Type N Type F Type S; colors complying with FS TT-P-1952.
1. Colors: Yellow and/or White. Accessible spaces shall typically be yellow with blue and white signage.

H. Pavement-Marking Paint Type 2: Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952, Type II, with drying time of no more than 15 minutes
1. Colors: Yellow and/or White. Accessible spaces shall typically be yellow with blue and white signage.
2. Glass Beads: AASHTO M 247, Type 1.

I. Wheel Stops:
1. Locate sidewalks away from curbs to avoid the need for wheel stops.
2. If necessary, wheel stops shall be precast, air-entrained concrete, 3500-psi minimum compressive strength. Provide chamfered corners, drainage slots on underside, and holes for anchoring to substrate.
J. Dowels: Reinforcing Bars: ASTM A 615, Grade 60; deformed

K. Imprinted Asphalt Materials:
   1. Templates: Imprinted-asphalt manufacturer’s standard flexible templates for imprinting pattern into hot asphalt paving.
   2. Pattern: Specify or indicate on Drawings.

L. Coating System: Imprinted-asphalt manufacturer’s standard system formulated for exterior application on asphalt paving surfaces.
   1. Base Coating: Portland cement and epoxy-modified acrylic polymer blended with sand and aggregate, formulated for exterior application on asphalt paving surfaces.
   2. Top Coating: Epoxy-modified acrylic polymer blended with sand and aggregate, formulated for exterior application on asphalt paving surfaces.
   3. Colorant: UV-stable pigment blend, added to each coating layer.
   4. Color: Specify or indicate on Drawings.

M. Mixes:
   1. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes designed according to the Illinois Modified Strategic Highway Research Program criteria and the IDOT Special Provision “Superpave Bituminous Concrete Mixtures”.
   2. Binder Course Mixture N50, IL-19.0, Surface Course Mixture N50, IL-9.5, Mix “C” designed in accordance with Sections 1030 and Sections 406 and 407 of the Standard Specifications for Road and Bridge Construction and the special provision, “Quality Control/Quality Assurance of Bituminous Concrete Mixtures.”
   3. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
   4. Emulsified-Asphalt Slurry: ASTM D 3910, Type 1, consisting of emulsified asphalt, fine aggregate, and mineral fillers.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to begin paving.

B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
   1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction]. Limit vehicle speed to 3 mph.
   2. Proof roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
   3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

C. Proceed with paving only after unsatisfactory conditions have been corrected.
3.2 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

B. Prime Coat: Apply uniformly over surface of compacted unbound-aggregate base course at a rate of 0.15 to 0.50 gal./sq. yd. Apply enough material to penetrate and seal but not flood surface. Allow prime coat to cure.

1. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.
2. Protect primed substrate from damage until ready to receive paving.

C. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd.

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.3 PAVING GEOTEXTILE INSTALLATION

A. Apply tack coat uniformly to existing pavement surfaces at a rate of 0.20 to 0.30 gal./sq. yd.

B. Place paving geotextile promptly according to manufacturer’s written instructions. Broom or roll geotextile smooth and free of wrinkles and folds. Overlap longitudinal joints 4 inches and transverse joints 6 inches.

1. Protect paving geotextile from traffic and other damage and place hot-mix asphalt paving overlay the same day.

3.4 COMPACTION

A. General: Begin compaction as soon as placed hot-mix pavement will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg F. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

B. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density: 96 percent of reference laboratory density according to ASTM D 6927 but not less than 94 percent nor greater than 100 percent.
2. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent nor greater than 96 percent.
C. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

D. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

E. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

F. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

G. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.5 INSTALLATION TOLERANCES

A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Base Course: Plus or minus 1/2 inch.
2. Surface Course: Plus 1/4 inch, no minus.

B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:

1. Base Course: 1/4 inch.
2. Surface Course: 1/8 inch.
3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

C. Traffic-Calming Devices: Compact and form asphalt to produce the contour indicated and within a tolerance of plus or minus 1/8 inch of height indicated above pavement surface.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: NU will typically engage a qualified testing agency to perform tests and inspections.

B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.

C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

D. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979.

1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.
2. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.
   a. One core sample will be taken for every 1000 sq. yd. or less of installed pavement, with no fewer than 3 cores taken.
   b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.

E. Replace and compact hot-mix asphalt where core tests were taken.

F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.7 DISPOSAL

A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill. Contractor shall not allow milled materials to accumulate on-site.

END OF SECTION 32 1216
SECTION 32 1313 – CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Comply with most current edition of the Northwestern University Design Standards.

1.2 SUMMARY

A. Provide all labor, materials and equipment as necessary to complete all work as indicated on the Drawings and specified herein.

B. This Section includes:
   1. Driveways and roadways.
   2. Parking lots.
   3. Curbs and gutters.
   4. Walkways.
   5. Unit paver base.

C. Related Sections:
   1. Division 31 Section "Earth Moving" for aggregate subbase and base courses and for aggregate pavement shoulders.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

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

C. Qualification Data: For qualified ready-mix concrete manufacturer and testing agency.

Material Certificates: For the following, from manufacturer:
   1. Cementitious materials.
2. Steel reinforcement and reinforcement accessories.
3. Fiber reinforcement.
4. Admixtures.
5. Curing compounds.
7. Bonding agent or epoxy adhesive.
8. Joint fillers.

D. Material Test Reports: For each of the following:
   1. Aggregates.

E. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Ready-Mix-Concrete 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" (Quality Control Manual - Section 3, "Plant Certification Checklist").

B. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
   1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

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

D. ACI Publications: Comply with ACI 301 unless otherwise indicated.

1.6 Project Conditions:

A. Steel Reinforcement: Comply with CRSI’s “Manual of Standard Practice” for fabricating, placing, and supporting reinforcement.”

PART 2 - PRODUCTS

2.1 Forms:

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces. Use flexible or curved forms for curves with a radius 100 feet or less.

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

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


C. Reinforcing Bars: ASTM A 615, Grade 60; deformed.

D. Epoxy-Coated Reinforcing Bars: ASTM A 775 or ASTM A 934; with ASTM A 615, Grade 60 deformed bars.

E. Joint Dowel Bars: Plain steel bars, ASTM A 615, Grade 60. Cut bars true to length with ends square and free of burrs.

F. Epoxy-Coated Joint Dowel Bars: ASTM A 775; with ASTM A 615, Grade 60, plain steel bars.

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

H. Hook Bolts: ASTM A 307, Grade A, internally and externally threaded. Design hook-bolt joint assembly to hold coupling against pavement form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.

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

1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.
2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.

2.3 Concrete Materials:

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

1. Portland Cement: ASTM C 150, Type I II I/II III, gray, Supplement with the following:
   a. Fly Ash: ASTM C 618, Class F.

2. Blended Hydraulic Cement: ASTM C 595, Type IP, portlandpozzolan, or I PM, pozzolan-modified portland cement.

B. Normal-Weight Aggregates: ASTM C 33, coarse aggregate, uniformly graded. Provide aggregates from a single source.

2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
C. Exposed Aggregate: Selected, hard, and durable; washed; free of materials with deleterious reactivity to cement or that cause staining; from a single source, with gap-graded coarse aggregate as follows:
   2. Aggregate Source, Shape, and Color:

D. Water: ASTM C 94/C 94M.


F. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.
   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.

G. Curing Materials:
   1. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry.
   4. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.
   5. Clear Waterborne Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.
      a. Dries to low or medium luster, UV resistant, no color change.
      b. Reduction of Water absorption (NCHRP Series II): 75% minimum
      c. Reduction of Chloride Ion absorption (NCHRP Series II): 85% minimum.

H. Joint Filler: Two types of joint filler are listed below. Confirm use of sealant with NU.

I. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored waterreducing admixtures; color stable, free of carbon black, nonfading, and resistant to lime and other alkalis.

J. Slip-Resistive Aggregate Finish: Factory-graded, packaged, rustproof, nonlazing, abrasive aggregate of fused aluminum-oxide granules or crushed emery with emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials.

K. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
L. Types I and II, non-load bearing IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

M. Chemical Surface Retarder: Water-soluble, liquid-set retarder with color dye, for horizontal concrete surface application, capable of temporarily delaying final hardening of concrete to a depth of 1/8 to 1/4 inch.

N. Pigmented Mineral Dry-Shake Hardener: Factory-packaged dry combination of portland cement, graded quartz aggregate, color pigments, and plasticizing admixture. Use color pigments that are finely ground, nonfading mineral oxides interground with cement.

O. Pavement Markings:
   1. Pavement-Marking Paint: Alkyd-resin type, lead and chromate free, ready mixed, complying with AASHTO M 248, Type N Type F.
   2. Color: Accessible Spaces Yellow

P. Wheel Stops: Two types of wheel stops are described below. Review requirements with NU.
   1. Wheel Stops – Type 1: Precast, air-entrained concrete, 3500-psi. Provide chamfered corners and drainage slots on underside and holes for anchoring to substrate.
   2. Wheel Stops – Type 2: Solid, integrally colored, 96 percent recycled HDPE or commingled postconsumer and postindustrial recycled plastic; UV stabilized. Provide chamfered corners and drainage slots on underside and holes for anchoring to substrate.

2.4 Concrete Mixtures:

A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete determined by either laboratory trial mixes or field experience.

B. Proportion mixtures to provide normal-weight concrete with the following properties:

   1. Minimum Compressive Strength (28 Days): 4,000 psi.
   2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.32-0.42.
   3. Slump Limit: 4 inches, plus or minus 1/2 inch.

C. Add air-entraining admixture at manufacturer’s prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:

   1. Air Content: 5 to 8 percent for 1-inch to 1-1/2-inch nominal maximum aggregate size.

D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

E. Chemical Admixtures: Use admixtures according to manufacturer’s written instructions.

   1. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

F. Cementitious Materials: Limit percentage, by weight, of cementitious material other than portland cement according to ACI 301 requirements for concrete exposed to deicing chemicals.
G. 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.

2.5 Concrete Mixing:

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C and ASTM C 1116. Furnish batch certificates for each batch discharged and used in the Work.

1. When air temperature is between 85 deg F and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 45 minutes.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drumtype batch machine mixer.

2.6 Field Quality Control:

A. Testing Agency: NU will typically engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subbase surface below sidewalks to identify soft pockets and areas of excess yielding.

1. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.
3.4 STEEL REINFORCEMENT

A. General: Comply with CRSI’s “Manual of Standard Practice” for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

D. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction. Support on chairs.

3.5 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.

1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.

1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.

2. Butt Joints: Use bonding agent at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.

1. Locate expansion joints at intervals as shown on drawings.

2. Extend joint fillers full width and depth of joint.

3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.

4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.

5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.

6. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as shown on drawings:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch radius. Repeat grooving of contraction joints after applying surface finishes.
2. **Sawed Joints**: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.

E. **Edging**: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes.

### 3.6 CONCRETE PLACEMENT

A. **Before placing concrete**, inspect and complete formwork installation, steel reinforcement and items to be embedded or cast-in.

B. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.

F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

G. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

H. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels and joint devices.

I. Scoot paving surface with a straightedge and strike off.

J. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

K. Curbs and Gutters: Use design mixture for automatic machine placement. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing.

L. **Slip-Form Paving**: Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.

M. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.

N. Dowels shall be used when proposed concrete pavement is installed abutting existing concrete pavement and/or existing building walls and foundations.
O. Cold-Weather Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:

1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
2. Do not use frozen materials or materials containing ice or snow.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.

P. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms, [steel reinforcement], and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.7 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

3.8 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

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

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound or a combination of these as follows:

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

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover, placed in widest practicable width, with sides and ends lapped at least 12 inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears occurring during installation or curing period using cover material and waterproof tape.

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

3.9 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 and as follows:

1. Elevation: 3/4 inch.
3. Surface: Gap below 10-foot-long, unleveled straightedge not to exceed 1/2 inch.
4. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: 1/2 inch per 12 inches of tie bar.
5. Lateral Alignment and Spacing of Dowels: 1 inch.
7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches of dowel.
8. Joint Spacing: 3 inches.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: NU will typically engage a qualified independent testing and inspection agency to perform tests and inspections and prepare test reports.

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

1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.
   a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

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

3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when it is 80 deg F and above, and one test for each composite sample.

5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.

6. Compressive-Strength Tests: ASTM C 39/C 39M; test one specimen at seven days and two specimens at 28 days.

   a. A compressive-strength test shall be the average compressive strength from two specimens obtained from the same composite sample and tested at 28 days.

C. Strength of each concrete mixture will be satisfactory if 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.

D. 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.

E. 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.

F. 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.

G. Concrete paving will be considered defective if it does not pass tests and inspections.

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

3.11 REPAIRS AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.

B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.

C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.
D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 32 1313
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Comply with most current edition of the Northwestern University Design Standards.

1.2 SUMMARY

A. Provide all labor, materials and equipment as necessary to complete all work as indicated on the Drawings and specified herein.

B. This Section includes:

   1. Brick pavers.
   2. Prepared subgrade.
   3. Subbase.
   4. Sand leveling course.
   5. Fabric layer.

C. Related Sections:

   1. Division 31 Section “Earth Moving.”
   2. Division 32 Section for “Concrete Paving.”
   3. Northwestern University’s current Concrete Paver Program.

1.3 SUSTAINABILITY/REGIONAL MATERIALS

A. Precast concrete pavers and curbs shall be manufactured within 500 miles of Project site from aggregates and cement extracted and manufactured within 500 miles of Project site.

B. Granite and natural stone curbs shall be manufactured within 500 miles of Project site from materials extracted and manufactured within 500 miles of Project site.

C. Aggregate and soil extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.

1.4 SUBMITTALS

A. Furnish Samples, manufacturer’s product data, test reports, and materials certifications for brick.
1.5 QUALITY ASSURANCE

A. Approved Installation Contractors:

1. List of previously approved contractors

1.6 WARRANTY

A. Contractor agrees that by acceptance of this work and in consideration thereof, and for each of the Subcontractors, binds them to the guarantees and warranties called for. Work to be free from defective workmanship for 2 years after the date of final acceptance.

B. Warranty shall include filling of paver joints 1 year after installation at no additional cost.

C. If within warranty period, it is found that the warranted work needs to be repaired or changed because of the use of defective materials, equipment, or inferior workmanship, or work not in accordance with the terms of the Agreement, the Contractor, upon notification, shall promptly and without additional expense to the Owner:

1. Place such warranted work in a satisfactory condition.
2. Repair or replace damage to the Project, or contents thereof, which is a result of such unsatisfactory warranted work.
3. Repair or replace work, materials, and equipment that are disturbed in fulfilling the warranty, including disturbed work, materials, and equipment that may have been warranted under another Contract.

D. Should the Contractor fail to proceed promptly in accordance with the warranty, the Owner may have such work performed at the expense of the Contractor and sureties.

E. Contractor shall execute and deliver to the Owner, before final payment, a written warranty subject to the stipulations and provisions above.

PART 2 - PRODUCTS

2.1 BRICK PAVERS

A. General: Provide solid brick paver units, class SX, in colors where indicated on Drawings. Colors will be subject to NU Project Manager approval. Units are to be made from clay, shale, fireclay, or mixtures thereof, and shall be fired to incipient fusion. The units are intended for use as a paving material to support pedestrian and light vehicular traffic. Units shall conform to ASTM C902.

1. Pavers Adjacent to Concrete Curbs: 2-1/4-inch x 4-inch x 8-inch with spacer bars; color shall be KW Old Smokie supplied by Glen-Gery Brickwork or Belden Brick.
2. Pavers in Walk Panels: 2-1/4-inch x 4-inch x 8 inch with spacer bars, color and pattern to be determined. Supplied by Glen-Gery Brickwork or Belden Brick.

B. Physical Requirements and Tests:

1. Compressive Strength: Not less than 8,000 psi for an average of 5 brick, with no individual unit having a strength of less than 7,000 psi.
2. Cold Water Absorption: Shall not exceed 8% for an average of 5 brick, with no individual unit having an absorption of greater than 11%.

3. Saturation Coefficient (Maximum): Shall not exceed 0.78 for an average of 5 brick, with no individual unit having a coefficient of greater that 0.80. Saturation coefficient is the ratio of absorption by 24 hour submersion in room temperature water to that after 5 hours of submersion in boiling water.

4. Warpage: Shall not exceed 1/16-inch for each 6 inches of brick length when measured in accordance with ASTM C67 Section 12.

5. Efflorescence: When units are tested in accordance with Section 10 of Methods C67, the rating for efflorescence shall not be more than "slightly effloresced."

6. Abrasion Requirements: The Abrasion Index for brick paver units shall not exceed 0.11. The Volume Abrasion Loss (CM^3/CM^5) shall not exceed 1.7.

7. Chippage: Maximum permissible extent of chippage from edges shall be 1/4-inch; from corners shall be 3/8-inch. The aggregate length of chips on a single unit shall not exceed 10% of the perimeter of the exposed face of the brick.

8. Dimensional Tolerances: Brick pavers shall conform to ASTM grade PX. Brick to be selected will be approximately 2-1/4-inch x 4-inch x 8-inch.

2.2 SUBBASE

A. Base Course: 6-inch thick concrete paving as specified in Division 32 Section “Concrete Paving.”

B. Leveling Course: Clean, coarse, concrete sand (not mason sand), with the following gradation limits:

1. Sieve Size: 3/4-inch; Percent Passing: 100.
2. Sieve Size: 4-inch; Percent Passing: 90 to 100.
3. Sieve Size: 8-inch; Percent Passing: 80 to 95.
4. Sieve Size: 16-inch; Percent Passing: 55 to 85.
5. Sieve Size: 50-inch; Percent Passing: 10 to 35.
6. Sieve Size: 200-inch; Percent Passing: 0 to 5.

2.3 SEPARATOR FABRIC

A. AMOCO Landscape Fabric; or approved equal.

2.4 JOINT SAND


2.5 EDGE RESTRAINTS

A. Stainless Steel or Aluminum.

2.6 CURBS

A. Precast concrete or Granite
PART 3 - EXECUTION

3.1 PLACEMENT

A. Leveling Course: Spread evenly over concrete base to be paved and screed to a level that will produce the required finished elevation when the brick pavers have been placed and vibrated.

B. Separator Fabric: Secure over concrete base drainage openings, as well as over leveling course. Locate to minimize seams, where seams are necessary, and overlap fabric 6-inch minimum.

C. Brick Pavers:
   1. Lay in the pattern indicated on Drawings; joints between units shall not exceed 1/8-inch. Brick shall be cut to a straight, even surface without cracks or chips. To minimize need for small brick segments, review brick layout with landscape architect. Brick row alignments shall be uniform and straight.
   2. Vibrate to final level by 2 or 3 passes of a vibrating plate compactor. After the first vibration, joint sand shall be swept into joints. To avoid scratching, do not pass vibrating plate over brick with sand on the surface. Execute additional passes of the plate vibrator. Sweep fill the joints again if necessary to completely fill joints. Surplus material shall then be swept from the surfaces and the entire site left clean. The finished surface shall be true to grade and shall not vary by more than 1/4-inch when tested with a 10-foot board at any location on the surface.

D. Install joint sand the full depth of the joints and as indicated in the manufacturer’s specifications.
   1. Water the pavers in a manner that will activate the polymeric binder without washing the sand away.

END OF SECTION 32 1400
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Comply with most current edition of the Northwestern University Design Standards.

1.2 SUMMARY

A. Provide all labor, materials and equipment as necessary to complete all work as indicated on the Drawings and specified herein.

B. This Section includes:

1. Irrigation systems.

C. Suggested Division of Work: Sleeves under roads shall be installed by excavation contractor and coordinated with irrigation contractor.

D. This irrigation system guideline is for design-build system as well as designed systems, and is considered minimum standards for Northwestern University.

E. A sample technical specification Section 32 8400 – Planting Irrigation prepared by Northwestern University is available for information and reference. Review specific project requirements with the NU Project Manager during the design phase.

F. Work specified or called for on the drawings, shall be executed in accordance with governing ordinances, laws, and regulations and shall meet local codes and conditions. Changes or additions in the work necessary to meet ordinances, regulations, and/or conditions shall have the prior written approval of Northwestern University.

1.3 SUBMITTALS

A. Furnish Samples, manufacturer's product data, test reports, and materials certifications for brick.

1.4 Design Considerations:

A. The design of the system shall be according to standard practices of the Irrigation Association, local codes, Northwestern Standards and manufacturer's recommendations.
B. Irrigation should contain rain-sensors, soil moisture sensors, solar clocks where applicable and/or other sustainable friendly measures. When possible irrigation water source should be derived from site water collection and re-use such as a cistern.

C. Maximum velocity of water through piping and equipment = 5ft per second all piping shall not exceed 75% of it rated GPM or psi capacity. Metallic pipe for any exposed piping, PVC pipe Sch40 1-1/2-inch and smaller SDR21 for 2-inch and larger 1-inch to 1-1/2-inch polyethylene may be used for lateral piping.

D. Rotary heads are only allowed on areas exceeding 16’ spacing the rotor must be equipped with the stainless steel riser models for areas with head spacing up to 50’ Hunter I-20stainless for areas with head spacing exceeding 50’ or heavy use areas such as sports fields or open activity areas use Toro 640 series.

E. Pop-up spray heads only. Use 4-inch pop-ups for turf areas and 12-inch pop-ups for plantings.

F. The angel of trajectory of the sprinkler head should be calculated so that the spray will be above the expected mature plant elevation use Rainbird 1800 series.

G. Planting beds and turf areas must be located on separate zones.

H. All sprinklers heads within a zone to operate at no more than a maximum loss of 3 psi from solenoid valve to farthest sprinkler head. The zone to have 25% available capacity for higher GPM nozzles or additional sprinklers.

I. The spray of the sprinklers shall not intentionally reach or spray over walk or pavement. Sprinkler heads spacing, only triangular or square sprinkler head spacing is to be used (signal row spacing is not allowed) 8’ maximum spacing for landscape planting areas. Detail all pipe sizes from the point of connection and all irrigation pipe sizes. Include a minimum of one quick coupler valve per 70’ hose can reach all areas.

J. Irrigation Controller to be housed in a stainless enclosure and UL listed. Controller to be internet based with all equipment including added lighting protection and flow meters to monitor all zones and to include starting at acceptance 1 year of Internet control programming communication of service Model Irritrols Rain Master Eagle Plus.

K. Show all details of tap, meter, meter pit, RPZ valve, RPZ enclosure, blowout connection and all other related details. Give a detailed description of winterization procedures and spring start-up, the description shall be detailed so Northwestern University can perform these procedures.

L. Pipe Depth – Minimum Finished Grade to Top of Pipe:

1. Lateral 16-inches to 24-inches.
2. Mainline 24-inches to 36-inches.

M. Sleeves: Pipes under walks or pavement to be sleeved with the sleeve shall be 2 times larger than the pipe size all wire shall be in a separate conduit or sleeve.

1. Minimum sleeve depth for walks: 24-inches.
2. For pavement with vehicle traffic: 36-inches.
1.5 SUBMITTALS

A. Submittals: Shop drawings and submittals are required shall be submitted and approved prior to starting work. Design drawings and submittals are to be prepared by an Illinois registered Professional Engineer or State of Illinois licensed Plumbing Contractor detailing the entire layout of the planned irrigation system.

1. Minimum requirements include characteristics of the system including pipe type, pipe size, manufactures, part names, part numbers, model numbers, equipment type and layout, and fabrication.

2. The design shall include calculations indicating gallons per minute, pressure all water calculations are to be indicated at point of connection solenoid valves, sprinkler heads and any other pertinent equipment.

3. An Illinois registered professional engineer or State of Illinois licensed Plumbing contractor shall stamp and put his or signature with identifying license number on each design drawing and submittal.

1.6 QUALITY ASSURANCE

A. Approved Installation Contractors:

1. List of previously approved contractors who are certified to install HDPE pipe and the fusion jointing of fittings to HDPE pipe

B. Coordination: Contractor shall coordinate irrigation and excavation work, and coordinate with NU for the installation of mainline, sleeves and Owner provided items.

C. Weekly construction meetings with irrigation contractor, NU staff and the Project Representative will be held to coordinate work and installation sequence. Attendance at meetings is mandatory.

1.7 SEQUENCING AND SCHEDULING

A. The Owner will contract separately for the removal and replacement of pavement surfaces, the installation of sleeves as indicated on Drawings.

B. The Owner will install electric power for well system, booster pumps and irrigation controllers.

C. Should existing valves require replacement, the Owner will perform that work. Contractor shall remove the existing piping downstream of valve and connect the new piping to the valve.

1.8 WARRANTY

A. For a period of 1 year from the date of final acceptance, Contractor shall provide a labor warranty to promptly furnish and install, without cost to the Owner, and all parts which prove defective in material or workmanship.

B. If irrigation system fails as a result of defective workmanship or materials, and the failure causes damage to landscape or site features and finishes, then repair of the irrigation system shall include repairing or replacing the damaged landscape and site features. Repair of the irrigation system and costs to repair landscape and site features shall be at Contractor’s expense.
C. Pipe warranty installation data form shall be filled out and forwarded to the company and warranty presented to the Owner after completion and prior to payment.

1.9 MAINTENANCE
A. Owner will winterize the system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Toro.

2.2 POLYETHYLENE PIPE
A. Lines 1-1/4-inch and smaller shall be high-density (HD) flexible, non-toxic polyethylene pipe made from 100% virgin polyethylene material, NSF approved. All sizes shall have a minimum 100 psi working pressure rating (ASTM F239), conforming to NSF standard for thermoplastic pipe dimensions ratio of SDR-15.

B. 2-inch and larger (where specified on drawings as HDPE) shall be high-density, flexible, non-toxic polyethylene pipe (HDPE) made from 100% virgin polyethylene material, NSF approved. All sizes shall have a minimum 100 psi working pressure rating (ASTM F239), conforming to NSF standard for thermoplastic pipe dimensions ratio of DR-11.

C. Polyethylene pipe shall be continuously and permanently marked with the manufacturer’s name, material, size and schedule.

D. Pipe shall conform to the US Department of Commerce Commercial Standard CS255-63-PE-3408 or latest version thereof. Pipe shall be suitable for potable water and shall bear the NSF trademark.

2.3 PVC PIPE
A. Lines 1-1/2-inch and larger shall be virgin, high-impact polyvinyl chloride (PVC-1120), conforming to NSF Standard 14 and ASTM D2241 for thermoplastic pipe with a minimum 160 psi test strength.

B. Pipe shall have standard thermoplastic pipe dimension ratio of SDR-26 and shall be continuously and permanently marked with the manufacturer’s name, material, size and schedule.

2.4 POLYETHYLENE PIPE FITTINGS
A. All fittings 1-1/4-inch and smaller, downstream of control valve, shall be plastic himax barbed insert fittings.

B. Fittings for HDPE pipe shall be fusion joined.
C. Joints shall be clamped with all stainless steel worm gear clamps.

2.5 PVC PIPE FITTINGS

A. Fittings 1-1/2-inch through 3-inch shall be Schedule 40 PVC solvent weld, Type 1, meeting the requirements of ASTM D2466. No saddles allowed.

B. 4-inch fittings shall be gasketed joint Harco PVC Class 200, meeting ASTM D1784 DR21 requirements. Bell shall be gasket joint conforming to ASTM D3139 with gaskets conforming to ASTM F477.

C. 6-inch and larger fittings shall be Harco Ductile Iron Fittings, manufactured with a grade of 65-45-12 in accordance with ASTM A536. Fittings shall have deep push-on joints with gaskets meeting ASTM F477 requirements.

2.6 VALVES AND VALVE BOXES

A. Isolation Valves:

1. Valves 2-inch and smaller shall be brass ball valves.
2. Valves 2-1/2-inch and larger shall be Matco 10RT-gate valve key operated.

B. Automatic Valves: As indicated on Drawings.

C. Quick Couplers: As indicated on Drawings.

D. Valve Boxes:

1. Manufacturer: [Coordinate with NU Facilities Management Operations]
2. Valves shall be protected by a 2-piece or 3-piece valve box assembly consisting of a removal cover, box and extension (if required). The enclosure shall be rigid plastic material composed of fibrous components chemically inert and unaffected by moisture, corrosion and temperature changes.
3. Box Sizes:
   a. 6-inch diameter for quick couplers.
   b. 10-inch diameter for all automatic valves, ball valves and splice locations.
   c. Side walls to extend to at least 2 inches below the bottom of the valve body; for deep mainline, appropriate extensions shall be used to reach depth of valve. Valve box shall not bear directly on pipe.
   d. 10 inch x 12 inch Rectangular box with locking lid for gate valves and drip zone valve assembly.
4. Valve box shall be supported on all sides with a 2-inch x 4-inch x 8-inch concrete brick; or approved equal.

2.7 SWING JOINTS

A. Sprinklers with the body of the unit buried in soil shall be attached to the piping with 2-elbow joints consisting of 3/8-inch flexible pipe with coordinating himax barbed elbows.
B. Quick coupling valves shall be installed using a Spears swing joint with brass assembly, model #5815-01018. Size shall match inlet size of quick coupling valve.

2.8 COMMUNICATION CIRCUITRY - ELECTRIC

A. Wire shall be 600-volt soft annealed copper, PVC insulated, UL approved, direct burial UF. Wire insulation color shall be of a different color than the wires used on the 115 volt A.C.

B. Minimum Wire Size:

1. 0 to 500 Lineal Foot Runs: No. 16 single strand.
2. 500 to 2,000 Lineal Foot Runs: No. 14 single strand.
3. Over 2,000 Lineal Foot Runs: No. 12 single strand.

C. Splice wires only at valve boxes. Join wires with wire nuts and 3M Scotchpack sealing kit or 3M DBR/Y direct bury splice kit.

2.9 SPRINKLER HEADS

A. Heads in landscape beds must be 12 inch bottom-feed pop-up type.

B. Heads in turf areas must be a 6 inch pop-up, 5 inch rotor, or 12 inch rotor.

2.10 CONTROLLERS

A. As indicated on Drawings.

B. Must be compatible with Sentinel Central Control system.

C. Must include an in-line flow sensor which is capable of reporting to Sentinel Central Control system.

2.11 BACK FLOW PREVENTION DEVICE

A. As indicated on Drawings.

2.12 SLEEVES

A. All sleeves to be sized at 6” which shall be a minimum PVC 160 or Schedule 40 DWV pipe. Sleeves to be installed perpendicular to hard surface with which it passes under unless otherwise specified by Owner.

B. Marker ball shall be used to mark at least one end of sleeve unless sleeve crosses hard surface in distance greater than 25’ then marker balls to be attached to both ends (Marker balls provided by Owner.) Refer to EARTHWORK- 312300 for appropriate color coding of marker ball for irrigation.
2.13 SOLVENT AND PRIMER

A. Solvent and primer used on PVC pipe shall meet the requirements of ASTM D2564 and shall be approved by the National Sanitation Foundation. All solvent and primer shall be used in accordance with manufacturer’s specifications. Primer to be purple in color.

B. Solvent shall be used as is from original container. No thinner shall be added to the solvent to change its viscosity. If viscosity or consistency is unsuitable, the solvent shall not be used.

PART 3 - EXECUTION

3.1 PREPARATION

A. Contractor shall contact utility-locator service (J.U.L.I.E.) for area where Project is located before excavating. A private utility locating service may be required for non-public utilities. Contractor shall be responsible for utilities damaged within 3 feet on either side of the staked route. It shall be the responsibility of Contractor to maintain the staked route throughout construction.

3.2 GENERAL

A. Place sleeves under pavement systems, with the top of pipe 18 inches below the finished surface.

B. Install equipment in strict accordance with the manufacturer’s recommendations.

C. Excavation and Backfill: In accordance with Division 31 Section “Earth Moving.”

D. Contractor shall be responsible for full and complete coverage of irrigated areas and will be required to make necessary minor adjustments at no additional cost to the Owner.

3.3 LAYOUT AND STAKING

A. Piping indicated on the Drawings is generally diagrammatic, however, the main line location on the Drawings is indicated where the Owner would prefer to see the route because of tree roots and other obstacles. Contractor and Owner shall together field verify the precise location of the main line, valves, and quick couplers. Contractor shall lay the system out for Owner approval.

3.4 TRENCHING

A. Trenches shall be excavated so that the irrigation lines are installed with the following minimum depths for pipe cover:

1. Polyethylene Lateral Pipe: Minimum depth 12 inches.
2. PVC Lateral Pipe 1-inch: Minimum depth 12 inches.
3. PVC Pipe:
   a. 1-1/2-inch to 2-inch Pipe Size: 16-inch cover.
   b. 2-1/2-inch to 4-inch Pipe Size: 20-inch cover.
   c. 6-inch to 8-inch Pipe Size: 24-inch cover.
B. PVC piping shall be trenched. PVC pipe 2-1/2-inch and smaller may be pulled provided depth of pipe is maintained at a minimum of 20-inch cover.

C. Polyethylene distribution pipe may be pulled provided a 12-inch minimum depth is maintained.

D. Trench excavation in excess of required depth shall have the bottom graded and tamped prior to placement of pipe.

E. Where trenching of PVC or polyethylene pipe lines is not possible because of adverse soil conditions or obstructions, and backhoe operations is required, provide labor, materials and equipment for this operation.

F. Existing soils may be assumed to be adequate to support pipe as bedding and excavated soils shall be used as backfill in all lawn areas. Backfill material shall be free from debris, including rocks, large stones, clay clumps or other unsuitable substances. Care shall be taken to prevent settling and damage to pipe during and after backfilling operations. New piping 4-inch and 6-inch diameter shall be laid on a leveling bed compacted to maximum thickness of 6 inches. If existing excavated onsite soils are found to be unacceptable for pipe bedding or backfill, the Owner shall provide and deliver to the Project site, sand to be used by Contractor for backfill. Contractor shall review such conditions with the Project Representative and sand backfill will be delivered within 48 hours of such determination. Contractor shall provide equipment to haul soils from onsite stockpile site to work area. Excess soils shall be hauled by Contractor to an NU disposal area as directed by the Project Representative. Dig holes in bedding for bells and fittings so pipe bears uniformly along its length. Hand compact the haunching under the spring line of the pipe. Take extra care to control the density of the haunching on plastic pipe in accordance with the manufacturer’s instructions. When backfilling, soil shall be tamped in 6-inch layers with a minimum of 6 inches of acceptable soil.

G. Pavement:

1. No pavement shall be removed to install sleeves without approval of the Campus Arborist.
2. If Contractor determines that pavement must be removed, the pavement shall include the entire flag of concrete paving or 24 inches on each side of the trench for bituminous paved areas.
3. Replacement paving shall match Owner’s specifications and be installed by the Owner’s unit cost Contractor. The cost for removing and replacing pavement shall be at the irrigation Contractor’s expense.

3.5 PIPING INSTALLATION

A. No work will be permitted within the drip-line of trees without approval of the Project Representative.

B. PVC pipe shall be laid on solid undisturbed soil or on thoroughly compacted full bed of sand. Maintain proper alignment and minimum slope for drainage.

C. Polyethylene pipe connections shall be made with insert fittings held tightly in place with worm gear driven stainless steel clamps and screws at ferrules. Pipe sized 1-1/4-inch shall be double clamped.
D. PVC pipe ends and PVC fittings shall be thoroughly cleaned for full depth of fitting with liquid cleaner cement. Method of application shall be in accordance with manufacturer’s recommendations for solvent weld connections.

E. At wall penetrations, pack the opening around pipe with non-shrink grout. At exterior face, leave perimeter slot approximately 1/2-inch wide by 4/5-inch deep. Fill this slot with backer rod and acceptable elastomeric sealant.

F. Install PVC pipe during dry weather when temperature is above 40 degrees F (4 degrees C), in strict accordance with manufacturer’s instructions. Allow joints to cure at least 24 hours at temperatures above 40 degrees F.

3.6 CONNECTION TO WATER SOURCE

A. Point of connection shall be as indicated on Drawings. Contractor shall verify point of connection with the Project Representative.

3.7 CROSS CONNECTION PROTECTION

A. Install according to State and local plumbing codes. Piping shall be galvanized steel pipe or copper pipe.

3.8 SPRINKLER HEADS

A. Flush circuit lines with full head of water and install heads after flushing is complete.

1. Install lawn heads at manufacturer’s recommended heights.
2. Install high pop risers flush with grade or as indicated on Drawings.
3. Locate part-circle heads to maintain minimum distance of 4 inches from walls and windows and 2 inches from other boundaries, unless directed by the Project Representative.
4. Irrigation heads shall be installed on swing joints, funny pipe, or as indicated on Drawings.
5. Nozzles shall match sprinkler head manufacturer.

3.9 DIELECTRIC PROTECTION

A. Use dielectric fittings at connections where pipes of dissimilar metals are joined.

3.10 THRUST BLOCK

A. Provide concrete thrust blocks on thrust side of mainline pipe wherever pipe changes direction at tees, bends, or dead ends and at other locations where thrust is to be expected. Thrust blocks on 4-inch or larger pipes.

B. Refer to pipe manufacturer’s recommendations of type and method of thrust blocks.

3.11 AUTOMATIC CONTROLLERS AND FLOW METERS

A. Install controller according to manufacturer’s recommendations and as indicated on Drawings. Electric power for controller will be provided by Owner.
B. Connect remote control valves to controller in the sequence as indicated on Drawings.

C. 2-inch PVC pipe (or size as required for larger wire bundle) shall be used as a conduit for control wires from 6 inches below ground at the main line to the control box. Secure the PVC pipe with metal brackets bolted to the building with proper anchors.

D. Install flow meter no less than 5 times the meter’s diameter away from the last obstruction (“T”, elbow, valve, etc.) and 10 times the meter’s diameter prior to the next obstruction.

### 3.12 ADJUSTING

A. Upon completion of the system, adjust system components to provide optimum performance, including:

1. Synchronization of controllers.
2. Adjustment to pressure regulators and pressure relief valves.
3. Part circle sprinkler head.
4. Individual station adjustments.
5. Other adjustments necessary to obtain satisfactory performance of system.
6. Flush lines and evacuate air and debris from system.

### 3.13 FIELD QUALITY CONTROL

A. Punch List: Upon completion of irrigation work, Contractor shall notify the Owner that installation is complete as indicated on the Drawings and in the Specifications and is ready for inspection. The Owner and Contractor will inspect the installation together. A punch list will be prepared by the Owner that indicates non-conformances with Drawings and Specifications. Contractor shall immediately correct errors identified.

B. Record (As-Built) Drawings: Contractor shall provide accurate record drawings showing dimensions from stationary points as they relate to items including valves, main and lateral lines, controllers, and quick couplers. Record drawings shall be submitted before final payment will be approved. Upon request, Owner will provide paper or electronic copies of design documents for Contractor’s convenience.

### 3.14 DEMONSTRATION

A. After completion, testing and acceptance of the system, instruct Owner’s staff regarding the operation and maintenance of the system.
SECTION 32 9200 – TURF AND NATIVE/ADAPTIVE PLANTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Comply with most current edition of the Northwestern University Design Standards.

1.2 SUMMARY

A. Provide all labor, materials and equipment as necessary to complete all work as indicated on the Drawings and specified herein. Review specific project requirements with NU during the design phase.

B. This Section includes:

1. Topsoil.
2. Fertilizer.
3. Seed.
4. Mulch.
5. Sod.

1.3 SUBMITTALS

A. Quality Assurance/Control Submittals: Supplier's certified analysis for each seed and fertilizer mixture required.

1.4 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in original, unbroken, brand marked containers or wrapping indicating weight, analysis and manufacturer's name.

B. Handle and store materials in a manner which will prevent deterioration, damage, contamination with foreign matter, damage by weather or elements, and in accordance with manufacturer's directions.

C. Reject damaged, deteriorated or contaminated material shall be immediately removed from the site. Replace rejected materials with new materials at no additional cost to NU.

1.5 PROJECT CONDITIONS

A. Contractor shall obtain and submit copies to Northwestern University all necessary related city and environmental permits (e.g. irrigation – water department permits; use of city hydrants - city hydrant permit, etc.).
PART 2 - PRODUCTS

2.1 MATERIALS

A. Topsoil:
   1. Natural loam topsoil.
   2. Uniform quality.
   3. Free of undesirable material.
   4. Organic content greater than 6% by weight.
   5. Acidity between pH 5.0 and pH 8.0.

B. Fertilizer:
   1. Dry Fertilizer: Ready mixed granular material containing equal amounts by weight of available nitrogen (N), readily available phosphoric acid (P2O5) and total available potash (K2O), (12-12-12).
   2. Liquid Fertilizer for Hydrosed: 16-32-4 containing no chlorine.
   3. Minimum 40% filler by weight.

C. Seed:
   1. Uniform mixtures composed of seed of the following proportions by weight:
      a. Drain Side Slopes, Spoil Banks, and Other Disturbed Areas: 35% creeping red fescue, 10% Kentucky bluegrass, 2% red top, 35% tall fescue, 3% timothy, 15% birdsfoot trefoil.
      b. Lawns: 30% perennial rye grass, 30% Kentucky bluegrass, 40% creeping red fescue.
   2. Legumes shall be inoculated with the proper nitrogen fixing bacteria within 24 hours prior to seeding.
   3. Germination of seeds shall be 80% minimum.
   4. Purity of seeds shall be 90% minimum.

D. Mulch:
   1. Anchoring Material for Small Grain Mulch:
      a. Netting:
         1) Biodegradable.
         2) Openings not to exceed 1-1/2 inches x 2 inches.
         3) Minimum Roll Width: 35 inches.
         4) Anchoring Staples or Pins: [Steel wire not permitted] [Wood pegs] [or No. 11 steel wire] at least 6 inches long.
   2. Hydromulch:
      a. Slurry: Minimum 60% wood fiber mulch with remaining being recycled cellulose fibers.
      b. Tackifier:
1) Synthetic fiber or gum.
2) Manufacturers: Finn Fiber Plus; Finn Fiber Gum; or equal.

PART 3 - EXECUTION

3.1 TOPSOIL

A. Lawns:
   1. Comply with local requirements.

B. Perennials:
   1. Comply with local requirements.

C. Shrubs:
   1. Comply with local requirements.

D. Other Areas: Spread existing topsoil.

3.2 FERTILIZING

A. Location:
   1. Leveled spoil.
   2. Other disturbed areas.
   3. No fertilizer shall be used with native seeding.

B. Dry Fertilizer:
   1. Broadcast on surface as first step in seeding process.
   2. Apply with seeding if drilled.
   3. Apply uniformly.
   4. Application Rate: Equivalent to \( \frac{240}{500} \) pounds per acre of 12-12-12.

C. Hydroseeding:
   1. Apply fertilizer with seeding.
   2. Application Rate: Equivalent to 272 pounds per acre of 16-32-4.

3.3 LAYING SOD

A. As specified by local requirements.
3.4 SEEDING

A. Scheduling:
   1. Within [30 days] [7 days] [24 hours] from the time the area was first disturbed.
   2. Channel Banks: Within 24 hours from the time the area was first disturbed.
   3. Seasonal Limitations:
      a. [April 20] [May 1] through November 1.
      b. Soil temperatures shall be between 50°F-65°F.

B. Sowing:
   1. Sow the seed following or in conjunction with the fertilizer and while the seed bed is in a friable condition.
   2. Do not sow seed through mulch.
   3. Application Rate:
      a. Lawns: Sow seed at a minimum rate of 100 pounds per acre.
      b. Ditch Banks, Spoil Berms, and Other Areas: Sow seed a minimum rate of 56 pounds per acre.

C. Method:
   1. Broadcast: Do not seed when wind velocity exceeds 5 miles per hour.
   2. Mechanical drills.
   3. Hydroseeder:
      a. Use only equipment specifically designed for hydraulic seeding application.
      b. Mix seed, fertilizer and pulverized mulch in water until uniformly blended into homogeneous slurry.
      c. Continue mixing during application.
      d. [Native seed must be applied with water only for direct seed-soil contact, not with pulverized mulch.]
      e. [Apply pulverized mulch after native seed is applied.]

D. Inspection:
   1. Visually inspect for uniform distribution.
   2. Reseed areas as required to establish a uniform and stable stand of grass.

E. Finishing: Incorporate seed into the upper 1/2-inch of soil.

3.5 MULCHING

A. Small Grain Mulch:
   1. Application:
      a. Immediately after seeding.
      b. Uniform distribution.
      c. Allow sunlight to penetrate mulch.
2. Application Rate:
   a. Two tons per acre (2-1/2 bales per 1000 square feet).
   b. Three tons per acre for dormant seeding.
   c. One ton per acre (1-1/4 bales per 1,000 square feet) for native seeding.

3. Anchoring:
   b. Slopes 3:1 (H:V) or Steeper for Netting: Install in accordance with manufacturer's instructions.

B. Hydromulch:
   1. Apply with hydroseed.
   2. Application Rate: 1,250 pounds per acre.
   3. Apply after native seed has been applied without mulch in slurry.

3.6 MAINTENANCE

A. Reseed, resod, reflertilize, remulch, or regrade as necessary to establish a uniform and stable grassed area.

END OF SECTION 32 9200
SECTION 32 9300 – PLANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Comply with most current edition of the Northwestern University Design Standards.

1.2 SUMMARY

A. Provide all labor, materials and equipment as necessary to complete all work as indicated on the Drawings and specified herein. Review specific project requirements with NU during the design phase.

B. Contractor shall obtain and submit copies to Northwestern University all necessary related city and environmental permits (e.g. irrigation – water department permits; use of city hydrants - city hydrant permit, etc.).

C. This Section includes:

   1. Plants.
   2. Tree stabilization.
   3. Tree-watering devices.

D. Related Requirements:

   1. Section 329200 "Turf and Native/Adaptive Plantings" for meadow planting, hydroseeding, and erosion-control materials.

1.3 DEFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation.

B. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with a ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.

C. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.

D. Finish Grade: Elevation of finished surface of planting soil.
E. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant. Some sources classify herbicides separately from pesticides.

F. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

G. Planting Area: Areas to be planted.

H. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

I. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.

J. Root Flare: Also called “trunk flare.” The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.

K. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.

L. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site. Contractor to take photos of the existing vegetation to remain. Copies of photos shall be distributed to Facilities Management Operations and kept in the construction trailer for reference at the end of the project.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

2. Plant Photographs: Include color photographs in digital format of each required species and size of plant material as it will be furnished to Project. Take photographs from an angle depicting true size and condition of the typical plant to be furnished. Include a scale rod or other measuring device in each photograph. For species where more than 20 plants are required, include a minimum of three photographs showing the average plant, the best quality plant, and the worst quality plant to be furnished. Identify each photograph with the full scientific name of the plant, plant size, and name of the growing nursery.

B. Samples for Verification: For each of the following:

1. Mulch: 1-pint (0.5-L) volume of each organic mulch required; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch.
Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of color, texture, and organic makeup.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For landscape Installer. Include list of similar projects completed by Installer demonstrating Installer’s capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners’ contact persons.

1. Submit qualification data for pesticide applier including state licensure for substances restricted by law.

B. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:

1. Manufacturer’s certified analysis of standard products.
2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.
3. Submit MSDS/SDS documentation to Owner for all fertilizers, lime, herbicides and pesticides.

C. Pesticides and Herbicides: Product label and manufacturer’s application instructions specific to Project. Submit MSDS/SDS documentation to Owner.

D. Sample Warranty: For special warranty.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before expiration of required maintenance periods.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of plants.

1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
2. Experience: Three years’ experience in landscape installation in addition to requirements in Section 014000 “Quality Requirements.”
3. Installer’s Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
4. Personnel Certifications: Installer’s field supervisor shall have certification in one of the following categories from the Professional Landcare Network:
   a. Landscape Industry Certified Technician - Exterior.
   b. Landscape Industry Certified Interior.
   c. Landscape Industry Certified Horticultural Technician.
5. Pesticide Applicator: State licensed, commercial.
B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.

1. Selection of plants purchased under allowances is made by Architect, who tags plants at their place of growth before they are prepared for transplanting.

C. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.

1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container-grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 6 inches (150 mm) above the root flare for trees up to 4-inch (100-mm) caliper size, and 12 inches (300 mm) above the root flare for larger sizes.

2. Other Plants: Measure with stems, petioles, and foliage in their normal position.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws if applicable.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.

2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.

3. Accompany each delivery of bulk materials with appropriate certificates.

C. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.

D. Handle planting stock by root ball.

E. Store bulbs, corms, and tubers in a dry place at 60 to 65 deg F (16 to 18 deg C) until planting.

F. Apply antidesiccant to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation.

1. If deciduous trees or shrubs are moved in full leaf, spray with antidesiccant at nursery before moving and again two weeks after planting.

G. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.

H. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate
aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.

1. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
2. Do not remove container-grown stock from containers before time of planting.
3. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly wet condition.

1.10 FIELD CONDITIONS

A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.

B. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.

2. Fall Planting: September 15 – November 15.

C. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.

1.11 WARRANTY

A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner.
   b. Structural failures including plantings falling or blowing over.

2. Warranty Periods: From date of Substantial Completion.
   a. Trees, Shrubs, Vines, and Ornamental Grasses: 12 months.
   b. Ground Covers, Biennials, Perennials, and Other Plants: 12 months.

3. Include the following remedial actions as a minimum:
   a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
   b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
   c. A limit of one replacement of each plant is required except for losses or replacements due to failure to comply with requirements.
   d. Provide extended warranty for period equal to original warranty period, for replaced plant material.
2.1 PLANT MATERIAL

A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant List, Plant Schedule, or Plant Legend indicated on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.

1. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk (“included bark”); crossing trunks; cut-off limbs more than 3/4 inch (19 mm) in diameter; or with stem girdling roots are unacceptable.
2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.

B. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to Architect, with a proportionate increase in size of roots or balls.

C. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which begins at root flare according to ANSI Z60.1. Root flare shall be visible before planting.

D. Labeling: Label at least one plant of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for the plant.

2.2 FERTILIZERS

A. Planting Tablets: Tightly compressed chip-type, long-lasting, slow-release, commercial-grade planting fertilizer in tablet form. Tablets shall break down with soil bacteria, converting nutrients into a form that can be absorbed by plant roots. Submit MSDS/SDS documentation to Owner.

1. Size: 5-gram tablets.
2. Nutrient Composition: 20 percent nitrogen, 10 percent phosphorous, and 5 percent potassium, by weight plus micronutrients.

2.3 MULCHES

A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:

1. Type: Shredded hardwood.
2. Size Range: 3 inches (76 mm) maximum, 1/2 inch (13 mm) minimum.
2.4 PESTICIDES

A. General: Pesticide registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction. Submit MSDS/SDS documentation to Owner.

B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

2.5 TREE-STABILIZATION MATERIALS

A. Trunk-Stabilization Materials:
   1. Upright and Guy Stakes: Rough-sawn, sound, new hardwood, free of knots, holes, cross grain, and other defects, 2-by-2-inch nominal (38-by-38-mm actual) by length indicated, pointed at one end.
   2. Guys and Tie Wires: ASTM A 641/A 641M, Class 1, galvanized-steel wire, two-strand, twisted, 0.106 inch (2.7 mm) in diameter.

2.6 TREE-WATERING DEVICES

A. Slow-Release Watering Device: Standard product manufactured for drip irrigation of plants and emptying its water contents over to three weeks; manufactured from UV-light-stabilized nylon-reinforced polyethylene sheet, PVC, or HDPE plastic.

   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. BIO-PLEX.
      b. Engineered Watering Solutions; PQ Partners, LLC.
      c. Spectrum Products, Inc.

   2. Color: dark chocolate or green.

2.7 MISCELLANEOUS PRODUCTS

A. Wood Pressure-Preservative Treatment: AWPA U1, Use Category UC4a; acceptable to authorities having jurisdiction, and containing no arsenic or chromium.

B. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer’s written instructions.

C. Burlap: Non-synthetic, biodegradable.
3.1 EXAMINATION

A. Examine areas to receive plants, with Installer present, for compliance with requirements and conditions affecting installation and performance of the Work.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. Verify that plants and vehicles loaded with plants can travel to planting locations with adequate overhead clearance.
3. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
4. Uniformly moisten excessively dry soil that is not workable or which is dusty.

B. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

C. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Architect’s acceptance of layout before excavating or planting. Make minor adjustments as required.

D. Lay out plants at locations directed by Architect. Stake locations of individual trees and shrubs and outline areas for multiple plantings.

3.3 PLANTING AREA ESTABLISHMENT

A. Loosen subgrade of planting areas to a minimum depth of 6 inches (150 mm). Remove stones larger than 1 inch (25 mm) in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner’s property.

1. Spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil.
   a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
2. Spread planting soil to a depth of 6 inches (150 mm) but not less than required to meet finish grades after natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
   a. Spread approximately one-half the thickness of planting soil over loosened subgrade. Mix thoroughly into top 2 inches (50 mm) of subgrade. Spread remainder of planting soil.

B. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

C. Before planting, obtain Landscape Architect’s acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 EXCAVATION FOR TREES AND SHRUBS

A. Planting Pits and Trenches: Excavate circular planting pits.
   1. Excavate planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are unacceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.
   2. Excavate approximately three times as wide as ball diameter for balled and burlapped and container-grown stock.
   3. Excavate at least 12 inches (300 mm) wider than root spread and deep enough to accommodate vertical roots for bare-root stock.
   4. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
   5. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
   6. Maintain angles of repose of adjacent materials to ensure stability. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
   7. Maintain supervision of excavations during working hours.
   8. Keep excavations covered or otherwise protected when unattended by Installer’s personnel.
   9. If drain tile is indicated on Drawings or required under planting areas, excavate to top of porous backfill over tile.

B. Backfill Soil: Subsoil and topsoil removed from excavations may be used as backfill soil unless otherwise indicated.

C. Obstructions: Notify Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.
   1. Hardpan Layer: Drill 6-inch- (150-mm-) diameter holes, 24 inches (600 mm) apart, into free-draining strata or to a depth of 10 feet (3 m), whichever is less, and backfill with free-draining material.

D. Drainage: Notify Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.
E. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

3.5 TREE, SHRUB, AND VINE PLANTING

A. Inspection: At time of planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.

B. Roots: Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.

C. Balled and Burlapped Stock: Set each plant plumb and in center of planting pit or trench with root flare 2 inches (50 mm) above adjacent finish grades.
   1. Backfill: Planting soil. For trees, use excavated soil for backfill.
   2. After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
   3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
   4. Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside the root ball about 1 inch (25 mm) from root tips; do not place tablets in bottom of the hole.
      a. Quantity: Two per plant.
   5. Continue backfilling process. Water again after placing and tamping final layer of soil.

D. Container-Grown Stock: Set each plant plumb and in center of planting pit or trench with root flare 1 inch (25 mm) above adjacent finish grades.
   2. Carefully remove root ball from container without damaging root ball or plant.
   3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
   4. Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside the root ball about 1 inch (25 mm) from root tips; do not place tablets in bottom of the hole.
      a. Quantity: Two per plant.
   5. Continue backfilling process. Water again after placing and tamping final layer of soil.

E. Slopes: When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball. See detail on plans.
3.6 TREE, SHRUB, AND VINE PRUNING

A. Remove only dead, dying, or broken branches. Do not prune for shape.

B. Prune, thin, and shape trees, shrubs, and vines as directed by Architect.

C. Prune, thin, and shape trees, shrubs, and vines according to standard professional horticultural and arboricultural practices. Unless otherwise indicated by Architect, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character.

D. Do not apply pruning paint to wounds.

3.7 TREE STABILIZATION

A. Trunk Stabilization by Upright Staking and Tying: Install trunk stabilization as follows unless otherwise indicated:

1. Upright Staking and Tying: Stake trees of 2- through 5-inch (50- through 125-mm) caliper. Stake trees of less than 2-inch (50-mm) caliper only as required to prevent wind tip out. Use a minimum of two stakes of length required to penetrate at least 18 inches (450 mm) below bottom of backfilled excavation and to extend to the dimension indicated on Drawings above grade. Set vertical stakes and space to avoid penetrating root balls or root masses.

2. Upright Staking and Tying: Stake trees with two stakes for trees up to 12 feet (3.6 m) high and 2-1/2 inches (63 mm) or less in caliper; three stakes for trees less than 14 feet (4.2 m) high and up to 4 inches (100 mm) in caliper. Space stakes equally around trees.

3. Support trees with bands of flexible ties at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.

4. Support trees with two strands of tie wire, connected to the brass grommets of tree-tie webbing at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.

3.8 GROUND COVER AND PLANT PLANTING

A. Set out and space ground cover and plants other than trees, shrubs, and vines as indicated on Drawings in even rows with triangular spacing.

B. Use planting soil for backfill.

C. Dig holes large enough to allow spreading of roots.

D. For rooted cutting plants supplied in flats, plant each in a manner that minimally disturbs the root system but to a depth not less than two nodes.

E. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.

F. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

G. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.
3.9 PLANTING AREA MULCHING

A. Mulch backfilled surfaces of planting areas and other areas indicated.

1. Trees in Meadow Areas: Apply organic mulch ring of 3-inch (75-mm) average thickness, with 36-inch (900-mm) radius around trunks or stems. Do not place mulch within 3 inches (75 mm) of trunks or stems.

2. Organic Mulch in Planting Areas: Apply 2-inch (50-mm) average thickness of organic mulch over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within [3 inches (75 mm)] [6 inches (150 mm)] of trunks or stems.

3.10 INSTALLING SLOW-RELEASE WATERING DEVICE

A. Provide one device for each tree.

B. Place device on top of the mulch at base of tree stem and fill with water according to manufacturer's written instructions.

3.11 PLANT MAINTENANCE

A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings.

B. Fill in, as necessary, soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.

C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices when possible to minimize use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

3.12 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents according to authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Pre-Emergent Herbicides (Selective and Nonselective): Apply to tree, shrub, and ground-cover areas according to manufacturer's written recommendations. Do not apply to seeded areas.

C. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.13 REPAIR AND REPLACEMENT

A. General: Repair or replace existing or new trees and other plants that are damaged by construction operations, in a manner approved by Architect.

1. Submit details of proposed pruning and repairs.
2. Perform repairs of damaged trunks, branches, and roots within 24 hours, if approved.
3. Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by Architect.

B. Remove and replace trees that are more than 25 percent dead or in an unhealthy condition before the end of the corrections period or are damaged during construction operations that Architect determines are incapable of restoring to normal growth pattern. Replacement trees shall be of same size and species.

3.14 CLEANING AND PROTECTION

A. During planting, keep adjacent paving and construction clean and work area in an orderly condition. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.

C. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

D. After installation and before Substantial Completion, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

E. At time of Substantial Completion, verify that tree-watering devices are in good working order and leave them in place. Replace improperly functioning devices.

3.15 MAINTENANCE SERVICE

A. Maintenance Service for Trees and Shrubs: Provide maintenance by skilled employees of landscape Installer. Maintain as required in "Plant Maintenance" Article. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:

1. Maintenance Period: 12 months from date of Substantial Completion.

B. Maintenance Service for Ground Cover and Other Plants: Provide maintenance by skilled employees of landscape Installer. Maintain as required in "Plant Maintenance" Article. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:

1. Maintenance Period: Six months or through the end of the next growing season, whichever is longer, from date of Substantial Completion.

END OF SECTION 32 9300