

**Project No. 506-328
Ambulatory Care Expansion**

**Office of Construction and Facilities Management Department of
Veterans Affairs
Ann Arbor, Michigan**

**100% BID DOCUMENT SUBMISSION
PROJECT MANUAL
(Book 3 of 3)**

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SECTION 31 20 00

EARTHWORK

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

- A. This section specifies the requirements for furnishing all equipment, materials, labor, tools, and techniques for earthwork including, but not limited to, the following:
1. Site preparation.
 2. Excavation.
 3. Underpinning.
 4. Filling and backfilling.
 5. Grading.
 6. Soil Disposal.
 7. Clean Up.

1.2 DEFINITIONS:

- A. Unsuitable Materials:
1. Fills: Topsoil; frozen materials; construction materials and materials subject to decomposition; clods of clay and stones larger than 75 mm (3 inches); organic material, including silts, which are unstable; and inorganic materials, including silts, too wet to be stable and any material with a liquid limit and plasticity index exceeding 40 and 15 respectively. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction, as defined by ASTM D698 and/or D1557.
 2. Existing Subgrade (Except Footing Subgrade): Same materials as 1.2.A.1, that are not capable of direct support of slabs, pavement, and similar items with possible exception of improvement by compaction, proofrolling, or similar methods.
 3. Existing Subgrade (Footings Only): Same as paragraph 1, but no fill or backfill. If materials differ from design requirements, excavate to acceptable strata subject to COR's approval.
- B. Building Earthwork: Earthwork operations required in area enclosed by a line located 1500 mm (5 feet) outside of principal building perimeter. It also includes earthwork required for auxiliary structures and buildings.
- C. Trench Earthwork: Trenchwork required for utility lines.

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- D. Site Earthwork: Earthwork operations required in area outside of a line located 1500 mm (5 feet) outside of principal building perimeter and within new construction area with exceptions noted above.
- E. Degree of compaction: Degree of compaction is expressed as a percentage of maximum density obtained by laboratory test procedure. This percentage of maximum density is obtained through use of data provided from results of field test procedures presented in ASTM D1556, ASTM D2167, and ASTM D6938.
- F. Fill: Satisfactory soil materials used to raise existing grades. In the Construction Documents, the term "fill" means fill or backfill as appropriate.
- G. Backfill: Soil materials or controlled low strength material used to fill an excavation.
- H. Unauthorized excavation: Removal of materials beyond indicated sub-grade elevations or indicated lines and dimensions without written authorization by the COR. No payment will be made for unauthorized excavation or remedial work required to correct unauthorized excavation.
- I. Authorized additional excavation: Removal of additional material authorized by the COR based on the determination by the Government's soils testing agency that unsuitable bearing materials are encountered at required sub-grade elevations. Removal of unsuitable material and its replacement as directed will be paid on basis of Conditions of the Contract relative to changes in work.
- J. Subgrade: The undisturbed earth or the compacted soil layer immediately below granular sub-base, drainage fill, or topsoil materials.
- K. Structure: Buildings, foundations, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- L. Borrow: Satisfactory soil imported from off-site for use as fill or backfill.
- M. Drainage course: Layer supporting slab-on-grade used to minimize capillary flow of pore water.
- N. Bedding course: Layer placed over the excavated sub-grade in a trench before laying pipe. Bedding course shall extend up to the springline of the pipe.

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- O. Sub-base Course: Layer placed between the sub-grade and base course for asphalt paving or layer placed between the sub-grade and a concrete pavement or walk.
- P. Utilities include on-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.
- Q. Debris: Debris includes all materials located within the designated work area not covered in the other definitions and shall include but not be limited to items like vehicles, equipment, appliances, building materials or remains thereof, tires, any solid or liquid chemicals or products stored or found in containers or spilled on the ground.
- R. Contaminated soils: Soil that contains contaminants as defined and determined by the COR or the Government's testing agency.

1.3 RELATED WORK:

- A. Materials testing and inspection during construction: Section 01 45 29, TESTING LABORATORY SERVICES.
- B. Protection of existing utilities, fire protection services, existing equipment, roads, and pavements: Section 01 00 00, GENERAL REQUIREMENTS.
- C. Subsurface Investigation: Section 01 00 00, GENERAL REQUIREMENTS, Article, PHYSICAL DATA.
- D. Paving sub-grade requirements: Section 32 12 16, ASPHALT PAVING.

1.4 CLASSIFICATION OF EXCAVATION:

- A. Unclassified Excavation: Removal and disposal of pavements and other man-made obstructions visible on surface; utilities, and other items including underground structures indicated to be demolished and removed; together with any type of materials regardless of character of material and obstructions encountered.

1.5 SUBMITTALS:

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Furnish to COR:

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1. Contactor shall furnish resumes with all personnel involved in the project including Project Manager, Superintendent, and on-site Engineer. Project Manager and Superintendent should have at least 3 years of experience on projects of similar size.
2. Soil samples.
 - a. Classification in accordance with ASTM D2487 for each on-site or borrow soil material proposed for fill, backfill, engineered fill, or structural fill.
 - b. Laboratory compaction curve in accordance with ASTM D698, D1557 for each on site or borrow soil material proposed for fill, backfill, engineered fill, or structural fill.
 - c. Test reports for compliance with ASTM D2940 requirements for subbase material.
 - d. Pre-excavation photographs and videotape in the vicinity of the existing structures to document existing site features, including surfaces finishes, cracks, or other structural blemishes that might be misconstrued as damage caused by earthwork operations.
3. Contractor shall submit procedure and location for disposal of unused satisfactory material. Proposed source of borrow material. Notification of encountering rock in the project. Advance notice on the opening of excavation or borrow areas. Advance notice on shoulder construction for rigid pavements.

1.6 APPLICABLE PUBLICATIONS:

- A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in text by basic designation only.
- B. American Association of State Highway and Transportation Officials (AASHTO):
 - T99-10.....Standard Method of Test for Moisture-Density Relations of Soils Using a 2.5 kg (5.5 lb) Rammer and a 305 mm (12 inch) Drop
 - T180-10.....Standard Method of Test for Moisture-Density Relations of Soils using a 4.54 kg (10 lb) Rammer and a 457 mm (18 inch) Drop
- C. American Society for Testing and Materials (ASTM):
 - C33-03.....Concrete Aggregate

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- D448-08.....Standard Classification for Sizes of Aggregate
for Road and Bridge Construction
- D698-07e1.....Standard Test Method for Laboratory Compaction
Characteristics of Soil Using Standard Effort
(12,400 ft. lbf/ft³ (600 kN m/m³))
- D1140-00.....Amount of Material in Soils Finer than the No.
200 (75-micrometer) Sieve
- D1556-07.....Standard Test Method for Density and Unit Weight
of Soil in Place by the Sand Cone Method
- D1557-09.....Standard Test Methods for Laboratory Compaction
Characteristics of Soil Using Modified Effort
(56,000 ft-lbf/ft³ (2700 kN m/m³))
- D2167-08.....Standard Test Method for Density and Unit Weight
of Soil in Place by the Rubber Balloon Method
- D2487-11.....Standard Classification of Soils for Engineering
Purposes (Unified Soil Classification System)
- D2940-09.....Standard Specifications for Graded Aggregate
Material for Bases or Subbases for Highways or
Airports
- D6938-10.....Standard Test Method for In-Place Density and
Water Content of Soil and Soil-Aggregate by
Nuclear Methods (Shallow Depth)
- D. Society of Automotive Engineers (SAE):
- J732-07.....Specification Definitions - Loaders
- J1179-08.....Hydraulic Excavator and Backhoe Digging Forces

PART 2 - PRODUCTS

2.1 MATERIALS:

- A. General: Provide borrow soil material when sufficient satisfactory soil materials are not available from excavations.
- B. Fills: Material in compliance with ASTM D2487 Soil Classification Groups GW, GP, GM, SW, SP, SM, and SC, or any combination of these groups; free of rock or gravel larger than 75 mm (3 inches) in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.
Material approved from on site or off site sources having a minimum dry

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density of 1760 kg/m³ (110 pcf), a maximum Plasticity Index of 15, and a maximum Liquid Limit of 40.

- C. Engineered Fill: Naturally or artificially graded mixture of compliance with ASTM D2487 Soil Classification Groups GW, GP, GM, SW, SP, SM, and SC, or any combination of these groups, or as approved by the Engineer or material with at least 90 percent passing a 37.5-mm (1 1/2-inch) sieve and not more than 12 percent passing a 75-µm (No. 200) sieve, per ASTM D2940;.
- D. Bedding: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940; except with 100 percent passing a 25 mm (1 inch) sieve and not more than 8 percent passing a 75-µm (No. 200) sieve.
- E. Drainage Fill: Washed, narrowly graded mixture of crushed stone, or crushed or uncrushed gravel; ASTM D448; coarse-aggregate grading Size 57; with 100 percent passing a 37.5 mm (1 1/2-inch) sieve and 0 to 5 percent passing a 2.36 mm (No. 8) sieve.
- F. Granular Fill:
 - 1. Under concrete slab, - granular fill shall consist of clean, poorly graded crushed rock, crushed gravel, or uncrushed gravel placed beneath a building slab with or without a vapor barrier to cut off the capillary flow of pore water to the area immediately below. Fine aggregate grading shall conform to ASTM C 33 with a maximum of 3 percent by weight passing ASTM D 1140, 75 micrometers (No. 200) sieve, or 37.5 mm (1-1/2 inches) and no more than 2 percent by weight passing the 4.75 mm (No. 4) size sieve or coarse aggregate Size 57, 67, or 77.
 - 2. Bedding for sanitary and storm sewer pipe, crushed stone or gravel graded from 13 mm (1/2 inch) to 4.75 mm (No 4), per ASTM D2940.
- G. Requirements for Offsite Soils: Offsite soils brought in for use as backfill shall be tested for TPH, BTEX and full TCLP including ignitability, corrosivity and reactivity. Backfill shall contain less than 100 parts per million (ppm) of total hydrocarbons (TPH) and less than 10 ppm of the sum of Benzene, Toluene, Ethyl Benzene, and Xylene (BTEX) and shall not fail the TCLP test. TPH concentrations shall be determined by using EPA 600/4-79/020 Method 418.1. BTEX concentrations shall be determined by using EPA SW-846.3-3a Method 5030/8020. TCLP shall be performed in accordance with EPA SW-846.3-3a Method 1311.

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Provide Borrow Site Testing for TPH, BTEX and TCLP from a composite sample of material from the borrow site, with at least one test from each borrow site.

- H. Buried Warning and Identification Tape: Polyethylene plastic and metallic core or metallic-faced, acid- and alkali-resistant polyethylene plastic warning tape manufactured specifically for warning and identification of buried utility lines. Provide tape on rolls, 3 inch minimum width, color coded as specific below for the intended utility with warning and identification imprinted in bold black letters continuously over the entire tape length. Warning and identification to read, "CAUTION, BURIED (intended service) LINE BELOW" or similar wording. Color and printing shall be permanent, Unaffected by moisture or soil. Warning tape color codes:

Red:	Electric
Yellow:	Gas, Oil, Dangerous Materials
Orange:	Telephone and Other Communications
Blue:	Water Systems
Green:	Sewer Systems
White:	Steam Systems
Gray:	Compressed Air

- I. Warning Tape for Metallic Piping: Acid and alkali-resistant polyethylene plastic tape conforming to the width, color, and printing requirements specified above. Minimum thickness of tape shall be 0.076 mm (0.003 inch). Tape shall have a minimum strength of 10.3 MPa (1500 psi) lengthwise, and 8.6 MPa (1250 psi) crosswise, with a maximum 350 percent elongation.
- J. Detectable Warning Tape for Non-Metallic Piping: Polyethylene plastic tape conforming to the width, color, and printing requirements specified above. Minimum thickness of the tape shall be 0.102 mm (0.004 inch). Tape shall have a minimum strength of 10.3 MPa (1500 psi) lengthwise and 8.6 MPa (1250 psi) crosswise. Tape shall be manufactured with integral wires, foil backing, or other means of enabling detection by a metal detector when tape is buried up to 0.9 m (3 feet) deep. Encase metallic element of the tape in a protective jacket or provide with other means of corrosion protection.

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PART 3 - EXECUTION

3.1 SITE PREPARATION:

- A. Clearing: Clear within limits of earthwork operations as shown. Work includes removal of trees, shrubs, fences, foundations, incidental structures, paving, debris, trash, and other obstructions. Remove materials from Property and dispose of in a legal manner.
- B. Grubbing: Remove stumps and roots 75 mm (3 inch) and larger diameter. Undisturbed sound stumps, roots up to 75 mm (3 inch) diameter, and nonperishable solid objects a minimum of 900 mm (3 feet) below subgrade or finished embankment may be left.
- C. Trees and Shrubs: Trees and shrubs, not shown for removal, may be removed from areas within 4500 mm (15 feet) of new construction and 2250 mm (7.5 feet) of utility lines when removal is approved in advance by COR. Remove materials from Property and dispose of in a legal manner. Trees and shrubs, shown to be transplanted, shall be dug with a ball of earth and burlapped in accordance with latest issue of, "American Standard for Nursery Stock" of the American Association of Nurserymen, Inc. Transplant trees and shrubs to a permanent or temporary position within two hours after digging. Maintain trees and shrubs held in temporary locations by watering as necessary and feeding semiannually with liquid fertilizer with a minimum analysis of 5 percent nitrogen, 10 percent phosphorus, and 5 percent potash. Maintain plants moved to permanent positions as specified for plants in temporary locations until conclusion of contract.
- D. Stripping Topsoil: Strip topsoil from within limits of earthwork operations as specified. Topsoil shall be a fertile, friable, natural topsoil of loamy character and characteristic of locality. Topsoil shall be capable of growing healthy horticultural crops of grasses. Stockpile topsoil and protect as directed by COR. Eliminate foreign materials, such as weeds, roots, stones, subsoil, frozen clods, and similar foreign materials larger than 0.014 m³ (1/2 cubic foot) in volume, from soil as it is stockpiled. Retain topsoil on station. Remove foreign materials larger than 50 mm (2 inches) in any dimension from topsoil used in final grading. Topsoil work, such as stripping, stockpiling, and similar topsoil work shall not, under any circumstances, be carried out when soil is wet so that the composition of the soil will be destroyed.

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- E. Concrete Slabs and Paving: Score deeply or saw cut to insure a neat, straight cut, sections of existing concrete slabs and paving to be removed where excavation or trenching occurs. Extend pavement section to be removed a minimum of 300 mm (12 inches) on each side of widest part of trench excavation and insure final score lines are approximately parallel unless otherwise indicated. Remove material from Property and dispose of in a legal manner.
- F. Lines and Grades: Registered Professional Land Surveyor or Registered Civil Engineer, specified in Section 01 00 00, GENERAL REQUIREMENTS, shall establish lines and grades.
1. Grades shall conform to elevations indicated on plans within the tolerances herein specified. Generally grades shall be established to provide a smooth surface, free from irregular surface changes. Grading shall comply with compaction requirements and grade cross sections, lines, and elevations indicated. Where spot grades are indicated the grade shall be established based on interpolation of the elevations between the spot grades while maintaining appropriate transition at structures and paving and uninterrupted drainage flow into inlets.
 2. Locations of existing and proposed elevations indicated on plans, except spot elevations, are approximate. Proposed spot elevations and contour lines have been developed utilizing the existing conditions survey and developed contour lines and may be approximate. Contractor is responsible to notify COR of any differences between existing elevations shown on plans and those encountered on site by Surveyor/Engineer described above. Notify COR of any differences between existing or constructed grades, as compared to those shown on the plans.
 3. Subsequent to establishment of lines and grades, Contractor will be responsible for any additional cut and/or fill required to ensure that site is graded to conform to elevations indicated on plans.
 4. Finish grading is specified in Section 32 90 00, PLANTING.
- G. Disposal: All materials removed from the property shall be disposed of at a legally approved site, for the specific materials, and all removals shall be in accordance with all applicable Federal, State and local regulations. No burning of materials is permitted onsite.

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3.2 EXCAVATION:

- A. Shoring, Sheet piling and Bracing: Shore, brace, or slope, its angle of repose or to an angle considered acceptable by the COR, banks of excavations to protect workmen, banks, adjacent paving, structures, and utilities.
1. Design of the temporary support of excavation system is the responsibility of the Contractor. The Contractor shall submit a Shoring and Sheet piling plan for approval 15 days prior to starting work. Submit drawings and calculations, certified by a registered professional engineer, describing the methods for shoring and sheet piling of excavations. Shoring, including sheet piling, shall be furnished and installed as necessary to protect workmen, banks, adjacent paving, structures, and utilities. Shoring, bracing, and sheet piling shall be removed as excavations are backfilled, in a manner to prevent caving.
 2. Construction of the support of excavation system shall not interfere with the permanent structure and may begin only after a review by the COR.
 3. Extend shoring and bracing to a minimum of 1500 mm (5 feet) below the bottom of excavation. Shore excavations that are carried below elevations of adjacent existing foundations.
 4. If bearing material of any foundation is disturbed by excavating, improper shoring or removal of existing or temporary shoring, placing of backfill, and similar operations, the Contractor shall underpin the existing foundation, per Section 3.3, provide a concrete fill support in compliance with specifications Section 31 23 23.33, FLOWABLE FILL, under disturbed foundations, as directed by COR, at no additional cost to the Government. Do not remove shoring until permanent work in excavation has been inspected and approved by COR.
 5. The Contractor is required to hire a Professional Geotechnical Engineer to provide inspection of excavations and soil/groundwater conditions throughout construction. The Geotechnical Engineer shall be responsible for performing pre-construction and periodic site visits throughout construction to assess site conditions. The Geotechnical Engineer shall update the excavation, sheet piling and dewatering plans as construction progresses to reflect changing conditions and shall submit an updated plan if necessary. A written

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report shall be submitted, at least monthly, informing the Contractor and COR of the status of the plan and an accounting of the Contractor's adherence to the plan addressing any present or potential problems. The Geotechnical Engineer shall be available to meet with the COR at any time throughout the contract duration.

- B. Excavation Drainage: Operate pumping equipment, and/or provide other materials, means and equipment as required to keep excavation free of water and subgrade dry, firm, and undisturbed until approval of permanent work has been received from COR. Approval by the COR is also required before placement of the permanent work on all subgrades. Groundwater flowing toward or into excavations shall be controlled to prevent sloughing of excavation slopes and walls, boils, uplift and heave in the excavation and to eliminate interference with orderly progress of construction. French drains, sumps, ditches or trenches will not be permitted within 0.9 m (3 feet) of the foundation of any structure, except with specific written approval, and after specific contractual provisions for restoration of the foundation area have been made. Control measures shall be taken by the time the excavation reaches the water level in order to maintain the integrity of the in situ material.
- C. Subgrade Protection: Protect subgrades from softening, undermining, washout, or damage by rain or water accumulation. Reroute surface water runoff from excavated areas and not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches. When subgrade for foundations has been disturbed by water, remove disturbed material to firm undisturbed material after water is brought under control. Replace disturbed subgrade in trenches with concrete or material approved by the COR.
- D. Blasting: Blasting will not be permitted.
- E. Proofrolling:
 - 1. After rough grade has been established in cut areas and prior to placement of fill in fill areas under building and pavements, proofroll exposed subgrade with a fully loaded dump truck to check for pockets of soft material.

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2. Proof rolling shall be done on an exposed subgrade free of surface water (wet conditions resulting from rainfall) which would promote degradation of an otherwise acceptable subgrade. After stripping, proof roll the existing subgrade of the prepared area with six passes of a dump truck loaded with 6 cubic meters (4 cubic yards) of soil. Operate the truck in a systematic manner to ensure the number of passes over all areas, and at speeds between 4 to 5.5 km/hour (2 1/2 to 3 1/2 mph). When proof rolling, one-half of the passes made with the roller shall be in a direction perpendicular to the other passes. Notify the COR a minimum of 3 days prior to proof rolling. Proof rolling shall be performed in the presence of the COR. Rutting or pumping of material shall be undercut as directed by the COR and replaced with approved engineered fill material.

F. Building Earthwork:

1. Excavation shall be accomplished as required by drawings and specifications.
2. Excavate foundation excavations to solid undisturbed subgrade.
3. Remove loose or soft materials to a solid bottom.
4. Fill excess cut under footings or foundations with 25 MPa (3000 psi) concrete poured separately from the footings.
5. Do not tamp earth for backfilling in footing bottoms, except as specified.
6. Slope grades to direct water away from excavations and to prevent ponding.
7. Capillary water barrier (granular fill) under concrete floor and area-way slabs on grade shall be placed directly on the subgrade and shall be compacted with a minimum of two passes of a hand-operated plate-type vibratory compactor.
8. Ensure that footing subgrades have been inspected and approved by the COR prior to concrete placement. Excavate to bottom of pile cap prior to placing or driving piles, unless authorized otherwise by the COR. Backfill and compact over excavations and changes in grade due to pile driving operations to 95 percent of ASTM D698 maximum density.

G. Trench Earthwork:

1. Utility trenches (except sanitary and storm sewer):

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- a. Excavate to a width as necessary for sheeting and bracing and proper performance of the work.
- b. Grade bottom of trenches with bell holes scooped out to provide a uniform bearing.
- c. Support piping on suitable undisturbed earth unless a mechanical support is shown. Unstable material removed from the bottom of the trench or excavation shall be replaced with select granular material placed in layers not exceeding 150 mm (6 inches) loose thickness.
- d. Length of open trench in advance of piping laying shall not be greater than is authorized by COR.
- e. Provide buried utility lines with utility identification tape. Bury tape 300 mm (12 inches) below finished grade; under pavements and slabs, bury tape 150 mm (6 inches) below top of subgrade
- f. Bury detection wire directly above non-metallic piping at a distance not to exceed 300 mm (12 inches) above the top of pipe. The wire shall extend continuously and unbroken, from manhole to manhole. The ends of the wire shall terminate inside the manholes at each end of the pipe, with a minimum of 0.9 m (3 feet) of wire, coiled, remaining accessible in each manhole. The wire shall remain insulated over its entire length. The wire shall enter manholes between the top of the corbel and the frame, and extend up through the chimney seal between the frame and the chimney seal. For force mains, the wire shall terminate in the valve pit at the pump station end of the pipe.
- g. Bedding shall be of the type and thickness shown. Initial backfill material shall be placed and compacted with approved tampers to a height of at least one foot above the utility pipe or conduit. The backfill shall be brought up evenly on both sides of the pipe for the full length of the pipe. Care shall be taken to ensure thorough compaction of the fill under the haunches of the pipe. Except as specified otherwise in the individual piping section, provide bedding for buried piping in accordance with AWWA C600, Type 4, except as specified herein. Backfill to top of pipe shall be compacted to 95 percent of ASTM D 698 maximum density. Plastic piping shall have bedding to spring line of pipe. Provide materials as follows:

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- 1) Class II: Coarse sands and gravels with maximum particle size of 40 mm (1.5 inches), including various graded sands and gravels containing small percentages of fines, generally granular and noncohesive, either wet or dry. Soil Types GW, GP, SW, and SP are included in this class as specified in ASTM D2487.
2. Sanitary and storm sewer trenches:
 - a. Trench width below a point 150 mm (6 inches) above top of pipe shall be 600 mm (24 inches) maximum for pipe up to and including 300 mm (12 inches) diameter, and four-thirds diameter of pipe plus 200 mm (8 inches) for pipe larger than 300 mm (12 inches). Width of trench above that level shall be as necessary for sheeting and bracing and proper performance of the work.
 - 1) Bed bottom quadrant of pipe on suitable undisturbed soil or granular fill. Unstable material removed from the bottom of the trench or excavation shall be replaced with select granular material placed in layers not exceeding 150 mm (6 inches) loose thickness.1) Undisturbed: Bell holes shall be no larger than necessary for jointing. Backfill up to a point 300 mm (12 inches) above top of pipe shall be clean earth placed and tamped by hand.
 - 2) Granular Fill: Depth of fill shall be a minimum of 75 mm (3 inches) plus one sixth of pipe diameter below pipe to 300 mm (12 inches) above top of pipe. Place and tamp fill material by hand.
 - c. Place and compact as specified remainder of backfill using acceptable excavated materials. Do not use unsuitable materials.
 - d. Use granular fill for bedding where rocky materials are excavated.
 - e. Provide buried utility lines with utility identification tape. Bury tape 300 mm (12 inches) below finished grade; under pavements and slabs, bury tape 150 mm (6 inches) below top of subgrade
 - f. Bury detection wire directly above non-metallic piping at a distance not to exceed 300 mm (12 inches) above the top of pipe. The wire shall extend continuously and unbroken, from manhole to manhole. The ends of the wire shall terminate inside the manholes at each end of the pipe, with a minimum of 0.9 m (3 feet) of wire, coiled, remaining accessible in each manhole. The wire shall

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remain insulated over it's entire length. The wire shall enter manholes between the top of the corbel and the frame, and extend up through the chimney seal between the frame and the chimney seal. For force mains, the wire shall terminate in the valve pit at the pump station end of the pipe.

- g. Bedding shall be of the type and thickness shown. Initial backfill material shall be placed and compacted with approved tampers to a height of at least one foot above the utility pipe or conduit. The backfill shall be brought up evenly on both sides of the pipe for the full length of the pipe. Care shall be taken to ensure thorough compaction of the fill under the haunches of the pipe. Except as specified otherwise in the individual piping section, provide bedding for buried piping in accordance with AWWA C600, Type 4, except as specified herein. Backfill to top of pipe shall be compacted to 95 percent of ASTM D698 maximum density. Plastic piping shall have bedding to spring line of pipe. Provide materials as follows:

- 1) Class II: Coarse sands and gravels with maximum particle size of 40 mm (1.5 inches), including various graded sands and gravels containing small percentages of fines, generally granular and noncohesive, either wet or dry. Soil Types GW, GP, SW, and SP are included in this class as specified in ASTM D2487.

- H. Site Earthwork: Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; together with soil, boulders, and other materials not classified as rock or unauthorized excavation. Excavation shall be accomplished as required by drawings and specifications. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 25 mm (1 inch). Extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, complying with OSHA requirements, and for inspections. Remove subgrade materials that are determined by COR as unsuitable, and replace with acceptable

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material. If there is a question as to whether material is unsuitable or not, the contractor shall obtain samples of the material, under the direction of the COR, and the materials shall be examined by an independent testing laboratory for soil classification to determine whether it is unsuitable or not. Testing of the soil shall be performed by the VA Testing Laboratory. When unsuitable material is encountered and removed, contract price and time will be adjusted in accordance with Articles, DIFFERING SITE CONDITIONS, CHANGES and CHANGES-SUPPLEMENT of the GENERAL CONDITIONS as applicable. Adjustments to be based on volume in cut section only.

1. Site Grading:

- a. Provide a smooth transition between adjacent existing grades and new grades.
- b. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
- c. Slope grades to direct water away from buildings and to prevent ponds from forming where not designed. Finish subgrades to required elevations within the following tolerances:

1) Lawn or Unpaved Areas: Plus or minus 25 mm (1 inch).

2) Walks: Plus or minus 13 mm (1/2 inch).

3) Pavements: Plus or minus 13 mm (1/2 inch).

- d. Grading Inside Building Lines: Finish subgrade to a tolerance of 13 mm (1/2 inch) when tested with a 3000 mm (10 foot) straightedge.

3.3 UNDERPINNING:

- A. Design of the underpinning system is the responsibility of the Contractor and should be designed by a registered professional engineer and is subject to review and approval by the COR.

3.4 FILLING AND BACKFILLING:

- A. General: Do not fill or backfill until all debris, water, unsatisfactory soil materials, obstructions, and deleterious materials have been removed from excavation. For fill and backfill, use excavated materials and borrow meeting the criteria specified herein, as applicable. Borrow will be supplied at no additional cost to the Government. Do not use unsuitable excavated materials. Do not backfill until foundation walls have been completed above grade and adequately braced, waterproofing or

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dampproofing applied, foundation drainage, and pipes coming in contact with backfill have been installed and work inspected and approved by COR.

- B. Placing: Place materials in horizontal layers not exceeding 200 mm (8 inches) in loose depth for material compacted by heavy compaction equipment, and not more than 100 mm (4 inches) in loose depth for material compacted by hand-operated tampers and then compacted. Place backfill and fill materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure. Place no material on surfaces that are muddy, frozen, or contain frost.
- C. Compaction: Compact with approved tamping rollers, sheepsfoot rollers, pneumatic tired rollers, steel wheeled rollers, vibrator compactors, or other approved equipment (hand or mechanized) well suited to soil being compacted. Do not operate mechanized vibratory compaction equipment within 3000 mm (10 feet) of new or existing building walls without prior approval of COR. Moisten or aerate material as necessary to provide moisture content that will readily facilitate obtaining specified compaction with equipment used. Backfill adjacent to any and all types of structures shall be placed and compacted to at least 90 percent laboratory maximum density for cohesive materials or 95 percent laboratory maximum density for cohesionless materials to prevent wedging action or eccentric loading upon or against the structure. Compact soil to not less than the following percentages of maximum dry density, according to ASTM D698 or ASTM D1557 as specified below:
 - 1. Fills, Embankments, and Backfill
 - a. Under proposed structures, building slabs, steps, and paved areas, scarify and recompact top 300 mm (12 inches) of existing subgrade and each layer of backfill or fill material in accordance with ASTM D698 or D1557, 95 percent.
 - b. Curbs, curbs and gutters, ASTM D698 or D1557, 95 percent.
 - c. Under Sidewalks, scarify and recompact top 150 mm (6 inches) below subgrade and compact each layer of backfill or fill material in accordance with ASTM D698 or D1557, 95 percent.
 - d. Landscaped areas, top 400 mm (16 inches), ASTM D698 or D1557, 85 percent.

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- e. Landscaped areas, below 400 mm (16 inches) of finished grade, ASTM D698 or D1557, 85 percent.
- 2. Natural Ground (Cut or Existing)
 - a. Under building slabs, steps and paved areas, top 150 mm (6 inches), ASTM D698 or D1557, 95 percent.
 - b. Curbs, curbs and gutters, top 150 mm (6 inches), ASTM D698 or D1557, 95 percent.
 - c. Under sidewalks, top 150 mm (6 inches), ASTM D698 or D1557, 95 percent.
- D. Borrow Material: Borrow material shall be selected to meet the requirements and conditions of the particular fill or embankment for which it is to be used. Borrow material shall be obtained from within the limits of the project site, or from approved private sources. Unless otherwise provided in the contract, the Contractor shall obtain from the owners the right to procure material, pay royalties and other charges involved, and bear the expense of developing the sources, including rights-of-way for hauling. Unless specifically provided, no borrow shall be obtained within the limits of the project site without prior written approval. Necessary clearing, grubbing, and satisfactory drainage of borrow pits and the disposal of debris thereon shall be considered related operations to the borrow excavation.

3.5 GRADING:

- A. General: Uniformly grade the areas within the limits of this section, including adjacent transition areas. Smooth the finished surface within specified tolerance. Provide uniform levels or slopes between points where elevations are indicated, or between such points and existing finished grades. Provide a smooth transition between abrupt changes in slope.
- B. Cut rough or sloping earth to level beds for foundations. In pipe spaces or other unfinished areas, fill low spots and level off with coarse sand or fine gravel.
- C. Slope backfill outside building away from building walls for a minimum distance of 1800 mm (6 feet).
- D. Finish grade earth floors in pipe basements as shown to a level, uniform slope and leave clean.
- E. Finished grade shall be at least 150 mm (6 inches) below bottom line of window or other building wall openings unless greater depth is shown.

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- F. Place crushed stone or gravel fill under concrete slabs on grade, tamped, and leveled. Thickness of fill shall be 150 mm (6 inches) unless otherwise shown.
- G. Finish subgrade in a condition acceptable to COR at least one day in advance of paving operations. Maintain finished subgrade in a smooth and compacted condition until succeeding operation has been accomplished. Scarify, compact, and grade subgrade prior to further construction when approved compacted subgrade is disturbed by Contractor's subsequent operations or adverse weather.
- H. Grading for Paved Areas: Provide final grades for both subgrade and base course to +/- 6 mm (0.25 inches) of indicated grades.

3.6 DISPOSAL OF UNSUITABLE AND EXCESS EXCAVATED MATERIAL:

- A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off property.
- B. Remove from site and dispose of any excess excavated materials after all fill and backfill operations have been completed.

3.7 CLEAN UP:

Upon completion of earthwork operations, clean areas within contract limits, remove tools, and equipment. Provide site clear, clean, free of debris, and suitable for subsequent construction operations. Remove all debris, rubbish, and excess material from Property.

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SECTION 32 05 23
CEMENT AND CONCRETE FOR EXTERIOR IMPROVEMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section shall cover site work concrete constructed upon the prepared subgrade and in conformance with the lines, grades, thickness, and cross sections shown on the Drawings. Construction shall include the following:
- B. Curb, gutter, and combination curb and gutter.
- C. Pedestrian Pavement: Walks, grade slabs, wheelchair curb ramps.

1.2 RELATED WORK

- A. Section 00 72 00, GENERAL CONDITIONS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES
- C. Section 01 45 29, TESTING LABORATORY SERVICES.
- D. Section 03 30 00, CAST-IN-PLACE CONCRETE.
- E. Section 05 50 00, METAL FABRICATIONS.
- F. Section 31 20 00, EARTHWORK.

1.3 DESIGN REQUIREMENTS

Design all elements with the latest published version of applicable codes.

1.4 WEATHER LIMITATIONS

- A. Hot Weather: Follow the recommendations of ACI 305 or as specified to prevent problems in the manufacturing, placing, and curing of concrete that can adversely affect the properties and serviceability of the hardened concrete. Methods proposed for cooling materials and arrangements for protecting concrete shall be made in advance of concrete placement and approved by VA COR.
- B. Cold Weather: Follow the recommendations of ACI 306 or as specified to prevent freezing of concrete and to permit concrete to gain strength properly. Use only the specified non-corrosive, non-chloride accelerator. Do not use calcium chloride, thiocyanates or admixtures containing more than 0.05 percent chloride ions. Methods proposed for heating materials and arrangements for protecting concrete shall be made in advance of concrete placement and approved by VA COR.

1.5 SUBMITTALS

Contractor shall submit the following.

- A. Manufacturers' Certificates and Data certifying that the following materials conform to the requirements specified.
 - 1. Expansion joint filler

2. Hot poured sealing compound
 3. Reinforcement
 4. Curing materials
- B. Jointing Plan for all concrete areas.
- C. Concrete Mix Design.
- D. Concrete Test Reports
- E. Construction Staking Notes from Surveyor.
- F. Data and Test Reports: Select subbase material.
1. Job-mix formula.
 2. Source, gradation, liquid limit, plasticity index, percentage of wear, and other tests as specified and in referenced publications.

1.6 APPLICABLE PUBLICATIONS

The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only. Refer to the latest edition of all referenced Standards and codes.

- A. American Association of State Highway and Transportation Officials (AASHTO):
- M147-65-UL.....Materials for Aggregate and Soil-Aggregate Subbase, Base and Surface Courses (R 2004)
- M148-05-UL.....Liquid Membrane-Forming Compounds for Curing Concrete (ASTM C309)
- M171-05-UL.....Sheet Materials for Curing Concrete (ASTM C171)
- M182-05-UL.....Burlap Cloth Made from Jute or Kenaf and Cotton Mats
- B. American Society for Testing and Materials (ASTM):
- A82/A82M-07.....Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
- A185/185M-07.....Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
- A615/A615M-12.....Standard Specification for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement
- A653/A653M-11.....Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc Iron Alloy Coated (Galvannealed) by the Hot Dip Process
- A706/A706M-09b.....Standard Specification for Low Alloy Steel Deformed and Plain Bars for Concrete Reinforcement

A767/A767M-09.....Standard Specification for Zinc Coated
(Galvanized) Steel Bars for Concrete
Reinforcement

A775/A775M-07b.....Standard Specification for Epoxy Coated
Reinforcing Steel Bars

A820/A820M-11.....Standard Specification for Steel Fibers for
Fiber Reinforced Concrete

C31/C31M-10.....Standard Practice for Making and Curing Concrete
Test Specimens in the field

C33/C33M-11a.....Standard Specification for Concrete Aggregates

C39/C39M-12.....Standard Test Method for Compressive Strength of
Cylindrical Concrete Specimens

C94/C94M-12.....Standard Specification for Ready Mixed Concrete

C143/C143M-10a.....Standard Test Method for Slump of Hydraulic
Cement Concrete

C150/C150M-12.....Standard Specification for Portland Cement

C171-07.....Standard Specification for Sheet Materials for
Curing Concrete

C172/C172M-10.....Standard Practice for Sampling Freshly Mixed
Concrete

C173/C173M-10b.....Standard Test Method for Air Content of Freshly
Mixed Concrete by the Volumetric Method

C192/C192M-07.....Standard Practice for Making and Curing Concrete
Test Specimens in the Laboratory

C231/C231M-10.....Standard Test Method for Air Content of Freshly
Mixed Concrete by the Pressure Method

C260/C260M-10a.....Standard Specification for Air Entraining
Admixtures for Concrete

C309-11.....Standard Specification for Liquid Membrane
Forming Compounds for Curing Concrete

C494/C494M-12.....Standard Specification for Chemical Admixtures
for Concrete

C618-12.....Standard Specification for Coal Fly Ash and Raw
or Calcined Natural Pozzolan for Use in Concrete

C666/C666M-03(2008).....Standard Test Method for Resistance of Concrete
to Rapid Freezing and Thawing

D1751-04(2008).....Standard Specification for Preformed Expansion
Joint Filler for Concrete Paving and Structural
Construction (Non-extruding and Resilient
Bituminous Types)

D4263-83(2012).....Standard Test Method for Indicating Moisture in
Concrete by the Plastic Sheet Method.

D4397-10.....Standard Specification for Polyethylene Sheeting
for Construction, Industrial and Agricultural
Applications

C. American Welding Society (AWS):

D1.4/D1.4M (2005).....Structural Welding Code - Reinforcing Steel

PART 2 - PRODUCTS

2.1 GENERAL

A. Concrete Type: Concrete shall be as per Table 1 - Concrete Type, air
entrained.

TABLE I - CONCRETE TYPE

	Concrete Strength		Air-Entrained	
	Min. 28 Day Comp. Str. Psi (MPa)	Min. Cement lbs/c. yd (kg/m ³)	Min. Cement lbs/c. yd (kg/m ³)	Max. Water Cement Ratio
Type B	4000 (30) ^{1,3}	550 (325)	570 (340)	0.50

1. If trial mixes are used, the proposed mix design shall achieve a
compressive strength 1200 psi (8.3 MPa) in excess of the compressed
strength. For concrete strengths above 5000 psi (35 Mpa), the
proposed mix design shall achieve a compressive strength 1400 psi
(9.7 MPa) in excess of the compressed strength.

2. For concrete exposed to high sulfate content soils maximum water
cement ratio is 0.44.

3. Determined by Laboratory in accordance with ACI 211.1 for normal
concrete or ACI 211.2 for lightweight structural concrete.

B. Maximum Slump: Maximum slump, as determined by ASTM C143 with tolerances
as established by ASTM C94, for concrete to be vibrated shall be as
shown in Table II.

TABLE II - MAXIMUM SLUMP - INCHES (MM)

TYPE	MAXIMUM SLUMP*
Curb & Gutter	3 inches (75 mm)
Pedestrian Pavement	3 inches (75 mm)
* For concrete to be vibrated: Slump as determined by ASTM C143. Tolerances as established by ASTM C94.	

2.2 REINFORCEMENT

A. The type, amount, and locations of steel reinforcement shall be as shown
on the drawings and in the specifications.

2.3 FORMS

- A. Use metal or wood forms that are straight and suitable in cross-section, depth, and strength to resist springing during depositing and consolidating the concrete, for the work involved.
- B. Do not use forms if they vary from a straight line more than 1/8 inch (3 mm) in any ten foot (3000 mm) long section, in either a horizontal or vertical direction.
- C. Wood forms shall be at least 2 inches (50 mm) thick (nominal). Wood forms shall also be free from warp, twist, loose knots, splits, or other defects. Use approved flexible or curved forms for forming radii.

2.4 CONCRETE CURING MATERIALS

- A. Concrete curing materials shall conform to one of the following:
 - 1. Burlap having a weight of seven ounces (233 grams) or more per yard (square meter) when dry.
 - 2. Impervious Sheeting conforming to ASTM C171.
 - 3. Liquid Membrane Curing Compound conforming to ASTM C309, Type 2 and shall be free of paraffin or petroleum.

2.5 EXPANSION JOINT FILLERS

Material shall conform to ASTM D1751-04.

PART 3 - EXECUTION

3.1 SUBGRADE PENETRATION

- A. Prepare, construct, and finish the subgrade as specified in Section 31 20 00, EARTHWORK.
- B. Maintain the subgrade in a smooth, compacted condition, in conformance with the required section and established grade until the succeeding operation has been accomplished.

3.2 SETTING FORMS

- A. Base Support:
 - 1. Compact the base material under the forms true to grade so that, when set, they will be uniformly supported for their entire length at the grade as shown.
 - 2. Correct imperfections or variations in the base material grade by cutting or filling and compacting.
- B. Form Setting:
 - 1. Set forms sufficiently in advance of the placing of the concrete to permit the performance and approval of all operations required with and adjacent to the form lines.
 - 2. Set forms to true line and grade and use stakes, clamps, spreaders, and braces to hold them rigidly in place so that the forms and joints are free from play or movement in any direction.

3. Forms shall conform to line and grade with an allowable tolerance of 1/8 inch (3 mm) when checked with a straightedge and shall not deviate from true line by more than 1/4 inch (6 mm) at any point.
 4. Do not remove forms until removal will not result in damaged concrete or at such time to facilitate finishing.
 5. Clean and oil forms each time they are used.
 6. Make necessary corrections to forms immediately before placing concrete.
 7. When any form has been disturbed or any subgrade or subbase has become unstable, reset and recheck the form before placing concrete.
- C. The Contractor's Registered Professional Land Surveyor, specified in Section 00 72 00, GENERAL CONDITIONS, shall establish the control, alignment and the grade elevations of the forms or concrete slipforming machine operations. Staking notes shall be submitted for approval to the VA COR prior to placement of concrete. If discrepancies exist between the field conditions and the Drawings, Contractor shall notify VA COR immediately. No placement of concrete shall occur if a discrepancy greater than 1 inch (25 mm) is discovered.

3.3 EQUIPMENT

- A. The VA COR shall approve equipment and tools necessary for handling materials and performing all parts of the work prior to commencement of work.
- B. Maintain equipment and tools in satisfactory working condition at all times.

3.4 PLACING REINFORCEMENT

- A. Reinforcement shall be free from dirt, oil, rust, scale or other substances that prevent the bonding of the concrete to the reinforcement. All reinforcement shall be supported for proper placement within the concrete section.
- B. Before the concrete is placed, the VA COR shall approve the reinforcement placement, which shall be accurately and securely fastened in place with suitable supports and ties. The type, amount, and position of the reinforcement shall be as shown on the Drawings.

3.5 PLACING CONCRETE - GENERAL

- A. Obtain approval of the VA COR before placing concrete.
- B. Remove debris and other foreign material from between the forms before placing concrete.
- C. Before the concrete is placed, uniformly moisten the subgrade, base, or subbase appropriately, avoiding puddles of water.

- D. Convey concrete from mixer to final place of deposit by a method which will prevent segregation or loss of ingredients. Deposit concrete so that it requires as little handling as possible.
- E. While being placed, spade or vibrate and compact the concrete with suitable tools to prevent the formation of voids or honeycomb pockets. Vibrate concrete well against forms and along joints. Over-vibration or manipulation causing segregation will not be permitted. Place concrete continuously between joints without bulkheads.
- F. Install a construction joint whenever the placing of concrete is suspended for more than 30 minutes and at the end of each day's work.
- G. Workmen or construction equipment coated with foreign material shall not be permitted to walk or operate in the concrete during placement and finishing operations.
- H. Cracked or Chipped Concrete Surfaces and Bird Baths. Cracked or chipped concrete and bird baths will not be allowed. Concrete with cracks or chips and bird baths will be removed and replaced to the nearest joints, and as approved by the VA COR, by the Contractor with no additional cost to the Government.

3.6 PLACING CONCRETE FOR CURB AND GUTTER, PEDESTRIAN PAVEMENT

- A. Place concrete in the forms in one layer of such thickness that, when compacted and finished, it will conform to the cross section as shown.
- B. Deposit concrete as near to joints as possible without disturbing them but do not dump onto a joint assembly.
- C. After the concrete has been placed in the forms, use a strike-off guided by the side forms to bring the surface to the proper section to be compacted.
- D. Consolidate the concrete thoroughly by tamping and spading, or with approved mechanical finishing equipment.
- E. Finish the surface to grade with a wood or metal float.
- F. All concrete pads and pavements shall be constructed with sufficient slope to drain properly.

3.7 CONCRETE FINISHING - GENERAL

- A. The sequence of operations, unless otherwise indicated, shall be as follows:
 - 1. Consolidating, floating, straight-edging, troweling, texturing, and edging of joints.
 - 2. Maintain finishing equipment and tools in a clean and approved condition.

3.8 CONCRETE FINISHING CURB AND GUTTER

- A. Round the edges of the gutter and top of the curb with an edging tool to a radius of 1/4 inch (6 mm) or as otherwise detailed.

- B. Float the surfaces and finish with a smooth wood or metal float until true to grade and section and uniform in textures.
- C. Finish the surfaces, while still wet, with a bristle type brush with longitudinal strokes.
- D. Immediately after removing the front curb form, rub the face of the curb with a wood or concrete rubbing block and water until blemishes, form marks, and tool marks have been removed. Brush the surface, while still wet, in the same manner as the gutter and curb top.
- E. Except at grade changes or curves, finished surfaces shall not vary more than 1/8 inch (3 mm) for gutter and 1/4 (6 mm) for top and face of curb, when tested with a 10 foot (3000 mm) straightedge.
- F. Remove and reconstruct irregularities exceeding the above for the full length between regularly scheduled joints.
- G. Correct any depressions which will not drain. See Article 3.6, Paragraph H, above.
- H. Visible surfaces and edges of finished curb, gutter, and/or combination curb and gutter shall be free of blemishes, form marks, and tool marks, and shall be uniform in color, shape, and appearance.

3.9 CONCRETE FINISHING PEDESTRIAN PAVEMENT

- A. Walks, Grade Slabs, Wheelchair Curb Ramps:
 - 1. Finish the surfaces to grade and cross section with a metal float, troweled smooth and finished with a broom moistened with clear water.
 - 2. Brooming shall be transverse to the line of traffic.
 - 3. Finish all slab edges, including those at formed joints, carefully with an edger having a radius as shown on the Drawings.
 - 4. Unless otherwise indicated, edge the transverse joints before brooming. The brooming shall eliminate the flat surface left by the surface face of the edger. Execute the brooming so that the corrugation, thus produced, will be uniform in appearance and not more than 1/16 inch (2 mm) in depth.
 - 5. The completed surface shall be uniform in color and free of surface blemishes, form marks, and tool marks. The finished surface of the pavement shall not vary more than 3/16 inch (5 mm) when tested with a 10 foot (3000 mm) straightedge.
 - 6. The thickness of the pavement shall not vary more than 1/4 inch (6 mm).
 - 7. Remove and reconstruct irregularities exceeding the above for the full length between regularly scheduled joints at no additional cost to the Government.

3.10 JOINTS - GENERAL

- A. Place joints, where shown on the Shop Drawings and Drawings, conforming to the details as shown, and perpendicular to the finished grade of the concrete surface.
- B. Joints shall be straight and continuous from edge to edge of the pavement.

3.11 CONTRACTION JOINTS

- A. Cut joints to depth as shown with a grooving tool or jointer of a radius as shown or by sawing with a blade producing the required width and depth.
- B. Construct joints in curbs and gutters by inserting 1/8 inch (3 mm) steel plates conforming to the cross sections of the curb and gutter.
- C. Plates shall remain in place until concrete has set sufficiently to hold its shape and shall then be removed.
- D. Finish edges of all joints with an edging tool having the radius as shown.
- E. Score pedestrian pavement with a standard grooving tool or jointer.

3.12 EXPANSION JOINTS

- A. Use a preformed expansion joint filler material of the thickness as shown to form expansion joints.
- B. Material shall extend the full depth of concrete, cut and shaped to the cross section as shown, except that top edges of joint filler shall be below the finished concrete surface where shown to allow for sealing.
- C. Anchor with approved devices to prevent displacing during placing and finishing operations.
- D. Round the edges of joints with an edging tool.
- E. Form expansion joints as follows:
 - 1. Without dowels, about structures and features that project through, into, or against any site work concrete construction.
 - 2. Using joint filler of the type, thickness, and width as shown.
 - 3. Installed in such a manner as to form a complete, uniform separation between the structure and the site work concrete item.

3.13 CONSTRUCTION JOINTS

- A. Place transverse construction joints of the type shown, where indicated and whenever the placing of concrete is suspended for more than 30 minutes.
- B. Use a butt-type joint with dowels in curb and gutter if the joint occurs at the location of a planned joint.
- D. Use keyed joints with tiebars if the joint occurs in the middle third of the normal curb and gutter joint interval.

3.14 FORM REMOVAL

- A. Forms shall remain in place at least 12 hours after the concrete has been placed. Remove forms without injuring the concrete.
- B. Do not use bars or heavy tools against the concrete in removing the forms. Promptly repair any concrete found defective after form removal.

3.15 CURING OF CONCRETE

- A. Cure concrete by one of the following methods appropriate to the weather conditions and local construction practices, against loss of moisture, and rapid temperature changes for at least seven days from the beginning of the curing operation. Protect unhardened concrete from rain and flowing water. All equipment needed for adequate curing and protection of the concrete shall be on hand and ready to install before actual concrete placement begins. Provide protection as necessary to prevent cracking of the pavement due to temperature changes during the curing period. If any selected method of curing does not afford the proper curing and protection against concrete cracking, remove and replace the damaged pavement and employ another method of curing as directed by the VA COR.
- B. Burlap Mat: Provide a minimum of two layers kept saturated with water for the curing period. Mats shall overlap each other at least 150 mm (6 inches).
- C. Impervious Sheeting: Use waterproof paper, polyethylene-coated burlap, or polyethylene sheeting. Polyethylene shall be at least 4 mils (0.1 mm) in thickness. Wet the entire exposed concrete surface with a fine spray of water and then cover with the sheeting material. Sheets shall overlap each other at least 12 inches (300 mm). Securely anchor sheeting.
- D. Liquid Membrane Curing:
 - 1. Apply pigmented membrane-forming curing compound in two coats at right angles to each other at a rate of 200 square feet per gallon (5 m²/L) for both coats.
 - 2. Do not allow the concrete to dry before the application of the membrane.
 - 3. Cure joints designated to be sealed by inserting moistened paper or fiber rope or covering with waterproof paper prior to application of the curing compound, in a manner to prevent the curing compound entering the joint.
 - 4. Immediately re-spray any area covered with curing compound and damaged during the curing period.

3.16 CLEANING

- A. After completion of the curing period:
 - 1. Remove the curing material (other than liquid membrane).

2. Sweep the concrete clean.
3. After removal of all foreign matter from the joints, seal joints as specified.
4. Clean the entire concrete of all debris and construction equipment as soon as curing and sealing of joints has been completed.

3.17 PROTECTION

The contractor shall protect the concrete against all damage prior to final acceptance by the Government. Remove concrete containing excessive cracking, fractures, spalling, or other defects and reconstruct the entire section between regularly scheduled joints, when directed by the VA COR, and at no additional cost to the Government. Exclude traffic from vehicular pavement until the concrete is at least seven days old, or for a longer period of time if so directed by the VA COR.

3.18 FINAL CLEAN-UP

Remove all debris, rubbish and excess material from the Property.

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SECTION 32 12 16
ASPHALT PAVING

PART 1 - GENERAL

1.1 DESCRIPTION

This work shall cover the composition, mixing, construction upon the prepared subgrade, and the protection of hot asphalt concrete pavement. The hot asphalt concrete pavement shall consist of an asphalt base course and asphalt surface course constructed in conformity with the lines, grades, thickness, and cross sections as shown. Each course shall be constructed to the depth, section, or elevation required by the drawings and shall be rolled, finished, and approved before the placement of the next course.

1.2 RELATED WORK

- A. Laboratory and field testing requirements: Section 01 45 29, TESTING LABORATORY SERVICES.
- B. Subgrade Preparation: Paragraph 3.3 and Section 31 20 00, EARTH MOVING.
- C. Pavement Markings: Section 32 17 23, PAVEMENT MARKINGS.

1.3 INSPECTION OF PLANT AND EQUIPMENT

The COR shall have access at all times to all parts of the material producing plants for checking the mixing operations and materials and the adequacy of the equipment in use.

1.4 ALIGNMENT AND GRADE CONTROL

The Contractor's Registered Professional Land Surveyor shall establish and control the pavement (aggregate or asphalt base course and asphalt surface course) alignments, grades, elevations, and cross sections as shown on the Drawings.

1.5 SUBMITTALS

- A. In accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, furnish the following:
- B. Data and Test Reports:
 - 1. Aggregate Base Course: Sources, gradation, liquid limit, plasticity index, percentage of wear, and other tests required by State Highway Department.
 - 2. Asphalt Base/Surface Course: Aggregate source, gradation, soundness loss, percentage of wear, and other tests required by State Highway Department.
 - 3. Job-mix formula.
- C. Certifications:

1. Asphalt prime and tack coat material certificate of conformance to State Highway Department requirements.
2. Asphalt cement certificate of conformance to State Highway Department requirements.
3. Job-mix certification - Submit plant mix certification that mix equals or exceeds the State Highway Specification.
- D. One copy of State Highway Department Specifications.
- E. Provide MSDS (Material Safety Data Sheets) for all chemicals used on ground.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Aggregate base and asphalt concrete materials shall conform to the requirements of the following and other appropriate sections of the latest version of the State Highway Material Specifications, including amendments, addenda and errata. Where the term "Engineer" or "Commission" is referenced in the State Highway Specifications, it shall mean the VA COR or VA Contracting Officer.

2.2 AGGREGATES

- A. Provide aggregates consisting of crushed stone, gravel, sand, or other sound, durable mineral materials processed and blended, and naturally combined.
- B. Base aggregate: MDOT 21AA limestone.
- C. Aggregates for asphaltic concrete paving: Comply with MDOT requirements for the specified asphalt design mixes.

2.3 ASPHALTS

- A. Comply with provisions of MDOT specifications for the asphalt design mixes listed on the Drawings.

PART 3 - EXECUTION

3.1 GENERAL

The Asphalt Concrete Paving equipment, weather limitations, job-mix formula, mixing, construction methods, compaction, finishing, tolerance, and protection shall conform to the requirements of the appropriate sections of the State Highway Specifications for the type of material specified.

3.2 MIXING ASPHALTIC CONCRETE MATERIALS

- A. Provide hot plant-mixed asphaltic concrete paving materials.
 1. Temperature leaving the plant: 143 degrees C(290 degrees F) minimum, 160 degrees C(320 degrees F) maximum.
 2. Temperature at time of placing: 138 degrees C(280 degrees F) minimum.

3.3 SUBGRADE

- A. Shape to line and grade and compact with self-propelled rollers.
- B. All depressions that develop under rolling shall be filled with acceptable material and the area re-rolled.
- C. Soft areas shall be removed and filled with acceptable materials and the area re-rolled.
- D. Should the subgrade become rutted or displaced prior to the placing of the subbase, it shall be reworked to bring to line and grade.
- E. Proof-roll the subgrade with maximum 45 tonne (50 ton) gross weight dump truck as directed by VA COR or VA Contracting Officer. If pumping, pushing, or other movement is observed, rework the area to provide a stable and compacted subgrade.

3.4 BASE COURSES

- A. Subbase
 - 1. Spread and compact to the thickness shown on the drawings.
 - 2. Rolling shall begin at the sides and continue toward the center and shall continue until there is no movement ahead of the roller.
 - 3. After completion of the subbase rolling there shall be no hauling over the subbase other than the delivery of material for the base and asphalt courses.
- B. Base
 - 1. Spread and compact to the thickness shown on the drawings.
 - 2. Rolling shall begin at the sides and continue toward the center and shall continue until there is no movement ahead of the roller.
 - 3. After completion of the base rolling there shall be no hauling over the base other than the delivery of material for the top course.
- C. Thickness tolerance: Provide the compacted thicknesses shown on the Drawings within a tolerance of minus 0.0mm (0.0") to plus 12.7mm (0.5").
- D. Smoothness tolerance: Provide the lines and grades shown on the Drawings within a tolerance of 5mm in 3m (3/16 inch in ten feet).
- E. Moisture content: Use only the amount of moisture needed to achieve the specified compaction.

3.5 PLACEMENT OF ASPHALTIC CONCRETE PAVING

- A. Remove all loose materials from the compacted base.
- B. Apply the specified prime coat, and tack coat where required, and allow to dry in accordance with the manufacturer's recommendations as approved by the Architect or Engineer.
- C. Receipt of asphaltic concrete materials:
 - 1. Do not accept material unless it is covered with a tarpaulin until unloaded, and unless the material has a temperature of not less than 130 degrees C(280 degrees F).

2. Do not commence placement of asphaltic concrete materials when the atmospheric temperature is below 10 degrees C (50 degrees F), not during fog, rain, or other unsuitable conditions.

D. Spreading:

1. Spread material in a manner that requires the least handling.
2. Where thickness of finished paving will be 76mm (3") or less, spread in one layer.

E. Rolling:

1. After the material has been spread to the proper depth, roll until the surface is hard, smooth, unyielding, and true to the thickness and elevations shown on the drawings.
2. Roll in at least two directions until no roller marks are visible.
3. Finished paving smoothness tolerance:
 - a. No depressions which will retain standing water.
 - b. No deviation greater than 3mm in 1.8m (1/8" in six feet).

3.6 PROTECTION

Protect the asphaltic concrete paved areas from traffic until cured and does not pick up under foot or wheeled traffic.

3.7 FINAL CLEAN-UP

Remove all debris, rubbish, and excess material from the work area.

- - - E N D - - -

**SECTION 32 17 23
PAVEMENT MARKINGS**

PART 1 - GENERAL

1.1 DESCRIPTION

This work shall consist of furnishing and applying paint on pavement surfaces, in the form of traffic lanes, parking bays, areas restricted to handicapped persons, crosswalks, and other detail pavement markings, in accordance with the details as shown or as prescribed by the COR. Conform to the Manual on Uniform Traffic Control Devices for Streets and Highways, published by the U.S. Department of Transportation, Federal Highway Administration, for details not shown.

1.2 SUBMITTALS

- A. In accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, furnish Manufacturer's Certificates and Data certifying that the following materials conform to the requirements specified.
- B. Paint.

1.3 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. Federal Specifications (Fed. Spec.):
 - TT-B-1325C.....Beads (Glass Spheres); Retro-Reflective
 - TT-P-1952D.....Paint, Traffic Black, and Airfield Marking,
Waterborne
- C. Master Painters Institute (MPI):
 - Approved Product List - 2010

PART 2 - PRODUCTS

2.1 PAINT

Paint for marking pavement (parking lot and zone marking) shall conform to MPI No. 97, color as shown. Paint for obliterating existing markings shall conform to Fed. Spec. TT-P-1952D. Paint shall be in containers of at least 18 L (5 gallons). A certificate shall accompany each batch of paint stating compliance with the applicable publication.

2.2 PAINT APPLICATOR

Apply all marking by approved mechanical equipment. The equipment shall provide constant agitation of paint and travel at controlled speeds. Synchronize one or more paint "guns" to automatically begin and cut off paint flow in the case of skip lines. The equipment shall have manual control to apply continuous lines of varying length and marking widths

as shown. Provide pneumatic spray guns for hand application of paint in areas where a mobile paint applicator cannot be used. An experienced technician that is thoroughly familiar with equipment, materials, and marking layouts shall control all painting equipment and operations.

2.3 SANDBLASTING EQUIPMENT

Sandblasting equipment shall include an air compressor, hoses, and nozzles of proper size and capacity as required for cleaning surfaces to be painted. The compressor shall furnish not less than 0.08 m³/s (150 cfm) of air at a pressure of not less than 625 kPa (90 psi) at each nozzle used.

PART 3 - EXECUTION

3.1 SURFACE PREPARATION

- A. Allow new pavement surfaces to cure for a period of not less than 14 days before application of marking materials.
- B. Thoroughly clean all surfaces to be marked before application of paint. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water, or a combination of these methods. Completely remove rubber deposits, existing paint markings, and other coatings adhering to the pavement with scrapers, wire brushings, sandblasting, mechanical abrasion, or approved chemicals as directed by the COR. The application of paint conforming to Fed. Spec. TT-P-1952D is an option to removal of existing paint markings on asphalt pavement. Apply the black paint in as many coats as necessary to completely obliterate the existing markings. Where oil or grease are present on old pavements to be marked, scrub affected areas with several applications of trisodium phosphate solution or other approved detergent or degreaser, and rinse thoroughly after each application. After cleaning, seal oil-soaked areas with cut shellac to prevent bleeding through the new paint. Pavement marking shall follow as closely as practicable after the surface has been cleaned and dried, but do not begin any marking until the COR has inspected the surface and gives permission to proceed. The Contractor shall establish control points for marking and provide templates to control paint application by type and color at necessary intervals. The Contractor is responsible to preserve and apply marking in conformance with the established control points.

3.2 APPLICATION

Apply uniformly painted pavement marking of required color(s), length, and width with true, sharp edges and ends on properly cured, prepared, and dried surfaces in conformance with the details as shown and established control points. The length and width of lines shall conform

within a tolerance of plus or minus 75 mm (3 inches) and plus or minus 3 mm (1/8 inch), respectively, in the case of skip markings. The length of intervals shall not exceed the line length tolerance. Temperature of the surface to be painted and the atmosphere shall be above 10°C (50°F) and less than 35°C (95°F). Apply the paint at a wet film thickness of 0.4 mm (0.015 inch). Apply paint in one coat. At the direction of the COR, markings showing light spots may receive additional coats. The maximum drying time requirements of the paint specifications will be strictly enforced, to prevent undue softening of asphalt, and pick-up, displacement, or discoloration by tires of traffic. If there is a deficiency in drying of the marking, discontinue paint operations until cause of the slow drying is determined and corrected. Remove and replace marking that is applied at less than minimum material rates; deviates from true alignment; exceeds stipulated length and width tolerances; or shows light spots, smears, or other deficiencies or irregularities. Use carefully controlled sand blasting, approved grinding equipment, or other approved method to remove marking so that the surface to which the marking was applied will not be damaged.

3.3 PROTECTION

Conduct operations in such a manner that necessary traffic can move without hindrance. Protect the newly painted markings so that, insofar as possible, the tires of passing vehicles will not pick up paint. Place warning signs at the beginning of the wet line, and at points well in advance of the marking equipment for alerting approaching traffic from both directions. Place small flags or other similarly effective small objects near freshly applied markings at frequent intervals to reduce crossing by traffic. Efface and replace damaged portions of markings at no additional cost to the Government.

3.4 DETAIL PAVEMENT MARKING

Use Detail Pavement Markings, exclusive of actual traffic lane marking, at exit and entrance islands and turnouts, on curbs, at crosswalks, at parking bays, and at such other locations as shown. Show the International Handicapped Symbol at indicated parking spaces. Color shall be as shown. Apply paint for the symbol using a suitable template that will provide a pavement marking with true, sharp edges and ends. Place detail pavement markings of the color(s), width(s) and length(s), and design pattern at the locations shown.

3.5 TEMPORARY PAVEMENT MARKING

When shown or directed by the COR, apply Temporary Pavement Markings of the color(s), width(s) and length(s) shown or directed. After the

temporary marking has served its purpose and when so ordered by the COR, remove temporary marking by carefully controlled sandblasting, approved grinding equipment, or other approved method so that the surface to which the marking was applied will not be damaged. As an option, an approved preformed pressure sensitive, reflective, adhesive tape type of temporary pavement marking of the required color(s), width(s) and length(s) may be furnished and used in lieu of temporary painted and reflective marking. The Contractor shall be fully responsible for the continued durability and effectiveness of such marking during the period for which its use is required. Remove any unsatisfactory tape type marking and replace with painted and reflective markings at no additional cost to the Government.

3.6 FINAL CLEAN-UP

Remove all debris, rubbish and excess material from the Property.

- - - E N D - - -

SECTION 32 90 00

PLANTING

GENERAL

DESCRIPTION

- A. The work in this section consists of furnishing and installing plant, soils, edging turf, grasses and landscape materials required as specified in locations shown.

RELATED WORK

- B. Topsoil Testing: Section 01 45 29, TESTING LABORATORY SERVICES.
C. Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS.
D. Stripping Topsoil, Stock Piling and Topsoil Materials: Section 31 20 00, EARTH MOVING.

DEFINITIONS

- E. Backfill: The earth used to replace earth in an excavation.
F. Balled and Burlapped Stock: ANSI Z60.1. Plants dug with firm, natural balls of earth in which they were grown, with ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball.
G. Balled and Potted Stock: ANSI Z60.1. Plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required.
H. 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.
I. Finish Grade: Elevation of finished surface of planting soil.
J. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

- K. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- L. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
- M. Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, turf and grasses, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.
- N. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.
- O. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
- P. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

DELIVERY, STORAGE AND HANDLING

- Q. Notify the Contracting Officer's Representative of the delivery schedule in advance so the plant material may be inspected upon arrival at the job site. Remove unacceptable plant and landscape materials from the job site immediately.
- R. Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws, as applicable. Keep seed and other packaged materials in dry storage away from contaminants.
- S. Bulk Materials:
 - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants. Keep bulk materials in dry storage away from contaminants.
 - 2. Provide erosion control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and

airborne dust reaching adjacent properties, water conveyance systems, or walkways.

3. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

T. 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.

U. Handle planting stock by root ball.

V. The use of equipment such as "tree spades" is permitted provided the plant balls are sized in accordance with ANSI Z60.1 and tops are protected from damage.

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

X. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than 6 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.

Y. Deliver plugs within 24 hours of harvesting, keep moist until planting.

Z. All pesticides and herbicides shall be properly labeled and registered with the U.S. Department of Agriculture. Deliver materials in original, unopened containers showing, certified analysis, name and address of manufacturer, product label, manufacturer's application instructions specific to the project and indication of conformance with state and federal laws, as applicable.

PROJECT CONDITIONS

AA. 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.

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

1. Spring Planting: April 15 through May 15.
2. Fall Planting: August 15 through September 15.

CC. 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.

DD. Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated.

1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

EE. Plant trees, shrubs, and other plants after finish grades and irrigation system components are established but not before irrigation system components are installed, tested and approved unless otherwise indicated.

1. When planting trees, shrubs, and other plants, protect irrigation system components and promptly repair damage caused by planting operations.

QUALITY ASSURANCE:

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

1. Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association with 5 years experience in landscape installation.
2. Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
3. Installer's field supervisor shall have certification in one of the following categories from the Professional Landcare Network and submit one copy of certificate to the Contracting Officer's Representative:
 - a. Certified Landscape Technician (CLT) - Exterior, with installation specialty area(s), designated CLT-Exterior.

- b. Certified Ornamental Landscape Professional, designated COLP.
- 4. Pesticide Applicator: Licensed in state of project, commercial.
- GG. A qualified Arborist shall be licensed and required to submit one copy of license to the Contracting Officer's Representative.
- HH. Include an independent or university laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.
- II. For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; deleterious material; pH; and mineral and plant-nutrient content of the soil.
 - 1. Testing methods and written recommendations shall comply with USDA's Handbook No. 60, "Diagnosis and Improvement of Saline and Alkali Soils".
 - 2. The soil-testing laboratory shall oversee soil sampling; with depth, location, and number of samples to be taken per instructions from Contracting Officer's Representative. A minimum of 3 representative samples shall be taken from varied locations for each soil to be used or amended for planting purposes.
 - 3. Report suitability of tested soil for plant growth.
 - a. Based upon the test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1000 sq. ft. (92.9 sq. m) or volume per cu. yd (0.76 cu. m) for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
 - b. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.
- JJ. Provide quality, size, genus, species, variety and sources of plants indicated, complying with applicable requirements in ANSI Z60.1.
- KK. Measure according to ANSI Z60.1. Do not prune to obtain required sizes.
 - 1. Measure trees and shrubs 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. Measure other plants with stems, petioles, and foliage in their normal position.

LL. Contracting Officer's Representative may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Contracting Officer's Representative retains right to observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and to reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.

1. Notify Contracting Officer's Representative of plant material sources a minimum of seven days in advance of delivery to site.

MM. Include product label and manufacturer's literature and data for pesticides and herbicides.

NN. Conduct a pre-installation conference at Project site.

SUBMITTALS

OO. Submit product data for each type of product indicated, including soils:

1. Include quantities, sizes, quality, and sources for plant materials.
2. Include EPA approved product label, MSDS (Material Safety Data Sheet) and manufacturer's application instructions specific to the Project.
3. Include color photographs in digital format of each required species and size of plant material as it will be furnished to the Project. Take photographs from an angle depicting true size and condition of the typical plant to be furnished. Include a scale rod or other measuring device in each photograph. For species where more than 20 plants are required, include a minimum of 3 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.

PP. Submit samples and manufacturer's literature for each of the following for approval before work is started.

1. Trees and Shrubs: 3 samples of each variety and size delivered to the site for review. Maintain approved samples on-site as a standard for comparison.
 2. Organic and Compost Mulch: 1-pint (0.5-liter) volume of each organic and compost 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.
 3. Submit edging materials and accessories in manufacturer's standard size, to verify color selected.
 4. Erosion Control Materials: 12 by 12 inches (300 by 300 mm).
 5. Tree Wrap: Width of panel by 12 inches (300 mm).
- QQ. Qualification data for qualified landscape Installer. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.
- RR. Prior to delivery, provide notarized certificates attesting that each type of manufactured product, from the manufacturer, meet the requirements specified and shall be submitted to the Contracting Officer's Representative for approval:
1. Plant Materials (Department of Agriculture certification by State Nursery Inspector declaring material to be free from insects and disease).
 2. Seed and Turf Materials notarized certificate of product analysis.
 3. Manufacturer's certified analysis of standard products.
 4. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.
- SS. Material Test Reports: For existing native surface topsoil and imported topsoil.
- TT. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before start of required maintenance periods.

PLANT AND TURF ESTABLISHMENT PERIOD

- UU. The establishment period for plants and turf shall begin immediately after installation, with the approval of the Contracting Officer's Representative, and continue until the date that the Government accepts

the project or phase for beneficial use and occupancy. During the Establishment Period the Contractor shall maintain the plants and turf as required in Part 3.

PLANT AND TURF MAINTENANCE SERVICE

VV. Provide initial maintenance service for trees, shrubs, ground cover and other plants by skilled employees of landscape Installer. 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: 6 months from date of Substantial Completion.

WW. Obtain continuing maintenance proposal from Installer to Owner, in the form of a standard yearly (or other period) maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

APPLICABLE PUBLICATIONS

XX. The publications listed below, form a part of this specification to the extent referenced. The publications are referenced in the text by basic designation only.

YY. American National Standards Institute (ANSI):

Z60.1-04 Nursery Stock

ZZ. Association of Official Seed Analysts (AOSA): Rules for Testing Seed.

AAA. American Society For Testing And Materials (ASTM):

B221-08 Aluminum and Aluminum-Alloy Extruded Bars,
Rods, Wire, Profiles, and Tubes

C33/C33M-11 Concrete Aggregates

C136-06 Sieve Analysis of Fine and Coarse Aggregates

C516-08 Vermiculite Loose Fill Thermal Insulation

C549-06 Perlite Loose Fill Insulation

C602-07 Agricultural Liming Materials

D977-05 Emulsified Asphalt (AASHTO M140)

D5268-07 Topsoil Used for Landscaping Purposes

BBB. Hortus Third: A Concise Dictionary of Plants Cultivated in the United States and Canada.

CCC. Turfgrass Producers International (TPI): Guideline Specifications to Turfgrass Sodding.

DDD. United States Department of Agriculture (USDA): Handbook No. 60
Diagnosis and Improvement of Saline and Alkali Soils; Federal Seed Act Regulations.

WARRANTY

EEE. The Contractor shall remedy any defect due to faulty material or workmanship and pay for any damage to other work resulting therefrom within a period of one year from final acceptance, unless noted otherwise below. Further, the Contractor will provide all manufacturer's and supplier's written guarantees and warranties covering materials and equipment furnished under this Contract.

1. Plant and Turf Warranty Periods will begin from the date of Substantial Completion.
 - a. Trees, Shrubs, Vines, and Ornamental Grasses: 12 months.
 - b. Ground Covers, Biennials, Perennials, Turf, and Other Plants: 12 months.
2. The Contractor shall have completed, located, and installed all plants and turf according to the plans and specifications. All plants and turf are expected to be living and in a healthy condition at the time of final inspection.
3. The Contractor will replace any dead plant material and any areas void of turf immediately, unless required to plant in the succeeding planting season. Provide extended warranty for period equal to original warranty period for replacement plant materials. Replacement plant and turf warranty will begin on the day the work is completed.
4. Replacement of relocated plants, that the Contractor did not supply, is not required unless plant failure is due to improper handling and care during transplanting. Loss through Contractor negligence requires replacement in plant type and size.
5. The Government will reinspect all plants and turf at the end of the Warranty Period. The Contractor will replace any dead, missing, or defective plant material and turf immediately. The Warranty Period will end on the date of this inspection provided the Contractor has complied with the warranty work required by this specification. The Contractor shall also comply with the following requirements:

- a. Replace plants that are more than 25 percent dead, missing or defective plant material prior to final inspection.
 - b. A limit of one replacement of each plant will be required except for losses or replacements due to failure to comply with requirements.
 - c. Mulch and weed plant beds and saucers. Just prior to final inspection, treat these areas to a second application of approved pre-emergent herbicide.
 - d. Complete remedial measures directed by the Contracting Officer's Representative to ensure plant and turf survival.
 - e. Repair damage caused while making plant or turf replacements.
- FFF. 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, or incidents that are beyond Contractor's control.
 - b. Structural failures including plantings falling or blowing over.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

PRODUCTS

PLANT MATERIAL

- GGG. Plant and turf materials: ANSI Z60.1; will conform to the varieties specified and be true to botanical name as listed in Hortus Third; nursery-grown plants and turf material true to genus, species, variety, cultivar, stem form, shearing, and other features indicated on Drawings; healthy, normal and unbroken root systems developed by transplanting or root pruning; well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf; free of disease, pests, eggs, larvae, and defects such as knots, sun scald, windburn, injuries, abrasions, and disfigurement.
- 1. Trees-deciduous and evergreen: Single trunked with a single leader, unless otherwise indicated; symmetrically developed deciduous trees and shrubs of uniform habit of growth; straight boles or stems; free from objectionable disfigurements; evergreen trees and shrubs with well developed symmetrical tops, with typical spread of branches for

each particular species or variety. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than 3/4 inch (19 mm) in diameter; or with stem girdling roots will be rejected.

2. Ground cover and vine plants: Provide the number and length of runners for the size specified on the Drawings, together with the proper age for the grade of plants specified. Provide vines and ground cover plants well established in removable containers, integral containers, or formed homogeneous soil sections. Plants shall have been grown under climatic conditions similar to those in the locality of the project. Spray all plants budding into leaf or having soft growth with an anti desiccant at the nursery before digging.
3. The minimum acceptable sizes of all plants, measured before pruning with branches in normal position, shall conform to the measurements designated. Plants larger in size than specified may be used with the approval of the Contracting Officer's Representative, with no change in the contract price. When larger plants are used, increase the ball of earth or spread of roots in accordance with ANSI Z60.1.
4. Provide nursery grown plant material conforming to the requirements and recommendations of ANSI Z60.1. Dig and prepare plants for shipment in a manner that will not cause damage to branches, shape, and future development after planting.
5. Balled and burlapped (B&B) plant ball sizes and ratios will conform to ANSI Z60.1, consisting of firm, natural balls of soil wrapped firmly with burlap or strong cloth and tied.
6. Container grown plants shall have sufficient root growth to hold the earth intact when removed from containers, but shall not be root bound.
7. Make substitutions only when a plant (or alternates as specified) is not obtainable and the Contracting Officer's Representative authorizes a change order providing for use of the nearest equivalent obtainable size or variety of plant with the same essential characteristics and an equitable adjustment of the contract price.
8. Existing plants to be relocated, ball sizes shall conform to requirements for collected plants in ANSI Z60.1, and plants shall be

dug, handled, and replanted in accordance with applicable sections of these specifications.

9. 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.

HHH. Label at least one plant of each variety, size, and caliper with a securely attached, waterproof and weather-resistant label bearing legible the correct designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for the plant as indicated in the Plant Schedule or Plant Legend shown on the Drawings. Labels shall be securely attached and not be removed.

III. INORGANIC SOIL AMENDMENTS

1.

JJJ. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent sulfur, with a minimum of 99 percent passing through No. 6 (3.35 mm) sieve and a maximum of 10 percent passing through No. 40 (0.425 mm) sieve.

KKK. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.

LLL. Aluminum Sulfate: Commercial grade, unadulterated.

MMM. Perlite: ASTM C549, horticultural perlite, soil amendment grade.

NNN. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through No. 50 (0.30 mm) sieve.

OOO. Coarse Sand shall be concrete sand, ASTM C33 Fine Aggregate, clean, sharp free of limestone, shale and slate particles, and toxic materials.

PPP. Vermiculite: ASTM C516, horticultural grade and free of any toxic materials.

QQQ. Diatomaceous Earth: Calcined, 90 percent silica, with approximately 140 percent water absorption capacity by weight.

RRR. Zeolites: Mineral clinoptilolite with at least 60 percent water absorption by weight.

ORGANIC SOIL AMENDMENTS

SSS. Organic matter: Commercially prepared compost. Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 3/4 inch (19 mm) sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5

percent inert contaminants and free of substances toxic to plantings;
and as follows:

1. Organic Matter Content: 50 to 60 percent of dry weight.

TTT.

UUU.

- 1.

VVV. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, debris, and material harmful to plant growth.

PLANT AND TURF FERTILIZERS

WWW. Soil Test: Evaluate existing soil conditions and requirements prior to fertilizer selection and application to minimize the use of all fertilizers and chemical products. Obtain approval of Contracting Officer's Representative for allowable products, product alternatives, scheduling and application procedures. Evaluate existing weather and site conditions prior to application. Apply products during favorable weather and site conditions according to manufacturer's written instructions and warranty requirements. Fertilizers to be registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer applicable to specific areas as required for Project conditions and application. Provide commercial grade plant and turf fertilizers, free flowing, uniform in composition and conforms to applicable state and federal regulations.

XXX. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition shall be nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

YYY. Slow-Release Fertilizer: Granular or pellet fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. Composition shall be nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

ZZZ. Plant 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.

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

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PLANTING SOILS

AAAA. Planting Soil: ASTM D5268 topsoil, with pH range of 5.5 to 7, a minimum of 4 percent organic material content; free of stones 1 inch (25 mm) or larger in any dimension and other extraneous materials harmful to plant growth. Mix ASTM D5268 topsoil with the following soil amendments and fertilizers as recommended by the soils analysis.

BBBB. Existing Planting Soil: Existing, native surface topsoil formed under natural conditions retained during excavation process and stockpiled on-site. Verify suitability of native surface topsoil to produce viable planting soil. Clean soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.

1. Supplement with another specified planting soil when quantities are insufficient.
2. Mix existing, native surface topsoil with the following soil amendments and fertilizers as recommended by the soils analysis.

CCCC. Imported Planting Soil: Imported topsoil—from off-site sources can be used if sufficient topsoil is not available on site to meet the depth as specified herein. The Contractor shall furnish imported topsoil. At least 10 days prior to topsoil delivery, notify the Contracting Officer's Representative of the source(s) from which topsoil is to be furnished. Obtain imported topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches (100 mm) deep; do not obtain from agricultural land, bogs, or marshes.

MULCH

DDDD. 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-
 - a. Wood cellulose fiber for use with hydraulic application of grass seed and fertilizer: Consist of specially prepared wood cellulose fiber, processed to contain no growth or germination inhibiting factors, and dyed an appropriate color to facilitate visual

metering of the application of materials. On an air dry weight basis, the wood cellulose fiber shall contain a maximum of 12 percent moisture, plus or minus 3 percent at the time of manufacture. The pH range shall be from 3.5 to 5.0. The wood cellulose fiber shall be manufactured so that:

- 1) After addition and agitation in slurry tanks with fertilizers, grass seeds, water, and other approved additives, the fibers in the material will become uniformly suspended to form an homogeneous slurry.
- 2) When hydraulically sprayed on the ground, the material will form a blotter like cover impregnated uniformly with grass seed.
- 3) The cover will allow the absorption of moisture and allow rainfall or applied water to percolate to the underlying soil.

2. Color shall be natural.

TACKIFIERS AND ADHESIVES

EEEE. Nonasphalt tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

EROSION CONTROL

FFFF. Erosion control blankets: Biodegradable wood excelsior, straw, or coconut fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended biodegradable staples, 6 inches (150 mm) long.

TREE WRAP

GGGG. Crinkle paper tree wrap: Two thicknesses of crinkled paper cemented together with a layer of bituminous material. Wrapping material shall be a minimum of 4 inches (100 mm) in width and have a stretch factor of 33 1/3 percent. Twine for tying shall be lightly tarred medium or coarse sisal yarn.

HHHH. Tree wrap shall be secured to the trunk using bio-degradable tape suitable for nursery use and which is expected to degrade in sunlight in less than 2 years after installation.

EDGING

IIII. Steel edging: Standard commercial steel edging, rolled edge, fabricated in sections of standard lengths, with loops stamped from or welded to face of sections to receive stakes.

1. Edging Size: 1/4 inch (6.4 mm) wide by 4 inches (100 mm).
2. Stakes: Tapered steel, a minimum of 12 inches (300 mm) long.
3. Accessories: Standard tapered ends, corners, and splicers.
4. Finish: Standard paint.
5. Paint color: Green.

WATER

JJJJ. Water shall not contain elements toxic to plant life.

ANTIDESICCANT

KKKK. Antidesiccant: An emulsion specifically manufactured for agricultural use that will provide a protective film over plant surfaces permeable enough to permit transpiration.

TURF SELECTIONS

LLLL. Grasses for Cool Regions shall be:

1. Bluegrasses: Kentucky (*Poa pratensis*)
2. Fescue: Tall (*Festuca arundinacea*)
3. Ryegrasses: Perennial (*Lolium perenne*)

SEED

MMMM. Grass Seed: Fresh, clean, dry, new-crop seed complying with "AOSA, Rules for Testing Seed" for purity and germination tolerances. Seed shall be labeled in conformance with U. S. Department of Agriculture rules and regulations under the Federal Seed Act and applicable state seed laws. Wet, moldy, or otherwise damaged seed will not be acceptable.

NNNN. Seed Species: Not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed.

1. Sun and Partial Shade: Proportioned by weight as follows:
 - a. 30 percent Kentucky Bluegrass.
 - b. 30 percent Perennial Ryegrass.
 - c. 40 percent Turf Type Tall Fescue.

PESTICIDES

OOOO. Consider IPM (Integrated Pest Management) practices to minimize the use of all pesticides and chemical products. Obtain approval of Chief Engineer for allowable products, product alternatives, scheduling and application procedures. Evaluate existing weather and site conditions prior to application. Apply products during favorable weather and site conditions according to manufacturer's written instructions and warranty requirements. Pesticides to be registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project

conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

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

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

EXECUTION

EXAMINATION

RRRR. Examine areas to receive plants for compliance with requirements and conditions affecting installation and performance.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
4. Uniformly moisten excessively dry soil that is not workable and which is too dusty.
5. Special conditions may exist that warrant a variance in the specified planting dates or conditions. Submit a written request to the Contracting Officer's Representative stating the special conditions and proposal variance.

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

TTTT. 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 Contracting Officer's Representative and replace with new planting soil.

PREPARATION

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

VVVV. 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.

WWWW. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain approval by the Contracting Officer's Representative of layout before excavating or planting. The Contracting Officer's Representative may approve adjustments to plant material locations to meet field conditions.

XXXX. 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.

YYYY. 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.

PLANTING AREA ESTABLISHMENT

ZZZZ. Loosen subgrade of planting areas to a minimum depth of 8 inches (200 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. Apply fertilizer directly to subgrade before loosening. 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.

AAAAA. 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.

BBBBB. Before planting, obtain Contracting Officer's Representative acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

EXCAVATION FOR TREES AND SHRUBS

CCCCC. Planting Pits and Trenches: Excavate circular planting pits with sides sloping inward at a 45 degree angle. Excavations with vertical sides are not acceptable. 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.

1. Excavate approximately 3 times as wide as ball diameter for balled and burlapped or container-grown stock.
2. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
3. 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.
4. Maintain required angles of repose of adjacent materials as shown on the Drawings. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
5. Maintain supervision of excavations during working hours.
6. Keep excavations covered or otherwise protected when unattended by Installer's personnel.
7. Use topsoil to form earth saucers or water basins for watering around plants. Basins to be 2 inches (50 mm) high for shrubs and 4 inches (100 mm) high for trees.

DDDDD. Subsoil and topsoil removed from excavations may not be used as planting soil.

EEEEEE. Notify Contracting Officer's Representative if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.

FFFFF. Notify Contracting Officer's Representative if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.

GGGGG. Fill excavations with water and allow water to percolate away before positioning trees and shrubs.

TREE, SHRUB, AND VINE PLANTING

HHHHH. Prior to 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.

IIIII. Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.

JJJJJ. Set balled and burlapped stock plumb and in center of planting pit or trench with root flare 1 inch (25 mm) above adjacent finish grades.

1. Use planting 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 full, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
4. Place planting tablets in each planting pit when pit is approximately one-half filled; in amounts recommended in soil reports from soil-testing laboratory. Place tablets beside soil-covered roots about 1 inch (25 mm) from root tips; do not place tablets in bottom of the hole or touching the roots.
5. Continue backfilling process. Water again after placing and tamping final layer of soil.

KKKKK. Set container-grown stock plumb and in center of planting pit or trench with root flare 1 inch (25 mm) above adjacent finish grades.

1. Use planting soil for backfill.
2. Carefully remove root ball from container without damaging root ball or plant. 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 full, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
4. Place planting tablets in each planting pit when pit is approximately one-half filled; in amounts recommended in soil reports from soil-testing laboratory. Place tablets beside soil-covered roots about 1 inch (25 mm) from root tips; do not place tablets in bottom of the hole or touching the roots.

5. Continue backfilling process. Water again after placing and tamping final layer of soil.

LLLLL. 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.

MECHANIZED TREE SPADE PLANTING

MMMMM. Trees may be planted with an approved mechanized tree spade at the designated locations. Do not use tree spade to move trees larger than the maximum size allowed for a similar field-grown, balled-and-burlapped root-ball diameter according to ANSI Z60.1, or larger than the manufacturer's maximum size recommendation for the tree spade being used, whichever is smaller.

NNNNN. When extracting the tree, center the trunk within the tree spade and move tree with a solid ball of earth.

OOOOO. Cut exposed roots cleanly during transplanting operations.

PPPPP. Use the same tree spade to excavate the planting hole as was used to extract and transport the tree.

QQQQQ. Where possible, orient the tree in the same direction as in its original location.

TREE, SHRUB, AND VINE PRUNING

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

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

TTTTT. Do not apply pruning paint to wounds.

TREE WRAP

WRAP THE TRUNKS OF DECIDUOUS TREES IMMEDIATELY AFTER PLANTING. WRAP THE TRUNKS OF DECIDUOUS TREES, 1-1/2 INCHES (40 MM) OR GREATER IN CALIBER WITH THE SPECIFIED MATERIAL BEGINNING AT THE BASE AND EXTENDING TO THE FIRST BRANCHES. REMOVE WRAPPING AFTER ONE YEAR. WHEN USING CRINKLED PAPER WRAP, SECURELY TIE WRAPPING AT THE TOP AND BOTTOM AND AT 18 INCH (450 MM) MAXIMUM INTERVALS WITH TWINE.

GROUND COVER AND PLANT INSTALLATION

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

VVVVV. Use planting soil for backfill.

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

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

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

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

AAAAA. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

BBBBB. Plant ground cover in areas to receive erosion control materials through the material after erosion control materials are in place.

MULCH INSTALLATION

CCCCC. Mulch backfilled surfaces of planting areas and other areas indicated. Keep mulch out of plant crowns and off buildings, pavements, utility standards/pedestals, and other structures.

1. Trees and Tree-like Shrubs in Turf Areas: Apply organic mulch ring of 3 inch (75 mm) average thickness, with 12 inch (300 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 3 inch (75 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) of trunks or stems.

EDGING INSTALLATION

DDDDDD. Install steel edging where indicated according to manufacturer's written instructions. Anchor with steel stakes spaced approximately 30 inches (760 mm) apart, driven below top elevation of edging.

PLANT MAINTENANCE

EEEEEE. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring plant saucers, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings. Spray or treat as required to keep trees and shrubs free of insects and disease.

FFFFFF. 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.

GGGGGG. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use IPM (Integrated Pest Management) practices whenever possible to minimize the use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

TURF AREA PREPARATION AND GRADING

HHHHHH. For newly graded subgrades loosen subgrade to a minimum depth of 8 inches (200 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.
2. Spread planting soil to a depth of 6 inches (150 mm) but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet

IIIIII. Finish grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch (13 mm) of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be planted in the immediate future.

PREPARATION FOR EROSION-CONTROL MATERIALS.

JJJJJJ. Prepare area as specified in "Turf Area Preparation and Grading" Article.

KKKKKK. For erosion control blanket or mesh, install from top of slope, working downward, and as recommended by material manufacturer for site conditions. Fasten with biodegradable materials as recommended by material manufacturer.

LLLLLL. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

HYDROSEEDING

MMMMMM. For hydroseeding, mix specified seed, fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.

1. Mix slurry with nonasphaltic tackifier.
2. Apply slurry uniformly to all areas to be seeded in a one-step process. Apply slurry at a rate so that mulch component is deposited at not less than 1500-lb/acre (15.6-kg/92.9 sq. m) dry weight, and seed component is deposited at not less than the specified seed-sowing rate.

TURF RENOVATION

NNNNNN. Renovate existing turf damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.

1. Reestablish turf where settlement or washouts occur or where minor regrading is required.
2. Install new planting soil as required.

OOOOOO. Remove sod and vegetation from diseased or unsatisfactory turf areas; do not bury in soil.

PPPPPP. Remove topsoil containing foreign materials such as oil drippings, fuel spills, stones, gravel, and other construction materials resulting from Contractor's operations, and replace with new planting soil.

QQQQQQ. Mow, dethatch, core aerate, and rake existing turf.

RRRRRR. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.

SSSSSS. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.

TTTTTT. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches (150 mm).

UUUUUU. Apply soil amendments and initial fertilizers required for establishing new turf and mix thoroughly into top 4 inches (100 mm) of existing soil. Install new planting soil to fill low spots and meet finish grades.

VVVVVV. Apply seed as required for new turf.

WWWWWW. Water newly planted areas and keep moist until new turf is established.

TURF MAINTENANCE

XXXXXX. Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.

1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use IPM (Integrated Pest Management) practices whenever possible to minimize the use of pesticides and reduce hazards.

YYYYYY. Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches (100 mm).

1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
2. Water turf with fine spray at a minimum rate of 1 inch (25 mm) per week unless rainfall precipitation is adequate.

ZZZZZZ. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 1/3 of grass height. Remove no more than 1/3 of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and

become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:

1. Mow to a height of 2 to 3 inches (50 to 75 mm).

SATISFACTORY TURF

AAAAAAA. Turf installations shall meet the following criteria as determined by Contracting Officer's Representative:

1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. (0.92 sq. m) and bare spots not exceeding 5 by 5 inches (125 by 125 mm).

BBBBBBB. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

PESTICIDE APPLICATION

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

DDDDDDD. Pre-Emergent Herbicides (Selective and Non-Selective): Applied to tree, shrub, and ground-cover areas in accordance with manufacturer's written recommendations. Do not apply to seeded areas.

EEEEEEE. Post-Emergent Herbicides (Selective and Non-Selective): Applied only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

CLEANUP AND PROTECTION

FFFFFFF. During planting, keep adjacent paving and construction clean and work area in an orderly condition.

GGGGGGG. 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.

HHHHHHH. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

IIIIIII. Erect temporary fencing or barricades and warning signs, as required to protect newly planted areas from traffic. Maintain fencing

and barricades throughout initial maintenance period and remove after plantings are established.

JJJJJJJ. 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.

KKKKKKK. Remove nondegradable erosion control measures after grass establishment period.

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

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SECTION 33 10 00
WATER UTILITIES

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies materials and procedures for construction of underground water distribution for domestic and/or fire supply systems outside the building that are complete and ready for operation. This includes piping, structures, appurtenances and all other incidentals.

1.2 RELATED WORK

- A. Excavation, Trench Widths, Pipe Bedding, Backfill, Shoring, Sheeting, Bracing: Section 31 20 00, EARTH MOVING.
- B. Concrete: Section 03 30 00, CAST IN-PLACE CONCRETE.
- C. Submittals: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.
- D. Erosion and Sediment Control: Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS.

1.3 DEFINITIONS

- A. Water distribution system: Pipelines and appurtenances which are part of the distribution system outside the building for potable water and fire supply.
- B. Water service line: Pipeline from main line to 5 feet outside of building.

1.4 ABBREVIATIONS

- A. PVC: Polyvinyl chloride plastic.
- B. DI: Ductile iron pipe.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Ensure that valves are dry and internally protected against rust and corrosion. Protect valves against damage to threaded ends and flange faces.

- B. Use a sling to handle valves and fire hydrants if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.
- C. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.
- D. Protect stored piping from moisture and dirt by elevating above grade. Protect flanges, fittings, and specialties from moisture and dirt.
- E. Store plastic piping protected from direct sunlight and support to prevent sagging and bending.
- F. Cleanliness of Piping and Equipment Systems:
 - 1. Care shall be exercised in the storage and handling of equipment and piping material to be incorporated in the work. Debris arising from cutting, threading and welding of piping shall be removed.
 - 2. Piping systems shall be flushed, blown or pigged as necessary to deliver clean systems.

1.6 COORDINATION

- A. Coordinate connection to water main with Public Utility indicated on the drawings.
- B. Coordinate water service lines with building contractor.

1.7 QUALITY ASSURANCE:

- A. Products Criteria:
 - 1. When two or more units of the same type or class of materials or equipment are required, these units shall be products of one manufacturer.
 - 2. A nameplate bearing manufacturer's name or trademark, including model number, shall be securely affixed in a conspicuous place on equipment. In addition, the model number shall be either cast integrally with equipment, stamped, or otherwise permanently marked on each item of equipment.
- B. Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least three years.
- C. Regulatory requirements:

1. Comply with the rules and regulations of the public utility organization(s) having jurisdiction over the connection to public water lines and the extension and/or modifications to public utility systems.
 2. Comply with the rules and regulations of the State and local agencies having jurisdiction for potable water-service.
 3. Comply with rules and regulations of State and local authorities having jurisdiction for fire-suppression water-service piping including materials, hose threads, installation and testing.
- D. Provide certification of factory hydrostatic testing of not less than 500 psi (3.5 MPa) in accordance with AWWA C151. Piping materials shall bear the label, stamp or other markings of the specified testing agency.
- E. Where installation procedures or any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations shall be furnished to the VA COR prior to installation.
- F. Applicable codes:
1. Plumbing Systems: IPC, International Plumbing Code.
 2. Fire-service main products shall be listed in the FM Global "Approval Guide" or Underwriters Laboratories (UL) "Fire Protection Equipment Directory".

1.8 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

B. American National Standards Institute (ANSI):

MSS SP-60-2004	Connecting Flange Joint Between Tapping Sleeves and Tapping Valves
MSS SP-108-2002	Resilient-Seated Cast Iron, Eccentric Plug Valves
MSS SP-123-1998(R2006)	Non-Ferrous Threaded and Solder-Joint Unions for Use With Copper Water Tube

C. American Society of Mechanical Engineers (ASME):

A112.1.2-2004	Air Gaps in Plumbing Systems (for Plumbing Fixtures and Water-Connected Receptors))
A112.6.3-2001	Floor Drains
B16.1-2010	Gray Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250
B16.18-2001	Cast Copper Alloy Solder Joint Pressure Fittings
B16.22-2001	Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
B16.24-2006	Cast Copper Alloy Pipe Flanges and Flanged Fittings; Classes 150, 300, 600, 900, 1500 and 2500
B31	Code for Pressure Piping Standards
D. American Society for Testing and Materials (ASTM):	
A36/A36M-08	Carbon Structural Steel
A48/A48M-08(2008)	Gray Iron Castings
A536-84(2009)	Ductile Iron Castings
A674-10	Polyethylene Encasement for Ductile Iron Pipe for Water or Other Liquids
B61-08	Steam or Valve Bronze Castings
B62-09	Composition Bronze or Ounce Metal Castings
B88/B88M-09	Seamless Copper Water Tube
C651-05	Disinfecting Water Mains
C858-10e1	Underground Precast Utility Structures
D1785-06	Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
D2239-03	Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter
D2464-06	Threaded Poly (Vinyl Chloride) PVC Pipe Fittings, Schedule 80

D2466-06	Poly (Vinyl Chloride) (PVC) Pipe Fittings, Schedule 40
D2467-06	Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
D2609-02(2008)	Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe
D3350-10a	Polyethylene Plastics Pipe and Fittings Materials
F714-10	Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
F1267-07	Metal, Expanded, Steel
E. American Water Works Association (AWWA):	
B300-10	Hypochlorites
B301-10	Liquid Chlorine
C104-08	Cement-Mortar Lining for Ductile Iron Pipe and Fittings
C105/A21.5-10	Polyethylene Encasement for Ductile Iron Pipe Systems
C110-08	Ductile Iron and Gray-Iron Fittings
C111/A21.11-07	Rubber-Gasket Joints for Ductile Iron Pressure Pipe and Fittings
C115/A21.11-11	Flanged Ductile Iron Pipe with Ductile Iron or Gray-Iron Threaded Flanges
C151/A21.51-09	Ductile Iron Pipe, Centrifugally Cast
C153/A21.53-11	Ductile Iron Compact Fittings for Water Service
C502-05	Dry-Barrel Fire Hydrants
C503-05	Wet-Barrel Fire Hydrants
C504-10	Rubber-Seated Butterfly Valves
C508-09	Swing-Check Valves for Waterworks Service, 2- In. Through 24-In. (50-mm Through 600-mm) NPS

C509-09	Resilient-Seated Gate Valves for Water Supply Service
C510-07	Double Check Valve Backflow Prevention Assembly
C511-07	Reduced-Pressure Principle Backflow Prevention Assembly
C512-07	Air Release, Air/Vacuum and Combination Air Valves
C550-05	Protective Interior Coatings for Valves and Hydrants
C600-10	Installation of Ductile Iron Mains and Their Appurtenances
C605-11	Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water
C606-11	Grooved and Shouldered Joints
C651-05	Disinfecting Water Mains
C700-09	Cold-Water Meters, "Displacement Type," Bronze Main Case
C800-05	Underground Service Line Valves and Fittings
C900-09	Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Transmission and Distribution
C906-07	Polyethylene (PE) Pressure Pipe and Fittings, 4 In. (100 mm) Through 64 In. (1,600 mm), for Water Distribution and Transmission
C907-04	Injection-Molded PVC Pressure Fittings, 4 Inch through 12 Inch (100 mm through 300 mm), for Water Distribution
M23-2nd Ed.	PVC Pipe, Design and Installation
M44-2nd Ed.	Distribution Valves: Selection, Installation, Field Testing and Maintenance

F. National Fire Protection Association (NFPA):

NFPA 24-2010 Ed. Installation of Private Fire Service Mains and
 Their Appurtenances

NFPA 1963-2009 Ed. Fire Hose Connections

G. NSF International (NSF):

NSF/ANSI 14 (2013) Plastics Piping System Components and Related
 Materials

NSF/ANSI 61-2012 Drinking Water System Components - Health
 Effects

NSF/ANSI 372-2011 Drinking Water System Components - Lead Content

H. American Welding Society (AWS):

A5.8/A5.8M-2004 Filler Metals for Brazing and Braze Welding

I. American Society of Safety Engineers (ASSE):

1003-2009 Water Pressure Reducing Valves

1015-2009 Double Check Backflow Prevention Assemblies and
 Double Check Fire Protection Backflow
 Prevention Assemblies

1020-2004 Pressure Vacuum Breaker Assembly

1047-2009 Performance Requirements for Reduced Pressure
 Detector Fire Protection Backflow Prevention
 Assemblies

1048-2009 Performance Requirements for Double Check
 Detector Fire Protection Backflow Prevention
 Assemblies

1060-2006 Performance Requirements for Outdoor Enclosures
 for Fluid Conveying Components

J. Underwriters' Laboratories (UL):

246 Hydrants for Fire-Protection Service

262 Gate Valves for Fire-Protection Service

312 Check Valves for Fire-Protection Service

405 Fire Department Connection Devices

753	Alarm Accessories for Automatic Water-Supply Control Valves for Fire Protection Service
789	Indicator Posts for Fire-Protection Service
1091	Butterfly Valves for Fire-Protection Service
1285	Pipe and Couplings, Polyvinyl Chloride (PVC), and Oriented Polyvinyl Chloride (PVC0) for Underground Fire Service

1.9 WARRANTY

A. The Contractor shall remedy any defect due to faulty material or workmanship and pay for any damage to other work resulting therefrom within a period of one year from final acceptance. Further, the Contractor will furnish all manufacturers' and supplier's written guarantees and warranties covering materials and equipment furnished under this Contract.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Material or equipment containing a weighted average of greater than 0.25 percent lead shall not be used in any potable water system intended for human consumption, and shall be certified in accordance with NSF/ANSI 61 or NSF 372.

2.2 FACTORY-ASSEMBLED PRODUCTS

A. Standardization of components shall be maximized to reduce spare part requirements. The contractor shall guarantee performance of assemblies of components, and shall repair or replace elements of the assemblies as required to deliver specified performance of the complete assembly.

2.3 LIFTING ATTACHMENTS

A. Equipment shall be provided with suitable lifting attachments to enable equipment to be lifted in its normal position. Lifting attachments shall withstand any handling conditions that might be encountered, without bending or distortion of shape, such as rapid lowering and braking of load.

2.4 DUCTILE IRON PIPE AND FITTINGS

- A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated, 350 psi (2400 kPa).
 - 1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 - 2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated, 350 psi (2400 kPa).
 - 1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 - 2. Gaskets: AWWA C111, rubber.
- C. Cement Mortar Internal Lining: Cement mortar lining and bituminous seal coat as per AWWA C104.
- D. Exterior Pipe Coating: The exterior of pipe shall have the standard asphaltic coating.

2.5 COPPER TUBE AND FITTINGS

- A. Soft Copper Tubing: ASTM B88, Type.
- B. Hard Copper Tubing: ASTM B88, Type K.
- C. Fittings: ASME B16.18, cast copper alloy, solder joint pressure fittings.
- D. Brazing Alloy: AWS A5.8/A5.8M, Classification BCuP.
- E. Copper Unions: ANSI MSS SP-123, cast copper alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.

2.6 VALVES

- A. Gate Valves: AWWA C509, Non-rising Stem, Resilient Seat, 200 psi (1380 kPa).
 - 1. Valves 3 inches (75 mm) and larger: Resilient seat valve with gray- or ductile iron body and bonnet; cast iron or bronze double-disc gate; bronze gate rings; non-rising bronze stem and stem nut.
 - 2. Interior and exterior coating: AWWA C550, thermo-setting or fusion epoxy.

3. Underground valve nut: Furnish valves with 2 inch (50 mm) nut for socket wrench operation.
4. Aboveground and pit operation: Furnish valves with hand wheels.
5. End connections shall be mechanical joint.
6. Turn direction as required by local agency having jurisdiction.

B. Gate Valve Accessories and Specialties

1. Tapping-Sleeve Assembly: ANSI MSS SP-60; sleeve and valve to be compatible with the drilling matching.
 - a. Tapping Sleeve: Stainless-Steel, two-piece bolted sleeve. Sleeve to match the size and type of pipe material being tapped.
 - b. Valve shall include one raised face flange mating tapping-sleeve flange.
2. Valve Boxes: AWWA M44 with top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over valve and with a barrel.
3. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut as required by local agency having jurisdiction.
4. Indicator Posts: UL 789, FMG approved, vertical-type, cast iron body with operating wrench, extension rod, and adjustable cast iron barrel of length required for depth of burial of valve.

C. Corporation Valves and Curb Valves

1. Service-Saddle Assemblies: AWWA C800.
 - a. Service Saddle: Copper alloy with seal and threaded outlet for corporation valve.
 - b. Corporation Valve: Bronze body and ground-key plug, with threaded inlet and outlet matching service piping material.
2. Curb Valves: AWWA C800, bronze body, ground-key plug or ball, wide tee head, with inlet and outlet matching service piping material, minimum pressure of 200 psi (1375 kPa).
3. Service Boxes for Curb Valves: AWWA M44, cast iron telescoping top section; plug shall include lettering "WATER"; bottom section with base that fits over curb valve.
4. Shutoff Rods: Steel, tee-handle with one pointed end. Stem length shall extend 2 feet (600 mm) above top of valve box for operation of deepest buried valve, with slotted end matching curb valve.

- D. Post-Indicator: NFPA 24 and be fully compatible with the valve and supervisory switches.

2.7 CONCRETE VAULTS

- A. Precast, reinforced-concrete vault: ASTM C858, designed for AASHTO H20-44 load designation.
1. Ladder: ASTM A36, steel or polyethylene-encased steel steps.
 2. Drain: ASME A112.6.3, cast iron floor drain with outlet. Include body anchor flange, light-duty cast iron grate, bottom outlet, and integral or field-installed bronze ball or clapper-type backwater valve.
 3. Manhole Frame and Cover: ASTM A48, Class No. 35A minimum tensile strength, 24 inch (610 mm) minimum diameter, unless otherwise indicated.
 4. Manhole Frame and Cover: ASTM A536, Grade 60-40-18, ductile iron, 24 inch (610 mm) minimum diameter, unless otherwise indicated.

2.8 FIRE HYDRANTS

- A. All hydrants shall have removable interiors capable of replacement without digging up the hydrant and be packable under pressure. Threaded joints or spindles shall be bronze and upper and lower barrels shall be of equal diameter. Upper barrel shall be of sufficient length to permit setting hydrant with barrel flange not more than 4 inches (100 mm) above finished grade. All fire hydrants shall have 6 inch (150 mm) bottom connection. Pressure Rating: 250 psi (1725 kPa). Hydrant valve shall open by turning operating nut to left or counterclockwise, unless required otherwise by the local agency having jurisdiction. Exterior finish shall be red alkyd-gloss enamel paint, unless otherwise indicated. Outlet threads shall meet NFPA 1963, with external hose thread used by local fire department. Include cast iron caps with steel chains and Pentagon, 1-1/2 inch (38 mm) point to flat operating and cap nuts.
- B. Hydrant assemblies shall be as required by the local agency having jurisdiction.
- C. Dry-Barrel Fire Hydrants:
1. AWWA C502, freestanding, one NPS 4-1/2 (DN 115) and two NPS 2-1/2 (DN 65) outlets, 5-1/4 inch (133 mm) main valve, drain valve, and NPS 6 (DN 150) mechanical-joint inlet; interior coating according

to AWWA C550; cast iron body, compression-type valve opening against pressure and closing.

2.9 FIRE DEPARTMENT CONNECTIONS

- A. Fire system base water supply must provide a minimum of 1000 gpm (3785 l/m) at 150 psi (1035 kPa) and 700 gpm (2650 l/m) at 200 psi (1380 kPa) at the Fire Department connection. For hydraulic calculations, the calculated demand shall not fall less than 10 percent below the water supply curve.
- B. Fire Department connections: UL 405, NFPA 1963, freestanding, cast bronze body, thread inlets, and matching local fire department hose threads, threaded bottom outlet, lugged caps, gaskets, and chains; lugged swivel connection and drop clapper for each hose-connection inlet; 18 inch (460 mm) high brass sleeve; round escutcheon plate, meeting the requirements of UL 405.
 - 1. Connections: Two NPS 2-1/2 (DN 65) inlets and one NPS 4 (DN 100) outlet. Meet fire department requirements if otherwise.
 - 2. Inlet Alignment: As required by fire department.
 - 3. Finish Including Sleeve: Polished bronze.
 - 4. Escutcheon Plate Marking: "STANDPIPE"

2.10 DISINFECTION CHLORINE

- A. Liquid chlorine: AWWA B301.
- B. Sodium Hypochlorite: AWWA B300 with 5 percent to 15 percent available chlorine.
- C. Calcium hypochlorite: AWWA B300 supplied in granular form of 5 g. tablets, and shall contain 65 percent chlorine by weight.

2.11 WARNING TAPE

- A. Warning tape shall be standard, 4 mil. Polyethylene, 3 inch (76 mm) wide tape, detectable type, blue with black letters and imprinted with "CAUTION BURIED WATER LINE BELOW".

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Use pipe, fittings, and joining methods for piping systems according to the following applications.
 - 1. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used, unless otherwise indicated.

2. Do not use flanges or unions for underground piping.
 3. Flanges, unions, grooved-end-pipe couplings, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.
- B. Underground water-service piping:
1. Soft copper tube with copper, pressure-seal fittings; and pressure-sealed joints.
 2. Ductile iron, push-on-joint pipe; ductile iron, push-on-joint fittings; and gasketed mechanical-joint pipe; ductile iron, mechanical-joint fittings; class pipe as required by agency having jurisdiction
- C. Underground Fire-Service-Main:
1. Ductile iron, push-on-joint pipe; ductile iron, push-on-joint fittings; and gasketed mechanical-joint pipe; ductile iron, mechanical-joint fittings; class pipe as required by agency having jurisdiction.

3.2 VALVE APPLICATIONS

- A. Use mechanical-joint-end valves for NPS 3 (DN 80) and larger underground installation.
- B. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
1. Underground Valves, NPS 3 (DN 80) and Larger: AWWA C509, cast iron, non-rising-stem, resilient-seated gate valves with valve box.
 2. Underground Valves, NPS 4 (DN 100) and Larger, for Indicator Posts: UL/FMG, cast iron, non-rising-stem gate valves with indicator post.

3.3 DUCTILE IRON PIPE

- A. Install Ductile Iron, water-service piping according to AWWA C600 and AWWA M41-3rd Edition.
1. Install PE corrosion-protection encasement according to ASTM A674 or AWWA C105/A21.5.
- B. Pipe shall be sound and clean before laying. When laying is not in progress, the open ends of the pipe shall be closed by watertight plug or other approved means.

- C. When cutting pipe is required, the cutting shall be done by machine, leaving a smooth cut at right angles to the axis of the pipe. Bevel cut ends of pipe to be used with push-on bell to conform to the manufactured spigot end. Cement lining shall be undamaged.
- D. Push on joints shall be made in strict accordance with the manufacturer's instruction. Pipe shall be laid with bell ends looking ahead.
- E. Electrical Conductivity: Externally carried across each ductile iron pipe joint joint.
 - 1. Sized to maintain 400 amperes for an extended period of time.
- 2. Permanently fastened to each side of joint.
 - 3. Coat connection areas per manufacturer's requirements.
 - 4. Bronze wedges are not allowed.

3.4 COPPER PIPE

- A. Copper piping shall be installed in accordance with the Copper Development Association's Copper Tube Handbook and manufacturer's recommendations.
- B. Copper piping shall be bedded in 6 inches (150 mm) of sand.

3.5 ANCHORAGE INSTALLATION

- A. All pipe deflections over twenty (20) degrees , all tees, and plugs and valves at the dead ends of lines shall be restrained, tied or harnessed in a manner acceptable to COR and the local agency having jurisdiction. The restraint shall be applied to joints each direction from the deflection or fitting an adequate distance to resist the axial thrust of the test pressure. Minimum acceptable distance for joint restraint shall be seventy (70) feet.
- B. Anchorages and restrained-joint types may include: concrete thrust blocks, locking mechanical joints, set-screw mechanical retainer glands, pipe clamps and tie rods, locking gaskets.
- C. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:
 - 1. Gasketed-Joint, Ductile Iron, Water-Service Piping: According to AWWA C600.

3.6 VALVE INSTALLATION

- A. AWWA Valves: Install each underground valve with stem pointing up and with valve box.
- B. Corporation Valves and Curb Valves: Install each underground curb valve with head pointed up and with service box.
- C. Raise or lower existing valve and curb stop boxes and fire hydrants to finish grade in areas being graded.

3.7 CONCRETE VAULT INSTALLATION

- A. Install precast concrete vaults according to ASTM C891.

3.8 FIRE DEPARTMENT CONNECTION INSTALLATION

- A. Install ball drip valves at each check valve for fire department connection to mains.
- B. Install protective pipe bollards on each fire department connection as indicated on the drawings.

3.9 FIRE HYDRANT INSTALLATION

- A. Install each fire hydrant with separate gate valve in supply pipe, anchor with restrained joints or thrust blocks, and support in upright position.

3.10 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties. Install water service lines to a point of connection within approximately 5 feet (1500 mm) outside of building(s) to which service is to be connected and make connections thereto. If building services have not been installed provide temporary caps and mark for future connection.

3.11 LINE AND GRADE

- A. Pipe shall be laid to grades and elevations indicated on the Drawings.
- B. Where no grades are indicated, pipe shall generally follow the grade of the ground surface and shall be placed with a minimum of five feet of cover, without creating high points between fire hydrants and blow off assemblies.

- C. At all sewer crossings, maintain at least 18" vertical clearance between the outer surface of the water main and the outer surface of the sewer.
- D. Fire hydrants shall be set with the center of the nozzles being no less than twenty one inches (21") , nor more than thirty-six inches (36") above the adjoining grade. The depth of the pipe shall be increased if the ground or finish grade elevation (whichever is applicable) over the pipe is higher than the ground or finish grade elevation (whichever is applicable) at the hydrant. Extensions shall be used where the intended finish grade elevation at the hydrant is higher than the ground or finish grade elevation (whichever is applicable) over the pipe. The costs for extensions or for adjusting the pipe depth shall be incidental to the prices paid for water main and fire hydrants, respectively.

3.12 FIELD QUALITY CONTROL

- A. Perform hydrostatic tests at one and one-half times operating pressure, but not less than 150 psi, for two hours.
- B. Conduct trench backfill compaction testing as required by the local agency.
- C. Conduct pressure testing in accordance with AWWA C600, Section 5, and in accordance with local agency requirements for notification and witnessing.
- D. Pre-test water system to identify and correct any leakage prior to formal testing.
- E. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.
- F. Conduct flushing in accordance with AWWA C600, Section 4.
- G. Conduct bacteriological testing as required by State of Michigan and the local agency having jurisdiction.
- H. Prepare reports of testing activities.

3.13 SEQUENCE

- A. Pressure test.
- B. Flush.
- C. Chlorinate.
- D. Wait 24 hours.
- E. Flush.

- F. Bacteriological sample.
- G. Wait 24 hours - DO NOT FLUSH.
- H. Bacteriological sampling.
- I. Place in service, or upon failed sample, repeat entire sequence.
- J. Remove corporation fittings installed for testing.

3.14 IDENTIFICATION

- A. Install continuous underground warning tape 12 inches (300 mm) directly over piping.

3.15 CLEANING

- A. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
- B. Use purging and disinfecting procedure prescribed by local utility provider or other authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:
 - 1. Fill the water system with a water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours.
 - 2. Drain the system of the previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow system to stand for 3 hours.
 - 3. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
 - 4. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.
- C. Prepare reports of purging and disinfecting activities.

3.16 BACTERIOLOGICAL TESTING

- A. Standard: AWWA C651.
- B. Two consecutive bacteriologically safe samples must be taken at 24 hour intervals for each section of pipe tested. Repeat disinfection if bacteriological test fails.
- C. Collect samples from each branch of pipe, at a maximum spacing of 1,000 feet.
- D. Promptly transport samples to lab for testing.

E. Laboratory testing shall be at Contractor's expense, and shall be incidental to the major items of work.

F. Upon completion of sampling, remove any corporation fitting used and install tapered brass plug as approved by COR.

--- E N D ---

SECTION 33 40 00

STORM SEWER UTILITIES

PART 1 - GENERAL

PART 2 - DESCRIPTION

This section specifies materials and procedures for construction of outside, underground storm sewer systems that are complete and ready for operation. This includes piping, structures and all other incidentals.

PART 3 - RELATED WORK

- A. Excavation, Trench Widths, Pipe Bedding, Backfill, Shoring, Sheeting, Bracing: Section 31 20 00, EARTH MOVING.
- B. Concrete Work, Reinforcing, Placement and Finishing: Section 03 30 00, CAST-IN-PLACE CONCRETE.
- C. Materials and Testing Report Submittals: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.
- D. Erosion and Sediment Control: Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS.

PART 4 - ABBREVIATIONS

- A. HDPE: High-density polyethylene
- B. PVC: Poly-Vinyl Chloride

PART 5 - DELIVERY, STORAGE, AND HANDLING

- A. Do not store plastic manholes, pipe, and fittings in direct sunlight.
- B. Handle manholes catch basins and stormwater inlets according to manufacturer's written rigging instructions.

PART 6 - COORDINATION

- A. Coordinate exterior utility lines and connections to building services up to the actual extent of building wall.

PART 7 - QUALITY ASSURANCE:

- A. Products Criteria:
 - 1. When two or more units of the same type or class of materials or equipment are required, these units shall be products of one manufacturer.

2. A nameplate bearing manufacturer's name or trademark, including model number, shall be securely affixed in a conspicuous place on equipment. In addition, the model number shall be either cast integrally with equipment, stamped, or otherwise permanently marked on each item of equipment.

PART 8 - SUBMITTALS

A. Manufacturers' Literature and Data shall be submitted, as one package, for pipes, fittings and appurtenances, including jointing materials, hydrants, valves and other miscellaneous items.

PART 9 - APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

B. American Society for Testing and Materials (ASTM):

A185/A185M-07	Steel Welded Wire Reinforcement, Plain, for Concrete
A242/A242M-04(2009)	High-Strength Low-Alloy Structural Steel
A536-84(2009)	Ductile Iron Castings
A615/A615M-09b	Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
A760/A760M-10	Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains
A798/A798M-07	Installing Factory-Made Corrugated Steel Pipe for Sewers and Other Applications
A849-10	Post-Applied Coatings, Paving, and Linings for Corrugated Steel Sewer and Drainage Pipe
A929/A929M-01(2007)	Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe
B745/B745M-97(2005)	Corrugated Aluminum Pipe for Sewers and Drains
B788/B788M-09	Installing Factory-Made Corrugated Aluminum Culverts and Storm Sewer Pipe

C14-07	Non-reinforced Concrete Sewer, Storm Drain, and Culvert Pipe
C33/C33M-08	Concrete Aggregates
C76-11	Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
C139-10	Concrete Masonry Units for Construction of Catch Basins and Manholes
C150/C150M-11	Portland Cement
C443-10	Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
C478-09	Precast Reinforced Concrete Manhole Sections
C506-10b	Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe
C507-10b	Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe
C655-09	Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe
C857-07	Minimum Structural Design Loading for Underground Precast Concrete Utility Structures
C891-09	Installation of Underground Precast Concrete Utility Structures
C913-08	Precast Concrete Water and Wastewater Structures
C923-08	Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals
C924-02(2009)	Testing Concrete Pipe Sewer Lines by Low-Pressure Air Test Method
C990-09	Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants

C1103-03(2009)	Joint Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines
C1173-08	Flexible Transition Couplings for Underground Piping Systems
C1433-10	Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers
C1479-10	Installation of Precast Concrete Sewer, Storm Drain, and Culvert Pipe Using Standard Installations
D448-08	Sizes of Aggregate for Road and Bridge Construction
D698-07e1	Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft ³ (600 kN-m/m ³))
D1056-07	Flexible Cellular Materials—Sponge or Expanded Rubber
D1785-06	Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
D2321-11	Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
D2751-05	Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings
D2774-08	Underground Installation of Thermoplastic Pressure Piping
D3034-08	Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
D3350-10	Polyethylene Plastics Pipe and Fittings Materials
D3753-05e1	Glass-Fiber-Reinforced Polyester Manholes and Wetwells
D4101-11	Polypropylene Injection and Extrusion Materials

D5926-09	Poly (Vinyl Chloride) (PVC) Gaskets for Drain, Waste, and Vent (DWV), Sewer, Sanitary, and Storm Plumbing Systems
F477-10	Elastomeric Seals (Gaskets) for Joining Plastic Pipe
F679-08	Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings
F714-10	Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
F794-03(2009)	Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter
F891-10	Coextruded Poly(Vinyl Chloride) (PVC) Plastic Pipe With a Cellular Core
F894-07	Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe
F949-10	Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe With a Smooth Interior and Fittings
F1417-11	Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air
F1668-08	Construction Procedures for Buried Plastic Pipe
F2648-13	Smooth Interior Corrugated HDPE Pipe
C. American Association of State Highway and Transportation Officials (AASHTO):	
M190-04	Bituminous-Coated Corrugated Metal Culvert Pipe and Pipe Arches
M198-10	Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
M252-09	Corrugated Polyethylene Drainage Pipe
M294-10	Corrugated Polyethylene Pipe, 12 to 60 In. (300 to 1500 mm) Diameter

D. American Water Works Association(AWWA):

C105/A21.5-10	Polyethylene Encasement for Ductile iron Pipe Systems
C110-08	Ductile-Iron and Gray-Iron Fittings
C219-11	Bolted, Sleeve-Type Couplings for Plain-End Pipe
C600-10	Installation of Ductile iron Mains and Their Appurtenances
C900-07	Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Transmission and Distribution
M23-2nd ed	PVC Pipe "Design And Installation"

E. American Society of Mechanical Engineers (ASME):

A112.6.3-2001	Floor and Trench Drains
A112.14.1-2003	Backwater Valves
A112.36.2M-1991	Cleanouts

F. American Concrete Institute (ACI):

318-05	Structural Commentary and Commentary
350/350M-06	Environmental Engineering Concrete Structures and Commentary

G. National Stone, Sand and Gravel Association (NSSGA): Quarried Stone for Erosion and Sediment Control

PART 10 - WARRANTY

The Contractor shall remedy any defect due to faulty material or workmanship and pay for any damage to other work resulting therefrom within a period of one year from final acceptance. Further, the Contractor will furnish all manufacturers' and suppliers' written guarantees and warranties covering materials and equipment furnished under this Contract.

PART 11 - PRODUCTS

PART 12 - FACTORY-ASSEMBLED PRODUCTS

- A. Standardization of components shall be maximized to reduce spare part requirements. The Contractor shall guarantee performance of assemblies of components, and shall repair or replace elements of the assemblies as required to deliver specified performance of the complete assembly.

PART 13 - HDPE PIPE AND FITTINGS

- A. Smooth-walled corrugated HDPE drainage pipe and fittings, NPS 8 to NPS 36; ASTM F2648 with smooth waterway for coupling joints.
1. Silt-tight Couplings: PE sleeve with ASTM D1056, Type 2, Class A, Grade 2 gasket material that mates with tube and fittings.
 2. Soil-tight Couplings: AASHTO M252, corrugated, matching tube and fittings.
 3. Water tight joints shall be made using a PVC or PE coupling and rubber gaskets as recommended by the pipe manufacturer. Rubber gaskets shall conform to ASTM F477. Soil tight joints shall conform to requirements in AASHTO HB-17, Division II, for soil tightness and shall be as recommended by the manufacturer.
- B. PVC Pipe And Fittings
1. PVC Pipe And Fittings: ASTM D3034, Schedule SDR26 with bell-and-spigot ends for gasketed joints with ASTM F477 elastomeric seals.

PART 14 - CONCRETE PIPE AND FITTINGS

- A. Reinforced-Concrete sewer pipe and fittings shall be ASTM C76 or ASTM C655.
1. Bell-and-spigot ends and gasketed joints with ASTM C443, rubber gaskets.
 2. Class III: Wall B
 3. Class V: Wall B

PART 15 - CLEANOUTS

- A. Cast-Iron Cleanouts: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
1. Top-Loading Classification(s): Heavy Duty

2. Pipe fitting and riser to cleanout shall be same material as main pipe line.

PART 16 - DRAINS

- A. Cast-Iron Area Drains: ASME A112.6.3, gray-iron round body with anchor flange and round grate. Include bottom outlet with inside calk or spigot connection, of sizes indicated.
 1. Top-Loading Classification(s): Heavy Duty
- B. Cast-Iron Trench Drains: ASME A112.6.3, 6 inch (150 mm) wide top surface, rectangular body with anchor flange or other anchoring device, and rectangular grate. Include units of total length indicated and quantity of bottom outlets with inside calk or spigot connections, of sizes indicated.
 1. Top-Loading Classification(s): Heavy Duty
- C. Steel Trench Drains: ASTM A242, welded steel plate, to form rectangular body with uniform bottom downward slope of 2 percent toward outlet, anchor flange, and grate.
 1. Plate Thicknesses: 1/4 inch (6.4 mm)
 2. Overall Widths: 7-1/2 inches (190 mm) or 12-1/3 inches (313 mm) as indicated on drawings
- D. Grate openings shall be 3/8 by 3 inch (9.5 by 76 mm) slots.

PART 17 - MANHOLES AND CATCH BASINS

- A. Standard Precast Concrete Manholes:
 1. Description: ASTM C478 (ASTM C478M), precast, reinforced concrete, of depth indicated, with provision for sealant joints.
 2. Diameter: 48 inches (1200 mm) minimum unless otherwise indicated.
 3. Ballast: Increase thickness of precast concrete sections or add concrete to base section as required to prevent flotation.
 4. Base Section: 6 inch (150 mm) minimum thickness for floor slab and 4-inch (102 mm) minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
 5. Riser Sections: 4 inch (102 mm) minimum thickness, and lengths to provide depth indicated.
 6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated, and top of cone of size that matches grade rings.
 7. Joint Sealant: ASTM C990 (ASTM C990M), bitumen or butyl rubber.

8. Resilient Pipe Connectors: ASTM C923 (ASTM C923M), cast or fitted into manhole walls, for each pipe connection.
9. Steps: If total depth from floor of manhole to finished grade is greater than 60 inches (1500 mm). Individual FRP steps, width of 16 inches (400 mm) minimum, spaced at 12 to 16 inch (300 to 400 mm) intervals.
10. Adjusting Rings: Reinforced-concrete rings, 6 to 9 inch (150 to 225 mm) total thickness, to match diameter of manhole frame and cover, and height as required to adjust manhole frame and cover to indicated elevation and slope.

B. Manhole Frames and Covers:

1. Description: Ferrous; 24 inch (610 mm) ID by 7 to 9 inch (175 to 225 mm) riser with 4 inch (102 mm) minimum width flange and 26-inch (600 mm) diameter cover, or as indicated on the drawings. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."
2. Material: ASTM A536, Grade 60-40-18 ductile iron unless otherwise indicated.

PART 18 - CONCRETE FOR MANHOLES AND CATCH BASINS

A. General: Cast-in-place concrete according to ACI 318, ACI 350/350R, and the following:

1. Cement: ASTM C150, Type II.
2. Fine Aggregate: ASTM C33, sand.
3. Coarse Aggregate: ASTM C33, crushed gravel.
4. Water: Potable.

B. Concrete Design Mix: 4000 psi (27.6 MPa) minimum, compressive strength in 28 days.

1. Reinforcing Fabric: ASTM A185, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A615, Grade 60 (420 MPa) deformed steel.

C. Manhole Channels and Benches: Channels shall be the main line pipe material. Include benches in all manholes and catch basins.

1. Channels: Main line pipe material or concrete invert. Height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope. Invert Slope: Same slope as the main line pipe. Bench to be concrete, sloped to drain into channel. Minimum of 6 inch slope from main line pipe to wall sides.

PART 19 - HEADWALLS

- A. Headwalls: Cast in-place concrete with a minimum compressive strength of 3000 psi (20 MPa) at 28 days.

PART 20 - FLARED END SECTIONS

- A. Flared End Sections: Sections shall be of standard design fabricated from zinc-coated steel sheets conforming to requirements of ASTM A929.

PART 21 - PRECAST REINFORCED CONCRETE BOX CULVERT

- A. Precast Reinforced Concrete Box Culvert: Designed for highway loadings with 2 feet (600 mm) of cover or more subjected to dead load only, conforming to ASTM C1433. For less than 2 feet (600 mm) of cover, subjected to highway loading, conform to ASTM C1433.

PART 22 - RESILIENT CONNECTORS AND DOWNSPOUT BOOTS FOR BUILDING ROOF DRAINS

- A. Resilient connectors and downspout boots: Flexible, watertight connectors used for connecting pipe to manholes and inlets, and shall conform to ASTM C923.

PART 23 - WARNING TAPE

- A. Standard, 4-Mil polyethylene 3 inch (76 mm) wide tape detectable type, purple with black letters, and imprinted with "CAUTION BURIED STORM SEWER BELOW".

PART 24 - EXECUTION

PART 25 - PIPE BEDDING

- A. The bedding surface of the pipe shall provide a firm foundation of uniform density throughout the entire length of pipe. Concrete pipe requirements are such that when no bedding class is specified, concrete pipe shall be bedded in a soil foundation accurately shaped and rounded to conform with the lowest one-fourth of the outside portion of circular pipe. When necessary, the bedding shall be tamped. Bell holes and depressions for joints shall not be more than the length, depth, and width required for properly making the particular type of joint. Plastic pipe bedding requirements shall meet the requirements of ASTM D2321. Bedding, haunching and initial backfill shall be either Class IB or Class II material. Corrugated metal pipe bedding requirements shall conform to ASTM A798.

PART 26 - PIPING INSTALLATION

- A. Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
 - 1. Do not lay pipe on unstable material, in wet trench or when trench and weather conditions are unsuitable for the work.
 - 2. Support pipe on compacted bedding material. Excavate bell holes only large enough to properly make the joint.
 - 3. Inspect pipes and fittings, for defects before installation. Defective materials shall be plainly marked and removed from the site. Cut pipe shall have smooth regular ends at right angles to axis of pipe.
 - 4. Clean interior of all pipe thoroughly before installation. When work is not in progress, open ends of pipe shall be closed securely to prevent entrance of storm water, dirt or other substances.
 - 5. Lower pipe into trench carefully and bring to proper line, grade, and joint. After jointing, interior of each pipe shall be thoroughly wiped or swabbed to remove any dirt, trash or excess jointing materials.
 - 6. Do not walk on pipe in trenches until covered by layers of shading to a depth of 12 inches (300 mm) over the crown of the pipe.
 - 7. Warning tape shall be continuously placed 12 inches (300 mm) above storm sewer piping.
- C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
- D. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.
- E. Install gravity-flow, nonpressure drainage piping according to the following:
 - 1. Install piping pitched down in direction of flow.

2. Install HDPE sewer piping according to ASTM D2321 with gasketed joints.
3. Install PVC cellular-core piping, PVC sewer piping, and PVC profile gravity sewer piping, according to ASTM D2321 and ASTM F1668.
4. Install reinforced concrete sewer piping according to ASTM C1479.

PART 27 - REGRADING

- A. Raise or lower existing manholes and structures frames and covers in regraded areas to finish grade. Carefully remove, clean and salvage cast iron frames and covers. Adjust the elevation of the top of the manhole or structure as detailed on the drawings. Reset cast iron frame and cover, grouting below and around the frame. Install concrete collar around reset frame and cover as specified for new construction.
- B. During periods when work is progressing on adjusting manholes or structures cover elevations, the Contractor shall install a temporary cover above the bench of the structure or manhole. The temporary cover shall be installed above the high flow elevation within the structure, and shall prevent debris from entering the wastewater stream.

PART 28 - CONNECTIONS TO EXISTING VA-OWNED MANHOLES

- A. Make pipe connections and alterations to existing manholes so that finished work will conform as nearly as practicable to the applicable requirements specified for new manholes, including concrete and masonry work, cutting, and shaping.

PART 29 - CONNECTIONS TO EXISTING PUBLIC UTILITY MANHOLES

- A. Comply with all rules and regulations of the public utility.
- B. Cleanout Installation
 1. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast iron soil pipe fittings in sewer pipes at branches for cleanouts and cast iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
 - a. Use Light-Duty, top-loading classification cleanouts in earth or unpaved foot-traffic areas.
 - b. Use Heavy-Duty, top-loading classification cleanouts in paved pedestrian and vehicle-traffic service areas.

2. Set cleanout frames and covers in earth in cast in-place concrete block, 18 by 18 by 12 inches (450 by 450 by 300 mm) 6 inches deep, but not less than indicated on drawings. Set with tops flush with surrounding earth grade.
- C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

PART 30 - DRAIN INSTALLATION

- A. Install type of drains in locations indicated.
 1. Use Light-Duty, top-loading classification cleanouts in earth or unpaved foot-traffic areas.
 2. Use Heavy-Duty, top-loading classification cleanouts in paved pedestrian and vehicle-traffic service areas.
- B. Embed drains in 4 inch (102 mm) minimum concrete around bottom and sides.
- C. Set drain frames and covers with tops flush with pavement surface.
- D. Assemble trench sections with flanged joints and embed trench sections in 4 inch (102 mm) minimum concrete around bottom and sides.

PART 31 - MANHOLE INSTALLATION

- A. Install manholes, complete with appurtenances and accessories indicated. Install precast concrete manhole sections with sealants according to ASTM C891.
- B. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches (76 mm) above finished surface elsewhere unless otherwise indicated.
- C. Circular Structures:
 1. Precast concrete segmental blocks shall lay true and plumb. All horizontal and vertical joints shall be completely filled with mortar. Parge interior and exterior of structure with 1/2 inch (15 mm) or cement mortar applied with a trowel and finished to an even glazed surface.
 2. Precast reinforced concrete rings shall be installed true and plumb. The joints between rings and between rings and the base and top shall be sealed with a preform flexible gasket material specifically manufactured for this type of application. Adjust the length of the rings so that the eccentric conical top section will be at the

required elevation. Cutting the conical top section is not acceptable.

3. Precast reinforced concrete manhole risers and tops. Install as specified for precast reinforced concrete rings.

D. Rectangular Structures:

1. Precast concrete structures shall be placed on a 8 inch (200 mm) reinforced concrete pad, or be provided with a precast concrete base section. Structures provided with a base section shall be set on an 8 inch (200 mm) thick aggregate base course compacted to a minimum of 95 percent of the maximum density as determined by ASTM D698. Set precast section true and plumb. Seal all joints with preform flexible gasket material.
2. Do not build structures when air temperature is 32 deg F (0 deg C), or below.
3. Invert channels shall be smooth and semicircular in shape conforming to inside of adjacent sewer section. Make changes in direction of flow with a smooth curve of as large a radius as size of structure will permit. Make changes in size and grade of channels gradually and evenly. Construct invert channels by one of the listed methods:
 - a. Forming directly in concrete base of structure.
 - b. Building up with brick and mortar.
4. Floor of structure outside the channels shall be smooth and slope toward channels not less than 1 to 12 or more than 1 to 6. Bottom slab and benches shall be concrete.
5. The wall that supports access rungs or ladder shall be 90 deg vertical from the floor of structure to manhole cover.
6. Install steps and ladders per the manufacturer's recommendations. Steps and ladders shall not move or flex when used. All loose steps and ladders shall be replaced by the Contractor.
7. Install manhole frames and covers on a mortar bed, and flush with the finish pavement. Frames and covers shall not move when subject to vehicular traffic. Install a concrete collar around the frame to protect the frame from moving until the adjacent pavement is placed. In unpaved areas, the rim elevation shall be 2 inches (50 mm) above the adjacent finish grade. Install an 8 inch (203 mm) thick, by 12 inch (300 mm) concrete collar around the perimeter of the frame. Slope the top of the collar away from the frame.

PART 32 - CATCH BASIN INSTALLATION

- A. Construct catch basins to sizes and shapes indicated.
- B. Set frames and grates to elevations indicated.

PART 33 - CONNECTIONS

- A. Connect nonpressure, gravity-flow drainage piping in building's storm building drains specified in Division 22 Section FACILITY STORM DRAINAGE PIPING.
- B. Encase entire connection fitting, plus 6 inch (150 mm) overlap, with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).
- C. Make connections to existing piping and underground manholes.
 - 1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping.
 - 2. Make branch connections from side into existing piping, NPS 4 to NPS 20 (DN 100 to DN 500). Remove section of existing pipe, install wye fitting into existing piping.
 - 3. Make branch connections from side into existing piping, NPS 21 (DN 525) or larger, or to underground manholes and structures by cutting into existing unit and creating an opening large enough to allow 3 inches (76 mm) of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe, manhole, or structure wall, use epoxy-bonding compound as interface between new and existing concrete and piping materials.
 - 4. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

PART 34 - CLOSING ABANDONED STORM DRAINAGE SYSTEMS

- A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:
 - 1. Close open ends of piping with at least 8 inch (203 mm) thick, brick masonry bulkheads.

2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.

B. Abandoned Manholes and Structures: Excavate around manholes and structures as required and use one procedure below:

1. Remove manhole or structure and close open ends of remaining piping.
2. Remove top of manhole or structure down to at least 36 inches (915 mm) below final grade. In paved areas, fill to within 12 inches (300 mm) of top with Class II engineered fill, compacted to 95% maximum density (modified proctor). Fill to top with concrete.
3. In unpaved areas, fill with suitable material approved by COR.

C. Backfill to grade according to Division 31 Section EARTH MOVING.

PART 35 - IDENTIFICATION

- A. Install green warning tape directly over piping and at outside edge of underground structures.

PART 36 - FIELD QUALITY CONTROL

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Prior to final acceptance, provide a video record of all piping from the building to the municipal connection to show the lines are free from obstructions, properly sloped and joined.
 1. Submit separate reports for each system inspection.
 2. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
 - c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.
 - e. Exfiltration: Water leakage from or around piping.
 3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
 4. Reinspect and repeat procedure until results are satisfactory.

PART 37 - TESTING OF STORM SEWERS:

- A. Submit separate report for each test.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours advance notice.
4. Submit separate report for each test.
5. Air test gravity sewers. Concrete Pipes conform to ASTM C924, Plastic Pipes conform to ASTM F1417, all other pipe material conform to ASTM C828 or C924, after consulting with pipe manufacturer. Testing of individual joints shall conform to ASTM C1103.

C. Leaks and loss in test pressure constitute defects that must be repaired. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

PART 38 - CLEANING

A. Clean interior of piping and storm structures of dirt and superfluous materials. Flush with potable water.

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above ground storage tank
air quality
asbestos/lead-based paint
baseline environmental assessment
brownfield redevelopment
building/infrastructure restoration
caisson/piles
coatings
concrete
construction materials services
corrosion
dewatering
drilling
due care analysis
earth retention system
environmental compliance
environmental site assessment
facility asset management
failure analyses
forensic engineering
foundation engineering
geodynamic/vibration
geophysical survey
geosynthetic
greyfield redevelopment
ground modification
hydrogeologic evaluation
industrial hygiene
indoor air quality/mold
instrumentation
masonry/stone
metals
nondestructive testing
pavement evaluation/design
property condition assessment
regulatory compliance
remediation
risk assessment
roof system management
sealants/waterproofing
settlement analysis
slope stability
storm water management
structural steel/welding
underground storage tank

GEOTECHNICAL EVALUATION REPORT

PROPOSED AMBULATORY ADDITION ANN ARBOR HEALTH SYSTEM UNITED STATES DEPARTMENT OF VETERANS AFFAIRS ANN ARBOR, MICHIGAN

**SME Project No. 068896.00
January 9, 2014**



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January 9, 2014

Mr. Steve Dickerson
Diekema Hamann
612 South Park Street
Kalamazoo, Michigan 49007

Via electronic mail: sdickerson@dhac.com (PDF file)

RE: Geotechnical Evaluation
Proposed Ambulatory Addition
Ann Arbor Health System
United States Department of Veterans Affairs
Ann Arbor, Michigan
SME Project No. 068896.00

Dear Mr. Dickerson:

We have completed our geotechnical evaluation for the proposed ambulatory addition to the Ann Arbor Health System for the United States Department of Veterans Affairs in Ann Arbor, Michigan. This report presents the results of our observations and analyses, our geotechnical recommendations for general site preparation, subgrade preparation for grade slabs, re-use of on-site soils as engineered fill, foundation design, and general construction considerations based on the information disclosed by the borings.

We appreciate the opportunity to be of service. If you have questions or require additional information, please contact me.

Very truly yours,

SOIL AND MATERIALS ENGINEERS, INC.

Kevin L. Wilk, PE
Senior Project Engineer

Report Prepared By

Kevin L. Wilk, PE
Senior Project Engineer

Report Reviewed By

Timothy H. Bedenis, PE
Principal

068896.00-010914-RPT.DOC

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consultants in the geosciences, materials, and the environment

Geotechnical Evaluation Report
Proposed Ambulatory Addition – Ann Arbor Health System
United States Department of Veterans Affairs – Ann Arbor, Michigan

SME Project No. 068896.00
January 9, 2014

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APPENDIX A: Boring Location Diagram
Boring Log Terminology
Boring Logs (B1 through B5)

APPENDIX B: Important Information about your Geotechnical Engineering Report
General Comments
Laboratory Testing Procedures

1. INTRODUCTION

This report presents the results of the geotechnical evaluation by Soil and Materials Engineers, Inc. (SME) for the proposed ambulatory addition to the Ann Arbor Health System of the United States Department of Veterans Affairs in Ann Arbor, Michigan. This evaluation was conducted in general accordance with the scope of services outlined in SME Proposal No. P02881.13REV dated November 14, 2013. This evaluation was authorized by Ms. Vicki H. Nelson of Diekema Hamann Architecture (DHA).

1.1 Site Conditions

The United States Department of Veterans Affairs Ann Arbor Health System (VAMC) facility is located at 2215 Fuller Road, which is east of Bonisteel Boulevard and west of Huron Parkway, in Ann Arbor, Michigan. The area for the proposed Ambulatory Expansion is located near the drop off loop on the north side of the hospital, just north of the connector between the clinical addition and east parking structure.

SME has a long history at the Ann Arbor VAMC facility having provided geotechnical, construction observation and testing (CMS) services, materials services, and pavement design for several projects on this site. Specifically, our geotechnical services have included:

- Clinical Addition and Building Renovations (Clinical Addition, Research Building, East and West Parking Structures, Connecting Link between West Parking Structure and Hospital, Connecting Link between East Parking Deck and Clinical Addition, Utility Tunnel, and access road improvements) in 1992 and 1993 including recommendations for shallow and deep foundation design, observing pile load tests, and providing recommendations for earth retention systems (SME Project No. E-18860);
- Linear Accelerator addition along the south side of the hospital in 2009 including recommendations for shallow foundation construction and pavement design (SME Project No. PG59652);
- Addition to East Parking Structure including recommendations for deep foundation design in 2010 (SME Project No. PG62404); and
- SCIP-1 Addition and SCIP-2 Addition geotechnical evaluation reports dated December 9, 2013 (SME Project Nos. 068586.00 and 068586.01).

As input to our current geotechnical evaluation, SME reviewed the following drawings and documents either emailed to SME on October 24, 2013, or contained within our project archives.

Geotechnical Evaluation Report
Proposed Ambulatory Addition – Ann Arbor Health System
United States Department of Veterans Affairs – Ann Arbor, Michigan

SME Project No. 068896.00
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- Site Grading and Paving Plan – Clinical Addition and Renovation (dated 10/18/94) prepared by Harley Ellington Pierce Yee Associates;
- Enlarged Plans, Sections, and Details - Clinical Addition and Renovation (dated 10/18/94) prepared by Harley Ellington Pierce Yee Associates;
- Boring Plan Research Building Energy Center - Clinical Addition and Renovation (dated 10/18/94) prepared by Harley Ellington Pierce Yee Associates;
- SME Boring Logs B21, B22, B26, B27, and B29 (dated October 1992) (SME Project No. PG18860) performed near the current proposed Ambulatory Expansion;
- SME Geotechnical Investigation Report – Clinical Addition and Renovation – VA Medical Center (VAMC) (dated February 16, 1993) (SME Project No. PG18860) prepared for Harley Ellington Pierce Yee Associates;
- Building Section “C” Looking West drawing (dated 10/18/94) preparer unknown; and
- VA AA Ambulatory Expansion drawing (dated 10/23/13) prepared by Dickema Hamann.

Based on the previously referenced drawings, the existing ground surface within the proposed addition area is at about elevation 825 feet, which is about 21 feet higher than the original ground surface of the site of about elevation 804 feet. Additionally, based on our previously referenced geotechnical report at the VAMC and information provided to SME in the referenced email, there is a mechanically stabilized earth (MSE) embankment retaining wall located east of the clinical addition, north of the connector, and west of the east parking structure. Based on the drawing, the MSE wall begins about 8 feet below the existing ground surface and extends about 20 feet outward from the existing building walls. Many layers of geotextile and engineered fill make up the MSE wall. The MSE wall was constructed to reduce lateral pressures on the basement wall of the connector. This significantly reduced the size and cost of the wall versus a gravity type retaining wall with a relatively large footing. The space between the MSE wall and basement wall may have been backfilled with a lightweight fill material such as vermiculite (based on our recollection of the original construction).

1.2 Project Description

The project will include the design and construction of a single-story slab-on-grade addition covering a plan area of about 14,000 square feet. We anticipate the addition will be a steel-framed and masonry structure. Therefore, based on our experience with similar structures, we anticipate relatively light structural loads (column loads of less than about 150 kips and wall loads of less than about 1 to 2 kips per lineal foot). We assume the existing site topography within the proposed building addition area is within about 1 to 2 feet of the design first floor FFE. The parking loop will also be reconfigured north of the building addition.

2. EVALUATION PROCEDURES

2.1 Field Exploration

SME completed five (5) borings at the site on December 14, 2013. Borings B1 through B4 were located within or near the building addition footprint and each extended 40 feet below the ground surface. However, the borings were located to specifically avoid the geogrids of the MSE wall. Boring B5 was located within the parking loop area and extended 10 feet below the ground surface. In total, about 170 linear feet of drilling was done. The approximate locations of the borings are depicted on the Boring Location Diagram included in Appendix A of this report.

The number, depths, and locations of the borings were determined by SME. SME staked the locations of the borings in the field using existing site features as reference. Since site topographical information was not provided to SME the existing ground surface elevation at the borings was not determined. The actual locations and elevations at the boring locations should be determined by the project surveyor.

The borings were drilled using a truck-mounted, rotary-type drill rig and were advanced using continuous-flight, solid-stem augers. The borings included soil sampling based upon the Split-Barrel Sampling procedure. Recovered split-barrel samples were sealed in glass jars by the driller.

Groundwater level measurements were recorded during and immediately after completion of each boring. The boreholes were backfilled with the auger cuttings after completion. Therefore, long-term groundwater levels were not obtained from the borings. Additionally, the borings were topped with asphalt cold-patch. Excess cuttings that could not be placed back in the boreholes were left on site in 55-gallon steel drums for the client to dispose of.

Soil samples recovered from the field exploration were returned to the SME laboratory for further observation and testing.

2.2 Laboratory Testing

The general laboratory testing program consisted of visual soil classification on recovered samples along with moisture content and hand penetrometer or Torvane shear tests on portions of cohesive samples obtained. The Laboratory Testing Procedures in Appendix B provide general descriptions of the general laboratory tests mentioned above.

Upon completion of the laboratory testing, boring logs were prepared and include materials encountered, penetration resistances, pertinent field observations made during the drilling operations, and the results of certain laboratory tests. The boring logs are included in Appendix A. The soil descriptions included on the boring logs were developed from both visual classification and the results of laboratory tests, where applicable.

Soil samples, retained over a long time, even sealed in jars, are subject to moisture loss and are no longer representative of the conditions initially encountered in the field. Therefore, soil samples are normally retained in our laboratory for 60 days and then disposed, unless instructed otherwise.

3. SUBSURFACE CONDITIONS

3.1 Soil Conditions

The soil conditions encountered at the borings generally consist of asphalt concrete pavement and aggregate base overlying sand fill underlain by natural silts and clays to the explored depth of the borings. A generalized summary of the materials encountered at the boring locations, beginning at the existing ground surface and proceeding downward, is provided below.

Stratum 1: Asphalt Concrete. The driller reported about 3.5 to 6 inches of asphalt concrete pavement at the boring locations. About 14 to 21 inches of aggregate base was encountered below the asphalt concrete at the boring locations.

Stratum 2: Sand Fill. Sand fill with varying silt and gravel content was encountered below the aggregate base at the boring locations and extended between about 22 to 32 feet below the ground surface at borings B1 through B4. At boring B5 the sand fill was penetrated about 8 feet to the explored depth of 10 feet. The sand fill was placed as part of the original adjacent building construction. Standard Penetration Test (SPT) resistances (N-values) in the sand fill varied from 7 to 53 blows per foot (bpf), indicating a loose to very dense condition. Generally the sand fill was in a dense condition.

Stratum 3: Natural Silt and Silty Sand. Natural silt and silty sand was encountered below the sand fill in deeper borings B1 through B4 and extended between about 33 to 36.5 feet below the ground surface. N-values within the silt and silty sand varied from about 15 to 27 bpf indicating a medium dense condition.

A layer of clay was encountered interbedded with the silt and sand in boring B2 from about 29 to 32 feet below the ground surface.

Stratum 4: Natural Clay. Natural clay was encountered below the silt and sand and extended to the explored depth of borings B1 through B4. Undrained shear strength estimates of 2.25 kips per square foot (ksf) to greater than 4.5 ksf were obtained in the clay indicating a very stiff to hard consistency. Measured moisture contents varied from about 18 to 22 percent.

The soil profile described above and included on the appended boring logs are generalized descriptions of the conditions encountered. The stratification depths described above and shown on the boring logs are intended to indicate a zone of transition from one soil type to another. They are not intended to show exact depths of change from one soil type to another. The soil descriptions are based on visual classification of the soils encountered. Soil conditions may vary between or away from the boring locations. Please refer to the boring logs for the soil conditions at the specific boring locations.

It is sometimes difficult to distinguish between fill and natural soils based on samples and cuttings from small-diameter boreholes, especially when portions of the fill do not contain man-made materials, debris, topsoil or organic layers, and when the fill appears similar in composition to the local natural soils. Therefore, the delineation of fill described above and on the appended boring logs should be considered approximate only. A more comprehensive evaluation of the extent and composition of the fill could be made by reviewing former site topography plans (such as grading plans from the original construction), aerial photographs, and other historic site records and by observing test pit excavations.

3.2 Groundwater Conditions

Groundwater was observed by the SME driller during the drilling operations from about 24.5 to 32 feet below the ground surface in borings B1 through B4. Immediately following the drilling operations the groundwater was observed by the driller from about 32 to 39 feet below the ground surface in borings B1 through B3. The groundwater encountered appears perched within the natural silt and sand overlying the less permeable site clays.

Hydrostatic groundwater levels, perched groundwater, and the potential rate of infiltration into excavations should be expected to fluctuate throughout the year, based on variations in precipitation, evaporation, run-off, and other factors. The groundwater levels indicated by the borings represent conditions at the time the readings were taken. The actual groundwater levels at the time of construction may vary.

4. ANALYSIS AND RECOMMENDATIONS

4.1 Site Preparation and Earthwork

4.1.1 General Site Subgrade Preparation

Sand fill was encountered below the aggregate base for the pavements at the boring locations. The sand fill extended about 22 to 32 feet below the ground surface at the four deep boring locations (B1 through B4) and was penetrated about 8 feet to the explored depth of boring B5. The sand fill was placed as part of the construction of the Clinical Addition and East Parking Structure in the mid 1990's.

The sand fill encountered at the site has relatively high N-values indicating a dense to very dense condition within the approximate upper 20 feet of sand fill subgrade encountered. Although, field density test reports from the placement of the fill are not currently available, the state of practice during the relatively recent construction would have required such tests which would have confirmed a minimum level of compaction. Therefore, we believe the existing fill was likely placed in a controlled manner and should be suitable for support of floor slabs and foundations. There is risk that the N-values observed at the borings are not representative of the entire mass of fill and that some of the existing fill is not dense or compacted. However, based on information available, we believe this risk to be low.

Based on the existing relatively flat site topography, we estimate cuts and fills of less than about 1 to 2 feet will be required to reach design final subgrade level for the building addition. *Scans low*

Existing below-grade structures, including but not limited to light pole bases and underground utilities must be removed in their entirety to expose suitable natural soils within the zone of influence of proposed foundations. Existing below-grade obstructions must be removed to at least 2.5 feet below final subgrade levels to avoid creating "hard spots" in the subgrade in slab-on-grade and pavement areas. These areas where obstructions are removed must be backfilled with granular engineered fill, which is placed in lifts and properly compacted to the final subgrade level.

Existing utilities (to remain) must be rerouted around the proposed building footprint. All abandoned utilities must be removed and backfilled with granular engineered fill to the design subgrade level. Abandoned utilities may be filled with flowable fill, provided those utilities do not interfere with (or adversely affect) the new construction, and provided the existing fill around/above those utilities is suitable for support of the new construction. In general, we expect some level of additional subgrade improvement (e.g., compaction, partial undercutting) would be required on the backfill around/above the abandoned utilities.

After clearing and stripping the site, and after cuts are made to design grades, the exposed subgrade should be thoroughly proofrolled in the presence of a representative from SME. The purpose of the proofroll is to locate areas of unsuitably loose or soft subgrade. Areas of unsuitable subgrade revealed during proofrolling should be mechanically improved (compacted) in place. If it is not possible to compact the unsuitable subgrade, it may be necessary to remove the unsuitable soils and replace them with engineered fill. Proofrolling should be done with a fully-loaded, tandem-axle truck or other suitable piece of pneumatic-tire construction equipment. During proofrolling, special attention should be directed to those areas where existing fill is left in place.

After proofrolling, engineered fill may then be placed on the prepared subgrade to establish required subgrade elevations. See Section 4.1.4 of this report for recommendations regarding suitable soils for engineered fill and our recommendations for placement and compaction.

4.1.2 Subgrade Preparation for Floor Slabs

We anticipate the final subgrade for the building pad will consist of suitable (and properly prepared) existing fill or engineered fill placed over suitably prepared fill. These materials are generally considered suitable for support of slabs-on-grade, provided the report comments/recommendations provided in Section 4.1.1 are understood and followed during construction.

Prior to concrete placement for floor slabs, the building pad subgrade should again be observed and tested for suitability of floor slab support. The purpose of the re-evaluation is to identify any areas of subgrade that were disturbed during construction activities and verify subgrade conditions are suitable for floor slab support. The re-evaluation of the subgrade should consist of a thorough proofroll unless the area is not accessible with proper proofrolling equipment. Otherwise, the evaluation of the exposed subgrade should consist of density testing and/or the use of appropriate hand-operated equipment such as hand augers and cone penetrometers. Unsuitable subgrade indicated by SME should be recompacted or removed and replaced with engineered fill.

In addition, we recommend the top 4 inches of the slab subbase consist of an approved granular material. The purpose of this is to provide a leveling surface for construction of the slab and a moisture capillary break between the slab and the underlying soils. An approved aggregate such as MDOT 21AA dense-graded aggregate is recommended for this purpose. The aggregate must also be compacted per the "Engineered Fill Requirements" section of this report (Section 4.1.4).

In general, we recommend providing vapor retarders below floor slabs that will receive an impermeable floor finish/seal, or a floor covering which would act as a vapor retarder. Even if these floor coverings are not planned, the vapor retarder can reduce the transmission of moisture vapor from the ground into the building, which can occur due to thermal and humidity variations and other conditions. Plastic sheeting that is continuously placed and overlapped at least 18 inches is generally considered suitable for the vapor retarder system. For durability purposes during construction, we recommend the thickness of the plastic sheets be no less than 10 mils. The vapor retarder should be protected from damage during construction and the use of plywood “runways” may be required to transport concrete across the prepared subgrade. However, the placement of a vapor retarder affects construction of the floor slab, concrete curing, and the rate of moisture loss as the concrete dries. We would be pleased to discuss considerations related to vapor retarders in more detail, if desired.

Slabs should be separated by isolation joints from structural walls and columns bearing on their own foundations to permit relative movement. A minimum of 6 inches of engineered fill should be provided between the bottom of the slab and the top of the shallow spread foundation below. Otherwise other arrangements should be made to allow for potential relative settlements, such as grade beams, thickened slabs with appropriate reinforcing steel or other appropriate details.

Differential settlement could be manifested where the grade slab of the building addition abuts the existing building. Hard-finish flooring surfaces should not span across the interface between the existing building and the new addition without control joints, as minor cracking and/or minor settlement at the interface between the two structures is likely to occur.

The slab-on-grade subgrade soils should be protected from frost during winter construction. Any frozen soils should be thawed and compacted or removed and replaced prior to slab-on-grade construction.

4.1.3 Engineered Fill Requirements

Any fill placed within the construction area, including utility trench backfill, must be an approved material, free of frozen soil, organics, or other deleterious materials. The fill must be placed on suitably prepared subgrade. The fill must also be spread in level layers not exceeding 9 inches in loose thickness and be compacted to a minimum of 95 percent of the maximum dry density as determined in accordance with the Modified Proctor test. Granular fill should be compacted using a drum roller or vibratory plate type compactors. Clay fill should be compacted using a sheepfoot type roller.

The on-site sands are generally considered suitable for reuse as engineered fill. Topsoil and other soils containing more than 4 percent organics and/or significant debris are not recommended for reuse as engineered fill.

Clayey soils are difficult to compact in confined areas where compaction by hand-operated equipment is required and should not be used where drainage is required. The effective reuse of engineered clay fill typically occurs in open areas where large compaction equipment can operate.

In confined areas and other areas where compaction is accomplished primarily by hand-operated equipment and drainage is likely required, an approved granular material, such as MDOT Class II granular material or MDOT 21AA crushed aggregate, should be used as backfill. Thinner lifts may be required in confined spaces to achieve compaction of the backfill.

4.2 Foundations

Shallow spread or continuous foundations, bearing on suitable existing sand fill or on engineered fill placed over suitable existing sand fill, are recommended for support of the proposed building addition. We anticipate suitable bearing soils will be encountered about 1 to 2 feet below the existing ground surface based on building borings B1 through B4.

We recommend a maximum net allowable soil bearing pressure of 4,000 psf for design of shallow foundations for this project. This bearing pressure ~~assumes the subgrade is properly prepared, and the foundations bear on suitable existing sand fill or engineered fill directly above suitable existing fill soils.~~

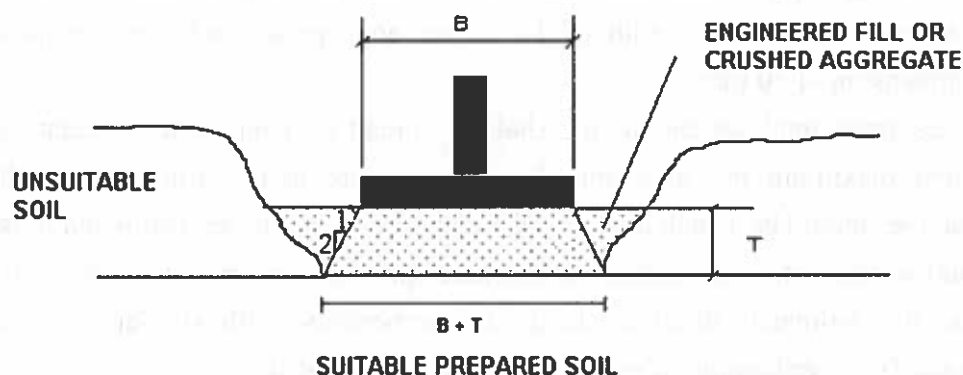
Foundation construction over existing undocumented fill is not typical construction practice. However, based on the relatively high N-values obtained in the fill and lack of deleterious materials, it appears the fill was placed in an engineered manner. Nevertheless, foundation excavations and potential bearing soils will have to be closely observed and tested by SME during construction to verify the suitability of the existing fill for support of the footings.

At least some of the footings will likely be constructed near or over the existing mechanically stabilized earth (MSE) section around the perimeter of the existing building. In general, the footings may also bear on the reinforced fill. However, the edge of the MSE is offset from the retaining wall by several feet. This annulus between the MSE wall and the concrete retaining wall was filled with a low density material (e.g., vermiculite). A concrete slab was to have been constructed over the low density material to support the weight of the overlying fill. However, the concrete slabs may not be suitable to support the additional pressures induced by a building footing.

We recommend an additional evaluation in the area of the MSE sections. Specifically, we recommend performing test pits near the existing building to expose and observe the buried concrete slab that overlies the lightweight fill adjacent to the basement walls. The buried slab should be cored to verify the concrete thickness and hand auger probes should be performed to verify the type of lightweight fill material that was used. Depending on the existing conditions encountered and the final location and position of the new footings, it may be necessary to remove or enhance the existing concrete slab and install a thicker reinforced slab to support the new footing loads along the existing the basement walls.

To verify suitable subgrade is exposed at the bearing surface of foundation excavations, SME must evaluate foundation subgrades during construction. If areas are encountered where existing fill is not considered suitable for the design bearing pressure, these soils must be undercut to expose suitable natural soils. Foundations could be constructed at this lower level where suitable subgrade is encountered. Alternatively, foundations could be constructed at normal foundation bearing levels on engineered fill or crushed aggregate placed as backfill in the undercut excavation. If crushed aggregate is used, it should consist of MDOT 21AA crushed limestone.

Where undercuts are required and the excavation will be backfilled to the design foundation bearing level, the undercut to remove unsuitable soils must extend laterally on a two vertical to one horizontal slope from the edge of the foundation. Please refer to the following Typical Foundation Undercutting Diagram:



Once each foundation area is exposed, foundation subgrade conditions must be observed and tested by SME to verify suitable soils are encountered or improvements are done as needed prior to backfilling and foundation construction. Housel penetrometers are not appropriate for evaluating the soils at this site and their use will give misleading results. Furthermore, the test

method must be capable of testing the soils several feet below the bearing level. SME must be at the construction site to do tests at foundation locations to verify the bearing pressure prior to constructing the foundations.

Foundations must be situated a minimum of 42 inches below final site grades along exterior walls or in any unheated areas for protection against frost action during normal winters. Interior foundations in heated areas of the building (if any) may be constructed at shallower levels if the foundations bear on engineered fill placed over suitable natural soils. However, the foundations and proposed bearing soils need to be protected from freezing during construction if work occurs in the winter months.

Neat cut trench foundations through the dense to very dense sand may be feasible at the site. For frost heave considerations, trench foundations must be excavated in a vertical manner and not be allowed to "mushroom out" near the top. If verticality of the earthen side-walls cannot be maintained, forming of foundation sidewalls will be necessary to maintain vertical faces for foundations and to reduce the potentially adverse effects resulting from frost heave. In addition, any caved soils must be removed to re-expose suitable bearing soils at the foundation bearing level before placing concrete.

The foundation subgrade is susceptible to disturbance, especially when exposed to water and trafficked. Disturbed soils must be removed immediately prior to foundation concrete placement. In excavation areas where groundwater accumulates, a working surface of either crushed aggregate or crushed concrete may be required to protect the exposed surface from disturbance.

For bearing capacity and settlement considerations, we recommend continuous (wall) foundations have a minimum width of 18 inches and spread (column) foundations have a minimum dimension of 30 inches.

We estimate total settlement for shallow spread or continuous foundations using the recommended maximum net allowable bearing pressure and bearing on suitable soils, as described above, should be 1 inch or less. Differential settlements are estimated to be about one-half the total settlement. The settlement estimates provided are based on the available boring information, the estimated structural loads, our experience with similar structures and soil conditions and field verification of suitable bearing soils by SME.

New foundations adjacent to existing foundations should be constructed at the same bearing level as the existing foundations to reduce the potential of transmitting additional loads to the existing foundations. If the new foundations extend deeper or shallower than the bearing level of the existing foundations, the project structural engineer should evaluate the design and make appropriate modifications to the new foundations. Bearing levels for new foundations can be established at certain distances from the existing building, depending on the distance between

the two bearing levels. As a guideline, the new foundation level should be at a level either above or below the existing foundation, no greater than the horizontal distance between the new and existing foundations, i.e., a 1 to 1 slope between the edges of the two foundations. For reasons of constructability, we recommend limiting vertical “steps” to 1-foot for every 2 horizontal feet. Flatter slopes may be required for foundation excavations in granular soils. Excavation for new foundations should not extend below existing foundations without first properly underpinning or shoring the existing foundations.

4.3 Seismic Site Class

Based on Plate 13 (Topography of the Bedrock Surface) in the Hydrogeologic Atlas of Michigan, the estimated level of the top of rock is about elevation 630 feet to 650 feet based on linear interpolation of rock contours plotted at 50-foot intervals. Based on the previously referenced drawings, the existing ground surface within the proposed addition area is at about elevation 825 feet. From this information, the glacial drift at the site is approximately 175 to 195 feet thick.

The information available from this site is limited to the explored depths of the current borings. According to the limited information obtained from the borings, the subgrade soils at this site can be designated as seismic site Class C in determining seismic design forces for this project in accordance with the 2009 MBC Code (Table 1613.5.2).

4.4 Construction Considerations

Groundwater levels are relatively deep and groundwater seepage should not be a significant factor during foundation and utility construction. Groundwater accumulations from precipitation events or surface run-off can be encountered. Standard sump pit and pump methods are generally considered adequate for handling relatively light groundwater seepages on a localized basis. A working surface of either crushed aggregate or crushed concrete can be used to protect the exposed subgrade where seepage is encountered.

The exposed subgrade soils may be easily disturbed due to weather and activity on-site. Therefore, the contractor should remove standing water from areas where water collects and prevent surface water from reaching the foundation excavations and areas of prepared subgrade. Also, to reduce the potential of subgrade disturbance across the site, construction traffic should be restricted to special construction roads, and not be allowed to randomly traffic the site. Disturbed soils may have to be moisture conditioned and recompacted in-place, or undercut and replaced with engineered fill. Moisture conditioning may not be feasible during seasonally cold and wet times of the year, resulting in a potential need for additional imported fill if the work is done between the late fall and early spring seasons. Areas of exposed subgrade at the site may

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be protected by placing crushed concrete or crushed aggregate on it. Under adverse weather conditions, the placement of a geotextile fabric for separation on the exposed subgrade may be beneficial. Doing site work during the drier summer months should reduce the potential for subgrade disturbance and the need for improvement of the subgrade.

The foundation bearing soils are susceptible to disturbance during construction. Disturbed foundation bearing soils should be recompacted in-place, or removed and replaced with compacted crushed aggregate or crushed concrete. Foundation concrete should be placed as soon as foundation excavations have been completed and the design bearing pressure verified to reduce the potential for disturbance of the foundation subgrade.

The contractor must take precautions to protect existing utilities, pavements, and any neighboring structures during construction. Care must be exercised during the excavating and compacting operations so that undermining and/or excessive vibrations do not cause undesirable movement of the existing utilities, pavements, and/or structures.

The contractor must provide a safely sloped excavation or an adequately constructed and braced shoring system in accordance with federal, state and local safety regulations for individuals working in an excavation that may expose them to the danger of moving ground. If material is stored or heavy equipment is operated near an excavation, stronger shoring must be used to resist the extra pressure due to the superimposed loads.

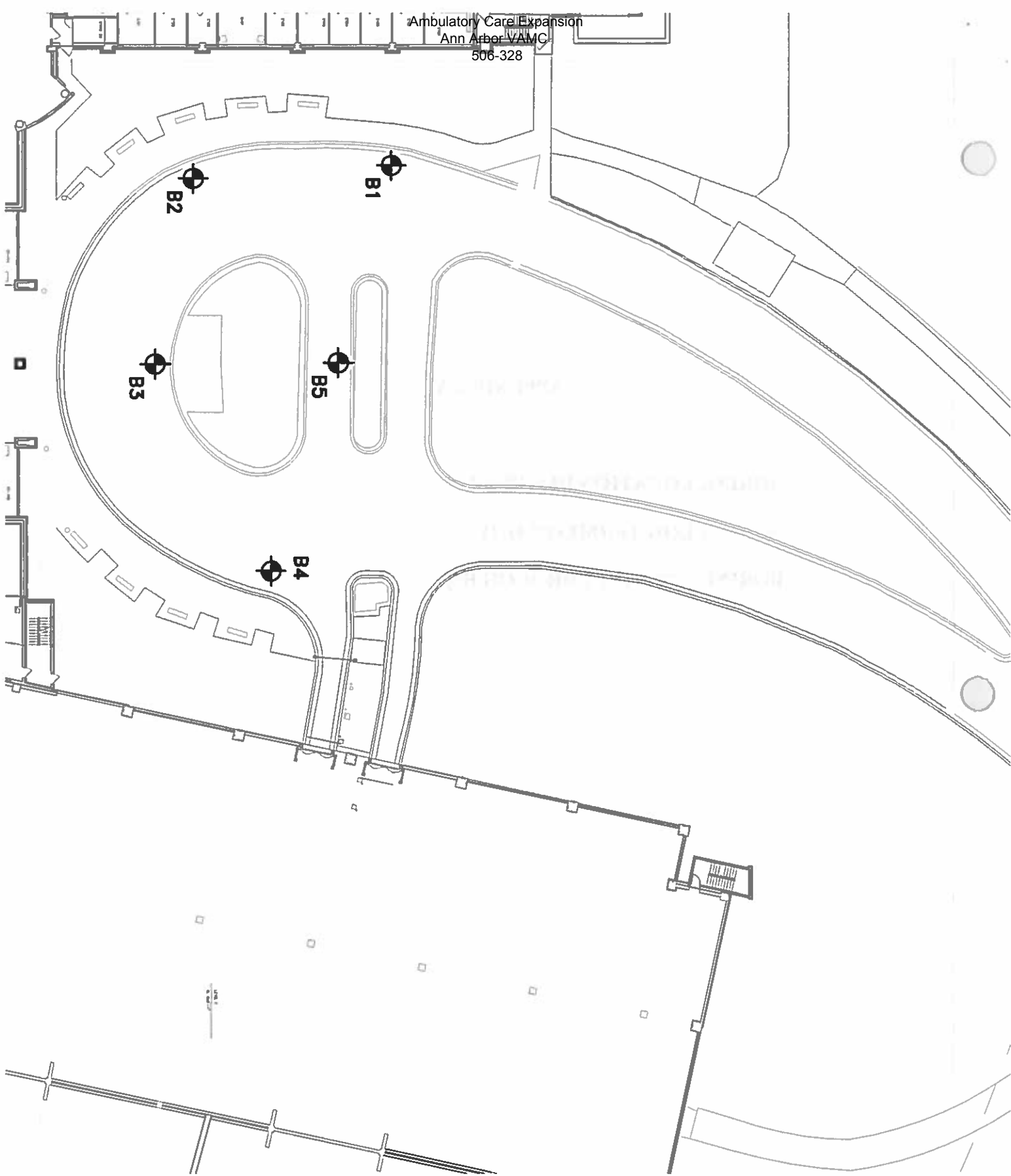
Any impacted soil and/or groundwater that may be encountered at the site must be handled in accordance with local, state, and federal regulations.

APPENDIX A

BORING LOCATION DIAGRAM

BORING LOG TERMINOLOGY

BORING LOGS (B1 THROUGH B5)





BORING LOG TERMINOLOGY

UNIFIED SOIL CLASSIFICATION AND SYMBOL CHART

COARSE-GRAINED SOIL (more than 50% of material is larger than No. 200 sieve size)		
Clean Gravel (Less than 5% fines)		
	GW	Well-graded gravel, gravel-sand mixtures, little or no fines
	GP	Poorly-graded gravel, gravel-sand mixtures, little or no fines
Gravel with fines (More than 12% fines)		
	GM	Silty gravel; gravel-sand-silt mixtures
	GC	Clayey gravel; gravel-sand-clay mixtures
Clean Sand (Less than 5% fines)		
	SW	Well-graded sand; sand-gravel mixtures, little or no fines
	SP	Poorly graded sand; sand-gravel mixtures, little or no fines
Sand with fines (More than 12% fines)		
	SM	Silty sand; sand-silt-gravel mixtures
	SC	Clayey sand; sand-clay-gravel mixtures
FINE-GRAINED SOIL (50% or more of material is smaller than No. 200 sieve size)		
	ML	Inorganic silt, sandy silt or gravelly silt with slight plasticity
	CL	Inorganic clay of low plasticity: lean clay, sandy clay, gravelly clay
	OL	Organic silt and organic clay of low plasticity
	MH	Inorganic silt of high plasticity: elastic silt
	CH	Inorganic clay of high plasticity: fat clay
	OH	Organic silt and organic clay of high plasticity
	PT	Peat and other highly organic soil

OTHER MATERIAL SYMBOLS

Topsoil	Void	Sandstone
Asphalt	Glacial Till	Siltstone
Base	Coal	Limestone
Concrete	Shale	Fill

LABORATORY CLASSIFICATION CRITERIA

GW	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4, $C_c = \frac{D_{30}}{D_{10} \times D_{60}}$ between 1 and 3
GP	Not meeting all gradation requirements for GW
GM	Atterberg limits below "A" line or PI less than 4
GC	Atterberg limits above "A" line with PI greater than 7
SW	$C_u = \frac{D_{60}}{D_{10}}$ greater than 6, $C_c = \frac{D_{30}}{D_{10} \times D_{60}}$ between 1 and 3
SP	Not meeting all gradation requirements for SW
SM	Atterberg limits below "A" line or PI less than 4
SC	Atterberg limits above "A" line with PI greater than 7

Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows:

Less than 5 percent GW GP SW SP
More than 12 percent GM, GC SM SC
5 to 12 percent Cases requiring dual symbols

- SP-SM or SW-SM (SAND with Silt or SAND with Silt and Gravel)
- SP-SC or SW-SC (SAND with Clay or SAND with Clay and Gravel)
- GP-GM or GW-GM (GRAVEL with Silt or GRAVEL with Silt and Sand)
- GP-GC or GW-GC (GRAVEL with Clay or GRAVEL with Clay and Sand)

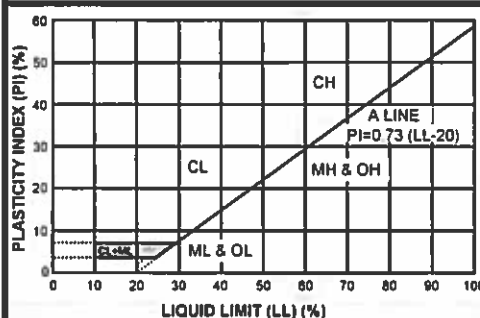
If the fines are CL-ML:

- SC-SM (SILTY CLAYEY SAND or SILTY CLAYEY SAND with Gravel)
- SM-SC (CLAYEY SILTY SAND or CLAYEY SILTY SAND with Gravel)
- GC-GM (SILTY CLAYEY GRAVEL or SILTY CLAYEY GRAVEL with Sand)
- GM-GC (CLAYEY SILTY GRAVEL or CLAYEY SILTY GRAVEL with Sand)

PARTICLE SIZES

Boulders	- Greater than 12 inches
Cobbles	- 3 inches to 12 inches
Gravel- Coarse	- 3/4 inches to 3 inches
Gravel- Fine	- No. 4 to 3/4 inches
Sand- Coarse	- No. 10 to No. 4
Sand- Medium	- No. 40 to No. 10
Sand- Fine	- No. 200 to No. 40
Silt and Clay	- Less than (0.0074 mm)

PLASTICITY CHART



VISUAL MANUAL PROCEDURE

When laboratory tests are not performed to confirm the classification of soils exhibiting borderline classifications, the two possible classifications would be separated with a slash, as follows:

For soils where it is difficult to distinguish if it is a coarse or fine-grained soil:

- SC/CL (CLAYEY SAND to Sandy LEAN CLAY)
- SM/ML (SILTY SAND to Sandy SILT)
- GC/CL (CLAYEY GRAVEL to Gravelly LEAN CLAY)
- GM/ML (SILTY GRAVEL to Gravelly SILT)

For soils where it is difficult to distinguish if it is sand or gravel, poorly or well-graded sand or gravel; silt or clay; or plastic or non-plastic silt or clay:

- SP/GP or SW/GW (SAND with Gravel to GRAVEL with Sand)
- SC/GC (CLAYEY SAND with Gravel to CLAYEY GRAVEL with Sand)
- SM/GM (SILTY SAND with Gravel to SILTY GRAVEL with Sand)
- SW/SP (SAND or SAND with Gravel)
- GP/GW (GRAVEL or GRAVEL with Sand)
- SC/SM (CLAYEY to SILTY SAND)
- GM/GC (SILTY to CLAYEY GRAVEL)
- CL/ML (SILTY CLAY)
- ML/CL (CLAYEY SILT)
- CH/MH (FAT CLAY to ELASTIC SILT)
- CL/CH (LEAN to FAT CLAY)
- MH/ML (ELASTIC SILT to SILT)
- OL/OH (ORGANIC SILT or ORGANIC CLAY)

DRILLING AND SAMPLING ABBREVIATIONS

2ST	- Shelby Tube - 2" O.D.
3ST	- Shelby Tube - 3" O.D.
AS	- Auger Sample
GS	- Grab Sample
LS	- Liner Sample
NR	- No Recovery
PM	- Pressure Meter
RC	- Rock Core diamond bit. NX size, except where noted
SB	- Split Barrel Sample 1-3/8" I.D., 2" O.D., except where noted
VS	- Vane Shear
WS	- Wash Sample

OTHER ABBREVIATIONS

WOH	- Weight of Hammer
WOR	- Weight of Rods
SP	- Soil Probe
PID	- Photo Ionization Device
FID	- Flame Ionization Device

DEPOSITIONAL FEATURES

Parting	- as much as 1/16 inch thick
Seam	- 1/16 inch to 1/2 inch thick
Layer	- 1/2 inch to 12 inches thick
Stratum	- greater than 12 inches thick
Pocket	- deposit of limited lateral extent
Lens	- lenticular deposit
Hardpan/Till	- an unstratified, consolidated or cemented mixture of clay, silt, sand and/or gravel, the size/shape of the constituents vary widely
Lacustrine	- soil deposited by lake water
Mottled	- soil irregularly marked with spots of different colors that vary in number and size
Varved	- alternating partings or seams of silt and/or clay
Occasional	- one or less per foot of thickness
Frequent	- more than one per foot of thickness
Interbedded	- strata of soil or beds of rock lying between or alternating with other strata of a different nature

CLASSIFICATION TERMINOLOGY AND CORRELATIONS

Cohesionless Soils

Relative Density

Very Loose
Loose
Medium Dense
Dense
Very Dense
Extremely Dense

N-Value (Blows per foot)

0 to 4
4 to 10
10 to 30
30 to 50
50 to 80
Over 80

Cohesive Soils

Consistency

Very Soft
Soft
Medium
Stiff
Very Stiff
Hard

N-Value (Blows per foot)

0 - 2
2 - 4
4 - 8
8 - 15
15 - 30
> 30

Undrained Shear Strength (kips/sq ft)

0.25 or less
0.25 to 0.50
0.50 to 1.0
1.0 to 2.0
2.0 to 4.0
4.0 or greater

Standard Penetration 'N-Value' = Blows per foot of a 140-pound hammer falling 30 inches on a 2-inch O.D. split barrel sampler, except where noted.



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BORING B 1

PAGE 1 OF 1

PROJECT NAME: Proposed Ambulatory Expansion

PROJECT NUMBER: 068896.00

CLIENT: Diekema Hamann

PROJECT LOCATION: Ann Arbor, Michigan

DATE STARTED: 12/14/13

COMPLETED: 12/14/13

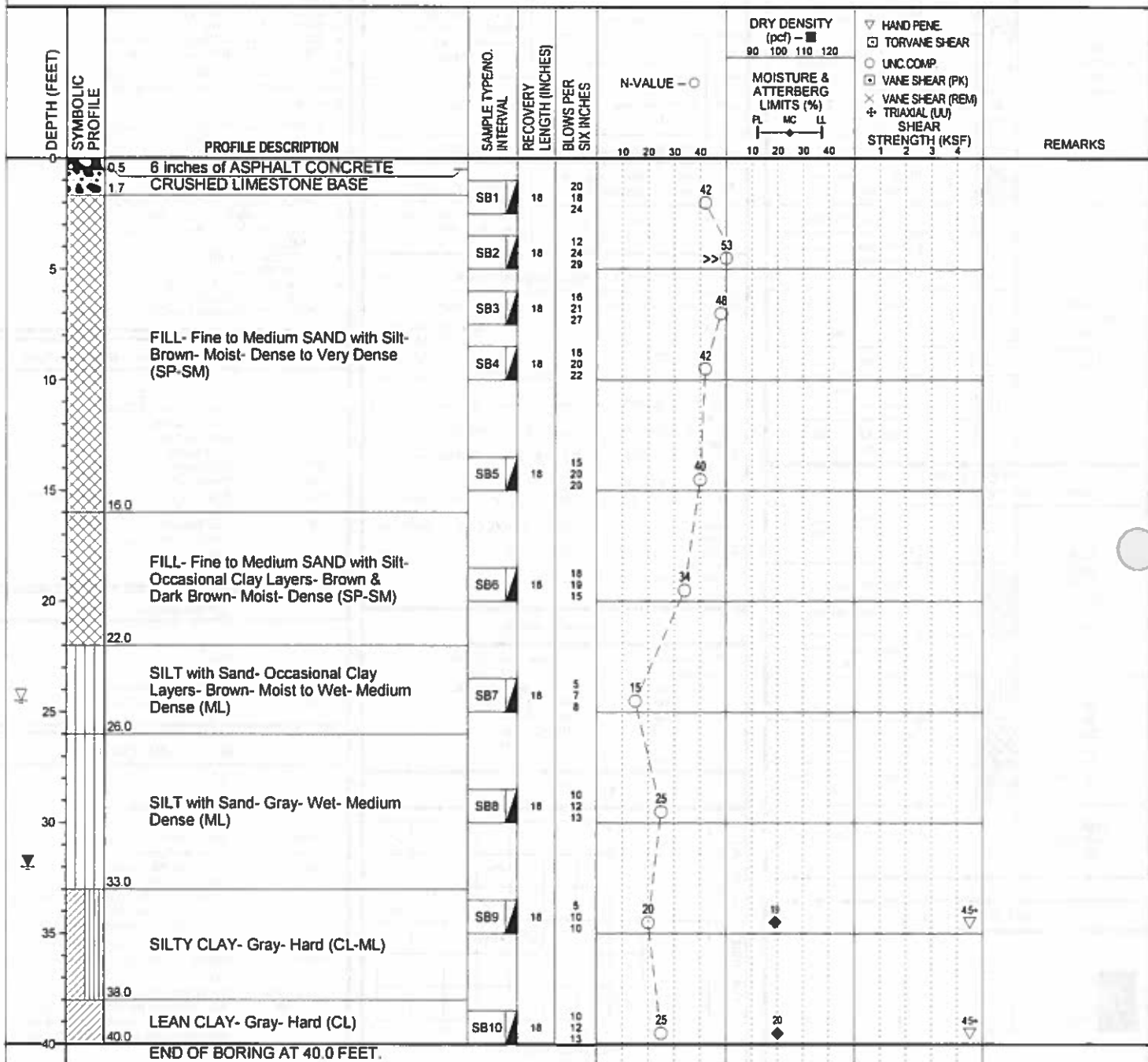
BORING METHOD: Solid-stem Augers

DRILLER: RM

RIG NO.: 281

LOGGED BY: SEB

CHECKED BY: KLV



GROUNDWATER & BACKFILL INFORMATION

DEPTH (FT)
▽ DURING BORING: 24.5
▽ AT END OF BORING: 32.0

BACKFILL METHOD: Auger Cuttings capped with Asphalt Cold Patch

NOTES: 1. The indicated stratification lines are approximate. In situ, the transition between materials may be gradual.



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BORING B 2

PAGE 1 OF 1

PROJECT NAME: Proposed Ambulatory Expansion

PROJECT NUMBER: 068896.00

CLIENT: Diekema Hamann

PROJECT LOCATION: Ann Arbor, Michigan

DATE STARTED: 12/14/13

COMPLETED: 12/14/13

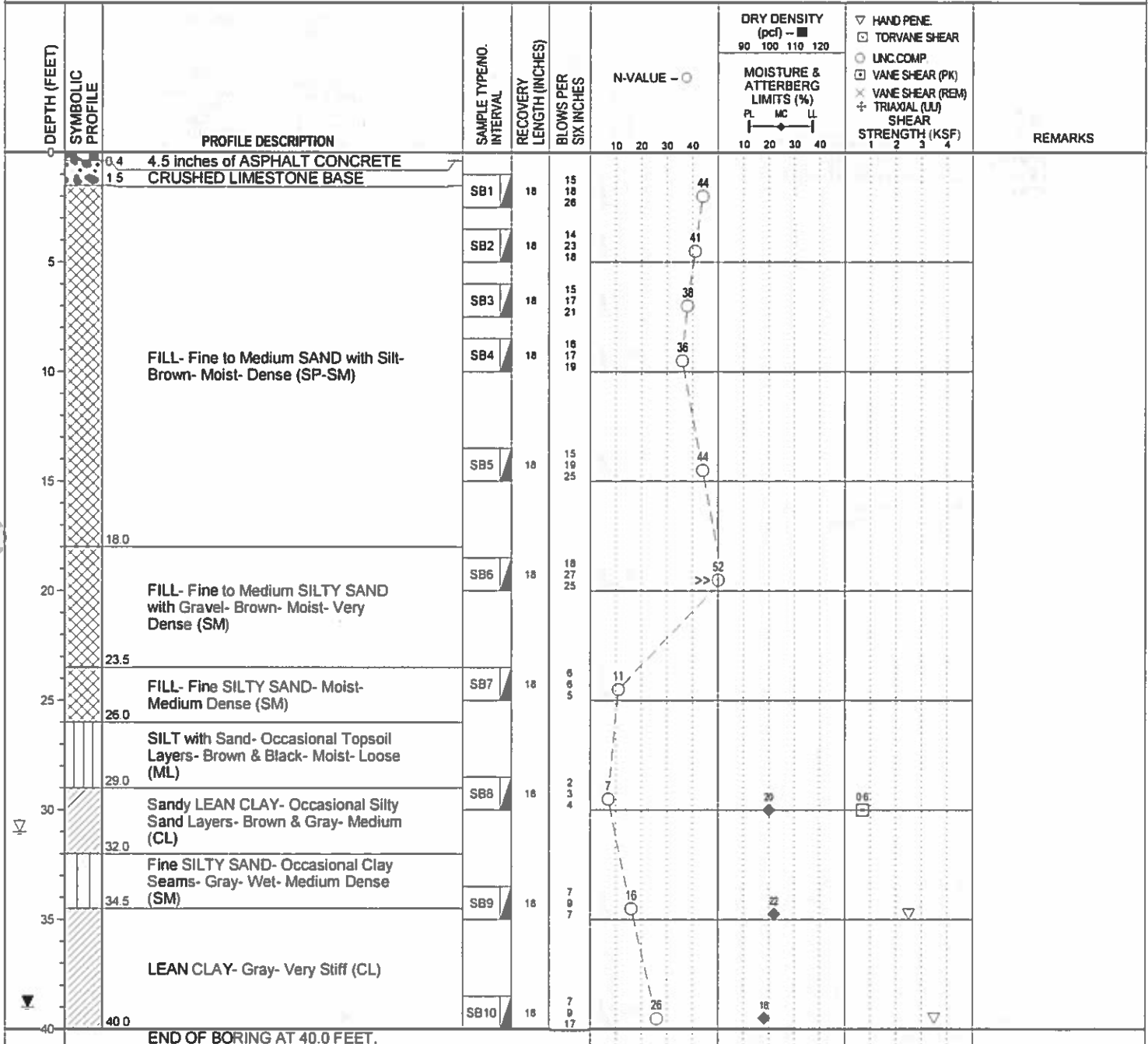
BORING METHOD: Solid-stem Augers

DRILLER: RM

RIG NO.: 281

LOGGED BY: SEB

CHECKED BY: KIW



GROUNDWATER & BACKFILL INFORMATION	
	DEPTH (FT)
▽ DURING BORING:	31.0
▽ AT END OF BORING:	39.0
BACKFILL METHOD: Auger Cuttings capped with Asphalt Cold Patch	

NOTES: 1. The indicated stratification lines are approximate. In situ, the transition between materials may be gradual.



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BORING B 3

PAGE 1 OF 1

PROJECT NAME: Proposed Ambulatory Expansion

PROJECT NUMBER: 068896.00

CLIENT: Diekema Hamann

PROJECT LOCATION: Ann Arbor, Michigan

DATE STARTED: 12/14/13

COMPLETED: 12/14/13

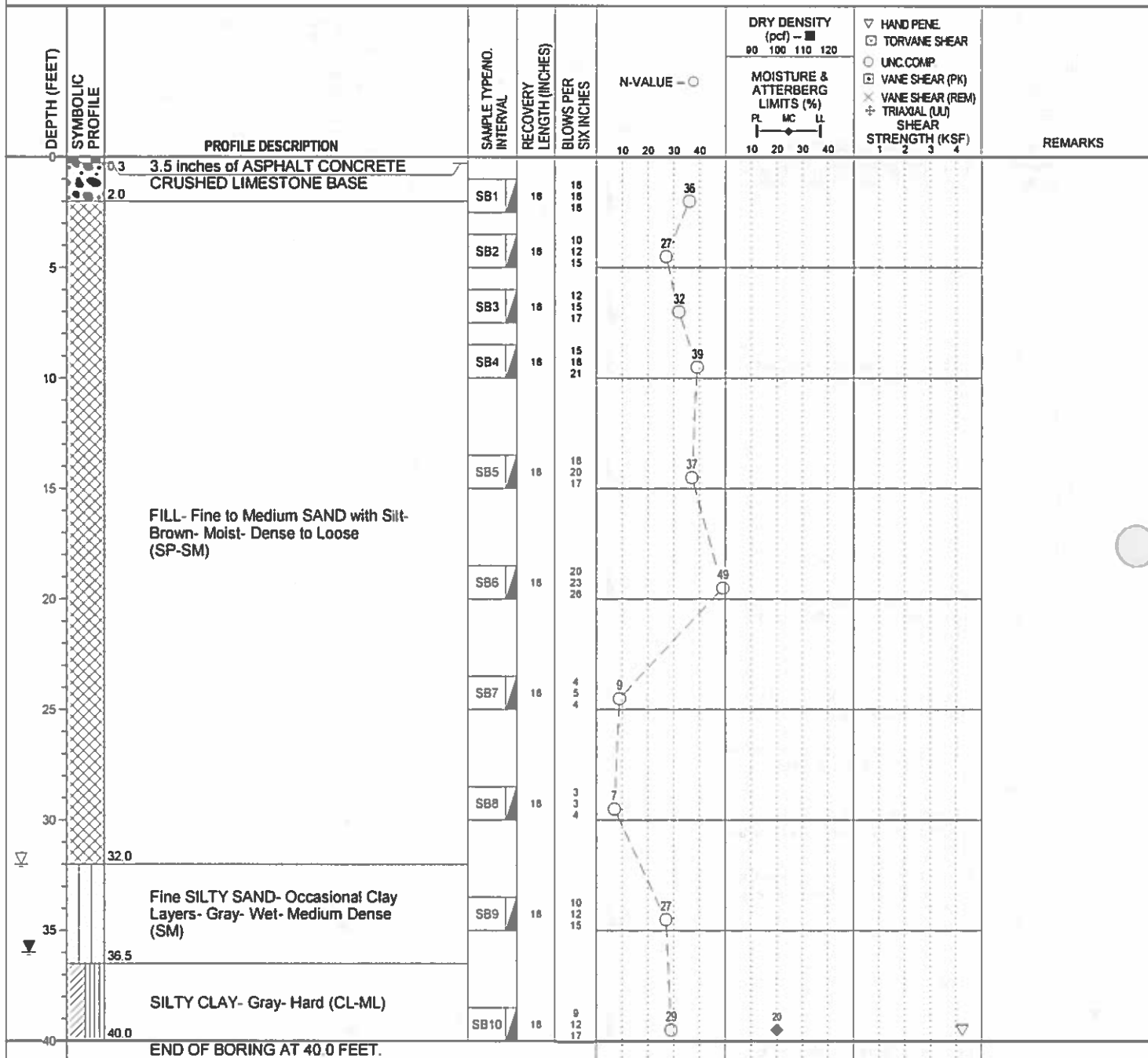
BORING METHOD: Solid-stem Augers

DRILLER: RM

RIG NO.: 281

LOGGED BY: SEB

CHECKED BY: KLV



GROUNDWATER & BACKFILL INFORMATION

NOTES: 1. The indicated stratification lines are approximate. In situ, the transition between materials may be gradual.

DEPTH (FT)

▼ DURING BORING: 32.0

▼ AT END OF BORING: 36.0

BACKFILL METHOD: Auger Cuttings capped with Asphalt Cold Patch



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BORING B 4

PAGE 1 OF 1

PROJECT NAME: Proposed Ambulatory Expansion

PROJECT NUMBER: 068896.00

CLIENT: Diekema Hamann

PROJECT LOCATION: Ann Arbor, Michigan

DATE STARTED: 12/14/13

COMPLETED: 12/14/13

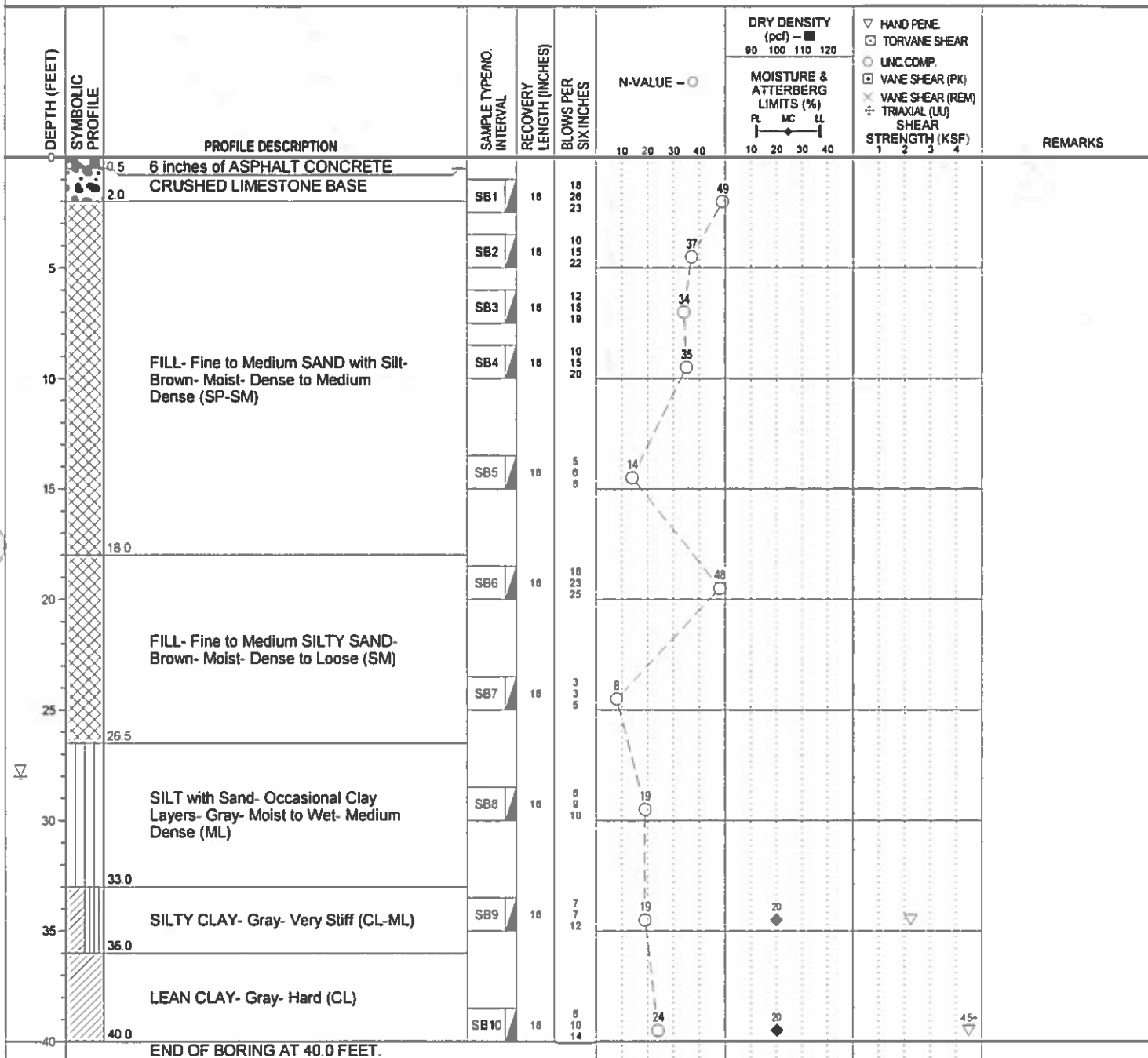
BORING METHOD: Solid-stem Augers

DRILLER: RM

RIG NO.: 281

LOGGED BY: SEB

CHECKED BY: KLV



GROUNDWATER & BACKFILL INFORMATION

DEPTH (FT)
 ▽ DURING BORING: 28.0
 ▽ AT END OF BORING: None
BACKFILL METHOD: Auger Cuttings capped with Asphalt Cold Patch

NOTES: 1. The indicated stratification lines are approximate. In situ, the transition between materials may be gradual.



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BORING B 5

PAGE 1 OF 1

PROJECT NAME: Proposed Ambulatory Expansion

PROJECT NUMBER: 068896.00

CLIENT: Diekema Hamann

PROJECT LOCATION: Ann Arbor, Michigan

DATE STARTED: 12/14/13

COMPLETED: 12/14/13

BORING METHOD: Solid-stem Augers

DRILLER: RM

RIG NO.: 281

LOGGED BY: SEB

CHECKED BY: KLV

DEPTH (FEET)	SYMBOLIC PROFILE	PROFILE DESCRIPTION	SAMPLE TYPE/NO. INTERVAL	RECOVERY LENGTH (INCHES)	BLOWS PER SIX INCHES	N-VALUE - ○	DRY DENSITY (pcf) -- ■ 90 100 110 120	MOISTURE & ATTERBERG LIMITS (%) PL MC LL	<div> ▽ HAND PENE ☐ TORVANE SHEAR ○ UNC. COMP ☐ VANE SHEAR (PK) × VANE SHEAR (REM) + TRIAXIAL (UU) SHEAR STRENGTH (KSF) 1 2 3 4 </div>	REMARKS
0		5 inches of ASPHALT CONCRETE								
0.4		CRUSHED LIMESTONE BASE								
2.0			SB1	18	21 23 31				54	
5		FILL- Fine to Medium SAND with Silt- Brown- Moist- Very Dense to Dense (SP-SM)	SB2	18	15 19 24				43	
			SB3	18	16 20 23				43	
10		END OF BORING AT 10.0 FEET.	SB4	18	16 20 23				43	
10.0										
15										
20										
25										
30										
35										
40										

GROUNDWATER & BACKFILL INFORMATION

GROUNDWATER WAS NOT ENCOUNTERED

BACKFILL METHOD: Auger Cuttings capped with
Asphalt Cold Patch

NOTES: 1. The indicated stratification lines are approximate. In situ, the transition between materials may be gradual.

APPENDIX B

IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL ENGINEERING REPORT

GENERAL COMMENTS

LABORATORY TESTING PROCEDURES

Important Information About Your Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

The following information is provided to help you manage your risks.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you — should apply the report for any purpose or project except the one originally contemplated.*

Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,

- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ—sometimes significantly—from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final*, because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual

subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.*

A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time to perform additional study.* Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that

have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, a number of mold prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

Rely on Your ASFE-Member Geotechnical Engineer for Additional Assistance

Membership in ASFE/The Best People on Earth exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you ASFE-member geotechnical engineer for more information.



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GENERAL COMMENTS

Basis of Geotechnical Report

This report has been prepared in accordance with generally accepted geotechnical engineering practices to assist in the design and/or evaluation of this project. If the project plans, design criteria, and other project information referenced in this report and utilized by SME to prepare our recommendations are changed, the conclusions and recommendations contained in this report are not considered valid unless the changes are reviewed, and the conclusions and recommendations of this report are modified or approved in writing by our office.

The discussions and recommendations submitted in this report are based on the available project information, described in this report, and the geotechnical data obtained from the field exploration at the locations indicated in the report. Variations in the soil and groundwater conditions commonly occur between or away from sampling locations. The nature and extent of the variations may not become evident until the time of construction. If significant variations are observed during construction, SME should be contacted to reevaluate the recommendations of this report. SME should be retained to continue our services through construction to observe and evaluate the actual subsurface conditions relative to the recommendations made in this report.

In the process of obtaining and testing samples and preparing this report, procedures are followed that represent reasonable and accepted practice in the field of soil and foundation engineering. Specifically, field logs are prepared during the field exploration that describe field occurrences, sampling locations, and other information. Samples obtained in the field are frequently subjected to additional testing and reclassification in the laboratory and differences may exist between the field logs and the report logs. The engineer preparing the report reviews the field logs, laboratory classifications, and test data and then prepares the report logs. Our recommendations are based on the contents of the report logs and the information contained therein.

Review of Design Details, Plans, and Specifications

SME should be retained to review the design details, project plans, and specifications to verify those documents are consistent with the recommendations contained in this report.

Review of Report Information With Project Team

Implementation of our recommendations may affect the design, construction, and performance of the proposed improvements, along with the potential inherent risks involved with the proposed construction. The client and key members of the design team, including SME, should discuss the issues covered in this report so that the issues are understood and applied in a manner consistent with the owner's budget, tolerance of risk, and expectations for performance and maintenance.

Field Verification of Geotechnical Conditions

SME should be retained to verify the recommendations of this report are properly implemented during construction. This may avoid misinterpretation of our recommendations by other parties and will allow us to review and modify our recommendations if variations in the site subsurface conditions are encountered.

Project Information for Contractor

This report and any future addenda or other reports regarding this site should be made available to prospective contractors prior to submitting their proposals for their information only and to supply them with facts relative to the subsurface evaluation and laboratory test results. If the selected contractor encounters subsurface conditions during construction, which differ from those presented in this report, the contractor should promptly describe the nature and extent of the differing conditions in writing and SME should be notified so that we can verify those conditions. The construction contract should include provisions for dealing with differing conditions and contingency funds should be reserved for potential problems during earthwork and foundation construction. We would be pleased to assist you in developing the contract provisions based on our experience.

The contractor should be prepared to handle environmental conditions encountered at this site, which may affect the excavation, removal, or disposal of soil; dewatering of excavations; and health and safety of workers. Any Environmental Assessment reports prepared for this site should be made available for review by bidders and the successful contractor.

Third Party Reliance/Reuse of This Report

This report has been prepared solely for the use of our Client for the project specifically described in this report. This report cannot be relied upon by other parties not involved in the project, unless specifically allowed by SME in writing. SME also is not responsible for the interpretation by other parties of the geotechnical data and the recommendations provided herein.

LABORATORY TESTING PROCEDURES

Visual Engineering Classification

Visual classification was performed on recovered samples. The appended General Notes and Unified Soil Classification System (USCS) sheets include a brief summary of the general method used visually classify the soil and assign an appropriate USCS group symbol. The estimated group symbol, according to the USCS, is shown in parentheses following the textural description of the various strata on the boring logs appended to this report. The soil descriptions developed from visual classifications are sometimes modified to reflect the results of laboratory testing.

Moisture Content

Moisture content tests were performed by weighing samples from the field at their in-situ moisture condition. These samples were then dried at a constant temperature (approximately 110° C) overnight in an oven. After drying, the samples were weighed to determine the dry weight of the sample and the weight of the water that was expelled during drying. The moisture content of the specimen is expressed as a percent and is the weight of the water compared to the dry weight of the specimen.

Hand Penetrometer Tests

In the hand penetrometer test, the unconfined compressive strength of a cohesive soil sample is estimated by measuring the resistance of the sample to the penetration of a small calibrated, spring-loaded cylinder. The maximum capacity of the penetrometer is 4.5 tons per square-foot (tsf). Theoretically, the undrained shear strength of the cohesive sample is one-half the unconfined compressive strength. The undrained shear strength (based on the hand penetrometer test) presented on the boring logs is reported in units of kips per square-foot (ksf).

Torvane Shear Tests

In the Torvane test, the shear strength of a low strength, cohesive soil sample is estimated by measuring the resistance of the sample to a torque applied through vanes inserted into the sample. The undrained shear strength of the samples is measured from the maximum torque required to shear the sample and is reported in units of kips per square-foot (ksf).

Loss-on-Ignition (Organic Content) Tests

Loss-on-ignition (LOI) tests are conducted by first weighing the sample and then heating the sample to dry the moisture from the sample (in the same manner as determining the moisture content of the soil). The sample is then re-weighed to determine the dry weight and then heated for 4 hours in a muffle furnace at a high temperature (approximately 440° C). After cooling, the sample is re-weighed to calculate the amount of ash remaining, which in turn is used to determine the amount of organic matter burned from the original dry sample. The organic matter content of the specimen is expressed as a percent compared to the dry weight of the sample.

Atterberg Limits Tests

Atterberg limits tests consist of two components. The plastic limit of a cohesive sample is determined by rolling the sample into a thread and the plastic limit is the moisture content where a 1/8-inch thread begins to crumble. The liquid limit is determined by placing a 1/2-inch thick soil pat into the liquid limits cup and using a grooving tool to divide the soil pat in half. The cup is then tapped on the base of the liquid limits device using a crank handle. The number of drops of the cup to close the gap formed by the grooving tool 1/2 inch is recorded along with the corresponding moisture content of the sample. This procedure is repeated several times at different moisture contents and a graph of moisture content and the corresponding number of blows is plotted. The liquid limit is the moisture content at a nominal 25 drops of the cup. From this test, the plasticity index can be determined by subtracting the plastic limit from the liquid limit.

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