

Invitation for Bid (IFB) – FQ15155  
Date of Issue: April 9, 2015

WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY (WMATA)  
600 FIFTH STREET, NW  
WASHINGTON, DC 20001

April 29, 2015

**AMENDMENT NO. 1**

INVITATION FOR BID

**BUS BAY, SAFETY AND ACCESS IMPROVEMENTS AT FRANCONIA SPRINGFIELD METRO RAIL STATION**

IFB – FQ1515155 requesting bids for the above referenced project is hereby changed in part as listed below:

1. Section 00320 GEOTECHNICAL REPORT - hereby deleted in its entirety and replace with:

**00320 GEOTECHNICAL REPORT**

Geotechnical Report for WMATA Springfield – Franconia Bus Canopy Project Springfield, VA Prepared for Gannett Fleming/Parsons Joint Venture (GFP) 100 M Street SE Washington, DC 20003 by HAS, Inc. 1818 New York Avenue N.E., Suite 106 Washington, DC 20002 Project No. 11-103W October, 2014 [Report attached hereto]

2. Volume 1 Procurement and Contracting Requirements / General Requirements – hereby amended to:

- Section 00800 Supplementary Conditions, 00844 METHOD OF PAYMENT, Paragraph M., delete \$410,000 and replace with \$10,000.

3. Volume 2 Technical Specifications - hereby amended to: [Revised Sections attached hereto]

- Specification Section 02750 CONCRETE PAVEMENT, PART 2 PRODUCTS, 2.01 MATERIALS, Line L: delete Class 3500 and replace with Class 4000.
- Add “Section 02764 – SITE FURNISHINGS”
- Add the following to Specification Section 16525 LIGHTING, 2.2 MANUFACTURED UNITS
  - H. Luminaire Pole Foundations
    1. Pole/Support Structure Bases: Anchor type with hold-down or anchor bolts, leveling nuts, and bolt covers.
    2. Embedded type with underground conduit/cable entry.
    3. Comply with Specification Section 03300 Cast-in-Place Structural Concrete.
    4. Design Strength: 4000-psi (20.7-MPa), 28-day compressive strength.
  - I. Luminaire Brackets
    1. Provide luminaire brackets of the type and style as indicated or scheduled on the Contract Drawings and color matched to light fixture.
    2. Provide luminaire brackets fabricated to be compatible with the configuration of the luminaire.

- Specification Section 02830 MECHANICALLY STABILIZED EARTH (MSE) RETAINING WALLS:
  - a. PART 1 GENERAL, 1.01 DESCRIPTION, Paragraph A. Delete “WMATA Guidelines” and replace with “WMATA Design Criteria”.
  - b. PART 1, GENERAL, 1.02 QUALITY ASSURANCE, Add Line “4. Comply with WMATA Design Criteria”.
  - c. PART 1, GENERAL, 1.03 DESIGN REQUIREMENTS, Paragraph E, Line 4, Add line “f. Design Factors of Safety per WMATA Design Criteria as specified in WMATA Manual of Design Criteria Facilities, Section 15”
  - d. PART 1, GENERAL, 1.03 DESIGN REQUIRMENTS, Paragraph E, Line 6, Add “Minimum reinforcement length shall meet Design Factors of Safety per WMATA Design Criteria which are specified in WMATA Manual of Design Criteria Facilities, Section 15”
  
- Specification Section 16112, CONDUITS FOR ELECTRICAL SYSTEMS, Delete ALL references to Electrical Metallic Tubing (EMT) conduit and Polyvinyl Chloride (PVC) conduit. EMT and PVC are NOT acceptable for this Project.

4. Volume 3 Drawings - hereby amended as follows:

**J03-C-128 Conceptual Maintenance of Traffic plan overall site: Add below stated notes.**

12. The Contractor shall develop a detailed Traffic Control Plan (TCP) outlining the terms and conditions for implementation of Maintenance of Traffic (MOT) for the project, based on the criteria noted in the Manual of Uniform Traffic Control Devices (MUTCD). The TCP shall include details on lane closure hours, temporary signing, pavement markings, lighting, pedestrian/bicycle access, work zone traffic control, bus hours operations, work area, etc. and shall base on continuous operation of seven (7) bus bay area all time. The TCP shall be developed with safety of pedestrian and vehicular traffic as priority over the welfare of all users within the limits of construction (at the Metro facility). The TCP shall be submitted for review and approval by WMATA appointed authorities.
13. Part of TCP, a separate MOT plans shall be developed for each phase of construction. The MOT plan shall include the limits of work on the bus bays, pedestrian detours that meet ADA guidelines for accessibility. The Contractor shall review the phasing plan for the purpose of including the option for 4th construction phase (continuous operation of seven (7) bus bays during construction), based on constructability.
14. The MOT Plan should include a separate Pedestrian Access Plan for each Phase/Area/Section per MUTCD guidelines. As part of the MOT Plan, the Contractor is responsible for conducting includes a detailed review and inventory of all existing, temporary and proposed new signing. All temporary signing shall be installed so as not to create conflicting messages for the public. All existing signing to be removed for construction shall be salvaged, and reinstalled upon completion of all work.
15. The contractor shall add on MOT for Pedestrian Crossing Warning Signs” alerting vehicles to stop for pedestrians at or before the crosswalks.
16. The contractor shall provide details for signs identified to be installed as shown on drawing J03-C-128.

17. Any section of sidewalk that is called out to be closed, a pedestrian detour must be developed by the Contractor and included as part of the overall detailed Maintenance of Traffic Plan (MOT) for each Phase of construction based on continuous operations of seven bus bay areas. The Pedestrian Detour Plan shall comply with the latest guidelines noted in the MUTCD and shall be submitted for review and approval by WMATA.

**Drawing J03-C-125:** Add Note 5: All new permanent signing shall meet the design requirements (i.e., sign size, text, mounting, etc.) of MUTCD and shall be ADA compliant. The permanent signing detail shall be reviewed approved by WMATA Architectural, CENI and ADAP office prior to installation.

**Drawing J03-C-107:** Add Note 2: Any section of existing concrete curb/and or sidewalk identified for removal shall be reviewed for WMATA’s drop-off policy regarding any changes existing roadway elevation, as part of the approved MOT Plan.

**Drawing J03-C-109:** Replace note provided at curb line which read as “and existing concrete curb removal” with “existing concrete curb and gutter removal”.

**Drawing J03-C-110:** Replace note provided at curb line which read as “Remove existing concrete curb and walk and replace with new platform” with “Remove existing concrete curb and gutter, and walk and replace with new curb and gutter, and new platform”.

**Drawing J03-C-112:** Add note: 1 -The 5’x8’ boarding and alighting outlines shown on the plans shall be labeled with the curb. The Bus Stops boarding area specified on C-112 shall meet the curb lines.

**Drawings J03-C-112:** Add note 2: The curb ramp on the south side of the two-directional roadway shall be moved outside of the curb radius. Moving the ramp approximately 8 feet to the west will provide a more usable ramp for pedestrians. Adjust the crosswalk and receiving ramp accordingly.

**Drawing J03-C-502,** Add Note 1 to Detail F: For ramp on left side, adjust the detectable warning tiles to be closer to the curb line near end to the slope, where pedestrians could encounter vehicles instead of shown at upper edges of ramp.

**Drawing J03-C-130:** Add following notes:

- a. Add Note 1.C: “Detour for pedestrians trying to use route D to E”.
- b. Add Note 8: “under note 8 “Curb ramp at T”
- c. Add Notes C to 7 and Note B to 8: “The construction of ramp “S”.
- d. Add Note B to note 13: “The ramp will be constructed while pedestrians are using the pathway from K-S-T and update Phasing and MOT plan accordingly.
- e. Add Note B to note 14: “The ramp will be constructed while pedestrians are using the pathway from K-S-T and update Phasing and MOT plan accordingly.
- f. Add note 16: “Contractor shall phase the work to have one existing ADA ramp at G is available to use until new ADA ramp at F is completed”
- g. Add note 17: The contractor shall provide an ADA compliant detour as note 16 for pedestrians traveling from the east to west”.

**Add note 25 to General notes on JO3\_E-001:** The Contractor shall perform any dewatering operations (and/or other) deemed as a necessary method to installing/performing all electrical work in manholes, conduits etc., to ensure the safety of all workers and to the general public.

**Add following notes to General notes on drawing J03-G-002:**

15. Remove and salvage existing bus stop signage for replacement after construction of bus shelters and canopies are completed. All new signs at new bus bays are to match existing. All bus signs are to be installed per WMATA standards.
16. The Contractor shall be responsible for coordinating all impacts to existing/new bus stops, including temporary removal/relocation of bus shelters, bus stops, etc., (throughout all phases of construction) with the Station Manager and WMATA Bus Planning.
17. All regulatory Signage shall not be removed (temporarily or permanently) until detailed review of signing is conducted and approved by WMATA.

**Drawing S-501:** Add note 5: “Cap or cover plate the exposed anchor bolts for the canopy steel supports/columns with stainless steel plate of gauge 14 with 6” cover all around. Exposed bolts are not acceptable”.

**Drawing J03 -C-125:** Add note 6: “The contractor shall restripe all existing crosswalks at under/near pedestrian bridge to metro station as per permanent marking plan”.

**Specification Section 16112:** Delete all reference of Electrical metallic tubing (EMT) conduit and PVC conduits as it is not allowed to use on the project. EMT and PVC are not acceptable to use on the project.

**Drawing J03-E-001:** Add following notes:

26. Contractor is to provide and install the interface to SCADA system. Contractor is to provide and install (1) HOA Selector switch with (1) one auxiliary contact and lighting contactor(s) with (1) auxiliary contact. The HOA status contact should be closed when in AUTO mode. The contactor and HOA switch should be located in the lighting control panel.
27. Lighting contactor: For 277V, 20A contacts, 120V coil. Add to provide 20% spare contacts to WMATA at the end of project before final invoice submission.

**Drawing J03-S-301:**

- a. Replace wording 4/S-301 with 3/S-301.
- b. Replace wording 4/S-301 with “Type B Canopy Foundation”
- c. Please read details 5/S-301 for Type C Canopy Foundation Plan in lieu of Type B.

**Drawing J03-C-111:** Add note 10: “The contractor shall maintain existing grade and profile for sidewalk and have prior survey of existing sidewalk which requires removing and replacing, before start of work”.

**Drawing J03-C-106:** Add note 17: “The contractor shall replace word “removed” with “relocated as per WMATA instruction or shown on signing and marking plan” where there is a reference of existing signs”.

**Drawing J03-C-111:** Add note 11: The contractor shall replace word “removed” with “relocated as per WMATA instruction or shown on signing and marking plan” where there is a reference of existing signs.

**Drawing J03-C-113:**

- a. Add note 3: “The contractor shall contact WMATA Park department minimum 45 days in advance to provide notification to third part leased company for the relocation locker.”
- b. Add note 4: “Restripe the existing crosswalk and “Stop” text at the station entrance within the bus bay area”

**Add following notes to General Note for Standard Bus Shelter:**

Note 3: WMATA did not develop a prototype bus shelter for the design.

Note 4: Probable vendors with available contact information for Bus shelters are:

- Conceptual Site Furnishing  
Karl Danielson: karldanielson@aol.com  
Sina Seng: sina@conceptualsite.com
- Landscape Forms  
Barbara Nolan: barbara@barbaranolaninc.com  
Vince Kleyla: vincek@landscapeforms.com
- Environmental Site Furnishings  
Kevin Mahoney: kmahoney@esfbysigma.com
- All Purpose MFG. INC.  
Orlando Vargas: ovargas@apmfg.net
- Brasco Inc.  
www.brasco.com
- Columbia Equipment  
www.columbiaequipment.com
- Allied Metal Group

**Drawings J03-A100:** Add to note # 7 at the end of note: Maintain 4” pedestal at all Canopy Columns.

**Drawing J03-C112:** Detail A: Height specified on left side of wall section for hand rail shall be from top of sidewalk and not from top of wall and same is applicable to right side section.

5. Volume 6 Attachments - hereby amended to add “WMATA MANUAL OF DESIGN CRITERIA FACILITIES, SECTION 15”, Release 9 [Manual attached hereto]
6. ATTACHED FOR REFERENCE – WMATA 4-29-15 Office of Parking drawing; Instructions for staging area and location (highlighted) at the job-site. [Referenced drawing attached hereto]

Invitation for Bid (IFB) – FQ15155

Date of Issue: April 9, 2015

Bidders are required to acknowledge receipt of this Amendment on the forms in the Solicitation. Failure to acknowledge all amendments may cause the proposal to be considered not responsive, which would require rejection of the Bid.

*William J. Geroux*

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William J. Geroux  
Contract Administrator  
Office of Procurement and Materials  
Washington Metropolitan Area Transit Authority

Attachments

## Section 00300

### INFORMATION AVAILABLE TO BIDDERS

This Section includes information made available to the Bidders.

#### 00301 INVITATION FOR BID (IFB) DOCUMENTS

- A. The IFB Documents, including General Conditions, Supplementary Conditions, General Requirements, Specifications, Drawings, reports, safety and security requirements, and quality requirements of this Invitation FQ15155 as referenced in this Section establish requirements for the construction of the Project. These IFB Documents shall be used by the Bidder to prepare the Bid.

#### 00302 GENERAL CONDITIONS, SUPPLEMENTARY CONDITIONS, AND GENERAL REQUIREMENTS

- A. The General Conditions, Supplementary Conditions, and General Requirements (Division 1 of the Contract Specifications) contain requirements for the administration and construction of the Project.

#### 00303 CONTRACT SPECIFICATIONS

- A. Specifications (Division 2 through 16 of the Contract Specifications) are the parts of the Contract Documents containing written directions or requirements that specify the requirements, which must be fulfilled for the completion of the Work.
- B. The WMATA Manual of Design Criteria establishes general design criteria for the Project that shall govern the design of temporary works as defined in the Specifications unless jurisdictional codes and regulations are more stringent, in which case the codes and regulations shall govern.

#### 00304 CONTRACT DRAWINGS

- A. Contract Drawings are the plans, profiles, typical cross sections, general cross sections, elevations, schedules, and details listed or included in the Contract Documents, which represent requirements for the Project.
- B. The WMATA CAD Manual shall be adhered to for preparation of As-built Drawings by the Contractor.

#### 00310 EXISTING CONDITIONS

- A. The Bidder shall conduct a site visit to familiarize itself with the site prior to submitting a Bid. The Authority will make the Site(s) available to the Bidder for this purpose.

**00320 GEOTECHNICAL REPORT**

Geotechnical Report for WMATA Springfield – Franconia Bus Canopy Project Springfield, VA  
Prepared for Gannett Fleming/Parsons Joint Venture (GFP) 100 M Street SE Washington, DC  
20003 by HAS, Inc. 1818 New York Avenue N.E., Suite 106 Washington, DC 20002 Project No. 11-  
103W October, 2014

**00330 ENVIRONMENTAL REPORT [N/A]**

**00340 WMATA SAFETY AND SECURITY REQUIREMENTS**

- A. This Section lists the safety and security related documents that establish the safety requirements for the Project.
  - 1. WMATA Construction Safety and Environmental Manual Requirements: A compilation of the safety and reporting requirements for this Project.
  - 2. WMATA Safety and Security Certification Program Plan: A compilation of the safety and security certification requirements for the Project.

**00350 QUALITY ASSURANCE AND QUALITY CONTROL**

- A. Section 01470, QUALITY MANAGEMENT SYSTEM, establishes the quality requirements for the development of the Quality Management Plan by the Contractor for execution of the Project.

END OF SECTION



# HSA, Inc.

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## GEOTECHNICAL REPORT

FOR

**WMATA SPRINGFIELD - FRANCONIA BUS CANOPY PROJECT  
SPRINGFIELD, VA**

PREPARED FOR

**GANNETT FLEMING/PARSONS JOINT VENTURE (GFP)  
100 M STREET SE  
WASHINGTON, DC 20003**

BY

**HSA, Inc.  
1818 NEW YORK AVENUE N.E., SUITE 106  
WASHINGTON, DC 20002  
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**PROJECT NO. 11-103W**

**OCTOBER, 2014**

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# HSA, Inc.

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October 30<sup>th</sup>, 2014

Mr. Gerald P. Maragos, P.E.  
Sr. Project Manager, Site Development Group  
Gannett Fleming/Parsons Joint Venture (GFP)  
100 M Street SE  
Washington, DC 20003

Re: Geotechnical Engineering Services  
WMATA Industrial Road Project  
Springfield, VA  
HSA Project No. 11-103W

Dear Mr. Maragos:

HSA has completed the study for the WMATA Springfield - Franconia Bus Canopy Project located in Springfield, VA. The work was performed in general accordance with our proposal dated May 22<sup>nd</sup> 2014 and GFP Task Order: 14-FQ10060-BLPN-06. Presented herein and attached is a summary of our investigation along with our conclusions and geotechnical recommendations for the proposed construction.

We wish to advise you we will store the soil samples obtained from the test borings for a period of sixty (60) days from the date of this letter, after which time the samples will be discarded, unless other disposition is requested.

We appreciate the opportunity to have been of service on this project. If there are any questions related to the information contained within this report, please call us.

Thank you,

Harish Senapathy  
HSA, Inc.

# HSA, Inc.

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## **TABLES**

Table 1 – Exploration Summary

Table 2 – Summary of Field and Laboratory Test Results

Table 3 – Engineering Properties of Soil

## **FIGURES**

Figure 1 – Site Vicinity Map

Figure 2 – Boring Location Plan

Figure 3 – Site Geology

Figure 4 – SPT versus Depth

Figure 5 – Atterberg Limits and Moisture Content versus Depth

Figure 6 – Active Lateral Pressures – Drained Condition

Figure 7 – Active Lateral Pressures – Undrained Condition

## **APPENDIX**

- Boring Logs
- Laboratory Test Results

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## **I. INTRODUCTION**

This report presents the results of the geotechnical investigation conducted for the WMATA Springfield - Franconia Bus Canopy Project located at a WMATA Springfield – Franconia Metro Station at Springfield, VA. The site is located on the west side of Frontier Dr., 150 feet east of the Springfield-Franconia Metro (See Figure 1 – Site Vicinity Map). The work was performed for Gannett Fleming/Parsons Joint Venture (GFP) out of Washington, DC in general accordance with our proposal dated May 8, 2014 and GFP Task Order: 14-FQ10060-BLPN-06.

## **II. PROJECT AND SITE DESCRIPTION**

The proposed scope of work includes completion of the final detailed design and development of the project, based on the concept developed to address bus terminal capacity, bicycle/pedestrian access, and safety and access improvements at Franconia-Springfield Metro Rail Station. Therefore, the base scope is for a geotechnical exploration related to the support of a pre-engineered open concept bus canopy system, cantilevered retaining wall and pavement design. Currently there exists concrete paved sidewalk within the project limits. Refer to Figure 2: Boring Location Plan for site specific information.

Based on information provided by GFP, the following are the estimated maximum foundation loads:

- Maximum compression (downward) load = 17 kips
- Maximum uplift (upward) load = 12 kips
- Maximum lateral load = 3 kips
- Maximum bending moment = 11 kip-ft

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At the time of this report preparation, there was no Project specific traffic data available. In accordance with GFP directions, the pavement section will be based on Section 12.28 "Entrance/Exit Roadways and Bus Areas" of WMATA Manual of Design Criteria (Reference 5). The following requirements are provided in the manual:

- 12.28.3.1 – WMATA pavement sections are based on a CBR value of 9. If the local soils do not meet this strength requirement, the Section Designer shall either devise a construction method to improve soil subgrade to CBR-9 or provide a new pavement design.
- 12.28.4 – Pavement – Design shall be based upon a 20-year design period, a maximum peak-hour frequency of 200 buses and an AASHTO equivalent single axle loading of 25,000 pounds. All bus areas shall be concrete pavement. The minimum total pavement thickness shall be as shown on the Civil Standard Drawings.

WMATA's Civil Standard Drawing No. ST-C-017 (Reference 6) shows the typical pavement section of Entrance Roadways and Bus Areas as:

- 10" Reinforced Concrete Pavement with welded wired fabric 6x6 – W 2.9 x 2.9
- 5" Aggregate Base
- Subgrade CBR of 9 or higher.

### **III. PURPOSE AND SCOPE**

The scope of our services included drilling nine (9) borings at locations showed Figure 2- boring location plan to characterize the existing subsurface conditions. Due to traffic closure concerns, none of the borings were drilled in the existing roadway areas. The report provides assessment of the existing subsurface conditions and foundation and earthwork recommendations. The proposed foundation type for the open concept

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canopy structures is strip footings. The east end of the canopy system will require cantilever retaining walls due to the grade of the existing site.

## **IV. FIELD INVESTIGATION**

The field investigation was conducted from June 10<sup>th</sup> to June 13<sup>th</sup> of 2014. A total of nine (9) borings for the proposed area (B-101 to B-109) were drilled at the locations shown on Figure 2 - Boring Location Plan. Table 1 provides a summary of the borings coordinates and surface elevations.

The borings were advanced to depths of 25 to 35 feet. The borings were drilled using a truck mounted drill rig. The boreholes were advanced using hollow stem augers. Standard penetration tests were conducted and split spoon samples were obtained in the borings at depth intervals of 2.5 feet in the upper 10 feet, and at depth intervals of 5 feet thereafter. A representative portion of each sample was placed in an airtight glass jar, and was appropriately marked. Bag samples were obtained in the upper five feet from four borings. At completion groundwater levels and cave-in depths were obtained, the borings were backfilled with drill cuttings and the surface was patched using cold patch.

## **V. LABORATORY TESTING**

All samples were visually classified in the laboratory by a geologist/engineer to corroborate and/or modify the field classifications. Selected soil samples were tested for their natural water content, Atterberg Limits and grain size. Modified Proctor tests and California Bearing Ratio (CBR) tests were conducted on two (2) bag samples. All tests were conducted in accordance with ASTM procedures. The results of the laboratory tests are included in the Appendix and summarized in Table 2.

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## **VI. GEOLOGY**

The USGS geological map of Virginia (Reference 1) indicates that the site is located western edge of the Coastal Plains very close to the Fall Line dividing the Piedmont Physiographic Province and the Coastal Plain Deposits (see Figures 3). Below man-made fills, the on-site materials consist of alluvial soils of the Coastal Plain Deposits. The soils of the Coastal Region are of the Cretaceous age consisting of the Patapsco formation underlain by Occoquan Granite of the Piedmont formation.

## **VII. SUBSURFACE CONDITIONS**

The boring logs included in the Appendix contain details related to the subsurface conditions encountered at the test boring locations. It should be noted that stratification lines shown on the boring logs represent approximate transitions between material types. Strata changes can occur gradually or at different levels than those shown on the boring logs, and the logs depict conditions at the specific locations and depths at the time of our subsurface exploration program.

At ground surface at all the boring locations, there exists 4 to 6 inches of concrete pavement underlain by about 1 to 2 inches of granular base material. Below the concrete pavement, from ground surface to the depths explored the subsurface conditions can be divided into three major strata as described below.

### *Stratum I – Existing FILL.*

A layer of FILL material consisting of brown/tan/reddish brown SAND with varying proportions of silt, clay and gravel was encountered in all the borings. The FILL layer extends to a depth of about 8 feet to 17 feet below existing grade



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at the boring locations. The FILL is generally thicker to the west and thinner to the east of the project location. The FILL material is similar to the in-situ material and therefore the distinction between fill and natural soil is not always very clear. The standard penetration resistance (SPT) N-values ranged from 2 blows per foot (BPF) to 36 BPF with a median value of 11 BPF. The natural moisture content varied from 6% to 27% with a median value of about 14%. (See Figure 4 – SPT vs Depth and Figure 5 - AL, MC vs. Depth)

## *Stratum II: Silty SAND with Silty Clayey SAND (SM, SC-SM)*

Below the FILL layer there is a layer of brown/tan/grey brown silty SAND with varying amounts of clay. In some areas the soil classifies as Sandy CLAY. This stratum extends to below the bottom of the boreholes at 25 feet to 35 feet below existing grade. In the lower portions the soil is more micaceous and contains weathered rock fragments. The standard penetration resistance (SPT) N-values ranged from 5 BPF to more than 32 BPF with a median value of about 13 BPF. The Silty SAND generally classifies as a SM material with some SC, ML and CL. The natural moisture content varies from 6% to 32% with a median value of 23 %. (See Figure 4 – SPT vs Depth and Figure 5 AL, MC vs. Depth)

## *Groundwater*

Groundwater levels were monitored during drilling and at completion. Groundwater was noted in all borings. The depth to observed groundwater varied from 15 feet to 29 feet. In elevation the groundwater level varied between El. 163.8 feet and El. 173.8 feet with a median of El. 169.7 feet. Most of the borings caved in at completion. Fluctuations of the water table, or the presence of a perched water level above less permeable soil

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layers, may occur depending upon the amount of precipitation and local surface development. For design, the recommended groundwater level is El. 173 feet.

## **VIII. ENGINEERING PROPERTIES OF SOIL**

Static engineering properties of the subsurface soils were estimated using methods outlined in References 2 and 3. A summary of engineering properties of the various soil strata is shown in Table 3.

## **IX. EVALUATION AND RECOMMENDATIONS**

The recommendations included in this report are based on our understanding of the proposed construction, the data obtained from the exploration, and our previous experience with similar subsurface conditions and projects. If there are any significant changes to the project characteristics, such as revised foundation loads differing significantly from those noted in the Project Description section, building location, finish grade elevations, etc., HSA should be advised so the recommendations of this report can be re-evaluated.

### **A. Earthwork**

#### **i) Site Preparation**

Prior to placement of fill in any pavement areas, all existing pavement materials should be broken and removed. Frozen or wet, excessively soft or loose soils and other deleterious materials should be removed and wasted.

The borings indicate the presence of fill at the site. After demolition of the existing pavement and excavation has been completed to the bottom of the

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proposed pavement and aggregate base, the exposed subgrade soils should be inspected by the Geotechnical Engineer or their approved representative. The subgrade should be proof-rolled utilizing a heavily-loaded dump truck or other pneumatic tired vehicle of similar size and weight. The purpose of proof-rolling is to locate any isolated areas of soft or loose soils requiring undercutting. All areas that “pump” or appear to be soft during proof-rolling should be undercut and replaced with compacted structural fill. Proof-rolling is not advised in wet areas which may deteriorate under repeated vehicular loading. Wet areas should be drained and allowed to dry prior to proof-rolling.

Precipitation may result in standing water in low areas. If the water is allowed to pond, the natural soils may deteriorate and over-excavation or subgrade improvement may be necessary in those areas. The subgrade should be graded to prevent ponding of water.

## **ii) Fill Selection, Placement and Compaction**

It is recommended that all materials to be used as structural fill be tested and approved by the Geotechnical Engineer prior to use. Acceptable borrow material should include SW, GW, SP, GP, GM and SM (with less than 20% fines) soils classified in accordance with the USCS system. In wet weather conditions, high quality, granular material that are not susceptible to moisture conditioning such as sand, gravel or sand/gravel mixtures should be used as structural fill.

All structural fill should be placed in maximum loose lifts of 8 inches and compacted to at least 95% of Modified Proctor Density (ASTM D1557). The water content of the soils at the time of placement and compaction should be within 3% of optimum moisture content for that soil. Fill in non-structural areas

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(landscape areas), where settlement is not of concern, may be compacted to 85% of Modified Proctor Density.

The proof-rolling and fill compaction operations should be extended at least five feet beyond the pavement limits. A sufficient number of in-place density tests should be performed by an engineering technician to verify that the proper degree of compaction is being obtained in all fill soils.

## **B. Foundations**

For satisfactory performance, the foundation of any structure must satisfy two independent design criteria. First, it must have an acceptable factor of safety against bearing failure in the foundation soils under maximum design load. Second, the settlements during the life of the structure must not be of a magnitude that will cause structural damage or impair the operational efficiency of the facility. Selection of the foundation type to satisfy these criteria depends on the nature and magnitude of dead and live loads, the base of the structure, and the settlement tolerances. Where more than one foundation type satisfies these criteria, then cost, scheduling, material availability, and local practice will probably influence or determine the final selection of the type of foundation.

*Bus Canopy Structure:* As described previously under "Subsurface Conditions", there is about 8 feet to 17 feet of existing fill under the entire site. The FILL is generally thicker to the west and thinner to the east. Due to the variable nature of the existing fill it is not considered suitable to support building foundations. Therefore it is recommended that the proposed foundations for the building extend below the existing fill. The estimated maximum building loads are 17 kips in compression, 12 kips in uplift, 3.2 kips lateral and 11 kip-ft in bending.

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Considering these factors it is recommended that the proposed building be supported on short piers extending below the existing fill material.

Based on the subsurface conditions and foundation loads of 17 kips compression and 12 kips uplift, it is recommended that the building columns be supported on 16-inch diameter, 20 feet long drilled concrete piers. The piers can be terminated at a shallower depth if drilling refusal is encountered before reaching a depth of 20 feet but in no case the length of the pier shall be less than 15 feet. Axial capacities of the piers were estimated based on the FHWA method (Reference 4). The allowable bearing capacity was calculated with a factor of safety of 3 applied to the estimated end bearing and 2 applied to the estimated ultimate skin friction. The allowable uplift capacities were calculated with a factor of safety of 2 for the skin friction to resist uplift, and no reduction of effective pile weight. The estimated pile length is from existing ground surface.

Lateral load versus deflection was estimated using the procedures provided in References 7, 8 and 9. The allowable lateral force is one-half the lateral force which will cause a 1 inch deflection at the pile top. The piles are assumed to be "free head" piles. The recommended allowable lateral load for the 16-inch pile is 5 kips. For piles in a group with center-to-center spacing less than six pile diameters (6D) there will be a reduction in lateral load capacity due to group effect. For the applied maximum load of 3.2 kips and 11 kip-ft bending moment, the estimated pile top deflection is less than 0.2 inches and the estimated maximum bending moment in the pile is 20 kip-ft.

*Retaining Wall:* Information from Project Engineering indicates that the retaining wall is generally in the eastern portions of the site where the FILL thickness is

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about 8 feet. The estimated maximum height of the retaining wall is 10 feet. The following options are recommended for retaining walls:

- Construct a flexible retaining wall system such as a mechanically stabilized earth (MSE) wall. These walls can be founded at a nominal depth of 30 inches below exterior grade for frost protection. The walls must be designed to accommodate settlement due to compression of the existing FILL.
- Construct a cantilevered reinforced concrete retaining wall. The existing FILL material is not suitable to support these walls. It is recommended that the wall foundations be lowered to at least two feet into the natural soil below the existing FILL. This will generally place the bottom of foundation at about El. 180 feet. The foundation may be sized using an allowable bearing pressure of 3,000 psf. The estimated maximum settlement is less than 1 inch.

## **C. Pavement**

As mentioned earlier, soaked California Bearing Ratio (CBR) tests were performed on two (2) bag samples obtained from the site. The CBR value obtained in borings B-102 and B-107 were 2.8 and 21.9, respectively. The CBR and Proctor test results are included in the Appendix. Due to the variable nature of the existing fill material, the pavement design using the on-site subgrade material must be based on a CBR value of 3.

As mentioned previously, WMATA's Civil Standard Drawing No. ST-C-017 (Reference 6) gives the typical pavement section of Entrance Roadways and Bus Areas as:

- 10" Reinforced Concrete Pavement with welded wired fabric

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6x6 – W 2.9 x 2.9

- 5" Aggregate Base

The above section is based on a subgrade CBR of 9 or higher. WMATA'S Manual of Design Criteria states "If the local soils do not meet this strength requirement, the Section Designer shall either devise a construction method to improve soil subgrade to CBR-9 or provide a new pavement design."

Using a CBR value of 3, the recommended pavement section is:

- 11.5" Reinforced Concrete Pavement with welded wired fabric  
6x6 – W 2.9 x 2.9
- 5" Aggregate Base

As an option, the subgrade soils shall be improved to meet the CBR requirement of 9. A few options to improve the subgrade are listed below:

- Option 1: Excavate 18 inches of subgrade material below the bottom of the proposed pavement and replace it with compacted dense graded aggregate with a CBR of 9 or higher.
- Option 2: Modify the top 12 inches of the subgrade material with cement. A mix design must be performed in an accredited lab to determine the amount of cement needed for subgrade modification. Typically 3% to 5% of cement is required.
- Option 3: Use geogrids to reinforce the subgrade and increase the equivalent CBR value of the subgrade.

Considering the size and scope of this Project, ground modification Option 1 above with WMATA's standard pavement section is the preferred option.

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## D. Lateral Pressure on Retaining Walls

Retaining walls in cut and in fill are planned around the site. Since the walls are free to rotate at the top, they will be subject to active lateral pressures. It is our understanding that construction of the retaining walls in cut will require a 1H:1V or flatter excavation behind the wall.

Backfill: Backfill immediately behind retaining walls should be relatively clean, granular material containing less than 10 percent passing the No. 200 sieve (0.074 mm). In addition, the compaction behind these walls should be limited to 92 percent of the maximum dry density in accordance with ASTM D-1557. Since excessive compaction may cause damage to the walls, hand operated equipment should be used near the walls. The top 18 inches of backfill around the walls should consist of an impervious material such as Silty CLAY or Clayey SILT to minimize the intrusion of water into the ground in the vicinity of the structure. Design parameters for backfill behind retaining walls are provided in Table 3.

Surface Preparation: Additionally, to mitigate the buildup of water behind the below grade walls, it is recommended that the finish grade around the structures be sloped to drain away from the structure.

Lateral Pressure under Drained Condition: Hydrostatic pressure behind the wall can be relieved using a drainage system. For retaining walls a drainage tile and/or weep holes can be utilized to control hydrostatic head buildup behind the retaining wall.



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It is assumed that the existing soil behind the wall is excavated and backfilled with relatively clean granular fill material. For the drained condition, it is recommended that below grade structure walls be designed to resist an equivalent fluid weight of 37 pcf. Refer to Figure 6 for loading parameters in the active, drained condition.

*Lateral Pressures under Undrained Condition:* It is likely that during periods of heavy precipitation there will be significant ponding of water outside the walls of the below grade structures and behind retaining walls. If the ponded water behind the wall is not drained, and proper drainage is not provided behind the walls, the retaining walls will be subject to hydrostatic pressure.

It is assumed that the existing soil behind the wall is excavated and backfilled with relatively clean granular fill material. For the undrained condition, it is recommended that the retaining walls be designed to resist an equivalent fluid weight of 60 pcf. Refer to Figure 7 for loading parameters in the active, undrained condition.

*Surcharge Loads:* A lateral surcharge loading should be applied in wall designs to account for all construction and future traffic loading to be applied adjacent to the wall. The below grade wall will also be subject to lateral pressures due to any existing structures adjacent to the wall.

*Adjacent Structures:* As mentioned above, the below grade wall will be subject to lateral pressures due to any existing structures adjacent to the wall. If the excavation is near an existing structure and extends below the foundation bottom of the existing structure, the existing foundation should be located at a distance apart which is equal to or greater than the difference in the elevations of the

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existing foundation and the bottom of the excavation. If the existing foundation is nearer than this distance, a temporary excavation support system should be installed to prevent undermining the existing structure. The impact of the excavation on adjacent existing structures should be evaluated on a case by case basis by a geotechnical engineer.

## **E. Slopes**

Permanent slopes, if any, should not be constructed steeper than 2.5-horizontal to 1-vertical. All permanent slopes should be covered with topsoil and seeded. Additional erosion control measures may be required for drainage channels and areas expected to encounter heavy runoff.

Fill to be placed on an existing slope steeper than 5-horizontal to 1-vertical for new slope construction should be stepped into the existing slope.

Temporary excavations for foundations and other structures can be made with conventional earth moving equipment. For excavations less than 4 feet deep, the cuts can be as steep as possible. For excavations more than 4 feet deep the excavations should be no steeper than 1H:1V. A 10-foot wide bench should be provided for every 20 feet of vertical excavation. If an open excavation is not feasible due to area limitations or due to economic considerations, then a temporary lateral support system should be designed and installed to support the sides of the excavation. All excavation and trenching operations should comply with OSHA and local health and safety regulations.

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## **F. Seismic Site Characterization**

Based on the subsurface conditions encountered in the borings, the local subsurface stratigraphy at the Project site is Site Class "D" in accordance with IBC-2006, Section 1613.5.5 (Reference 10).

## **X. REPORT LIMITATIONS**

This report has been prepared solely and exclusively for Gannett Fleming / Parsons Joint Venture to provide guidance to design professionals in developing facilities plans for the WMATA Springfield – Franconia Bus Canopy Project located in Springfield, VA. This report is not intended for use by others, and the information contained herein is not applicable to other sites. The Consulting Engineer cannot be held accountable for any problems which occur due to the application of this report to other than its intended purpose.

The analyses and recommendations are, of necessity, based on the concepts made available to us at the time of the writing of this report, and on-site conditions, surface and subsurface conditions that existed at the time the exploratory borings were drilled. Further assumption has been made that the limited exploratory borings, in relation both to the areal extent of the site and to depth, are representative of conditions across the site.

## **XI. REFERENCES**

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## **TABLES**

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## **TABLES**

**TABLE 1. Exploration Summary**

Boring Number	Coordinates		Existing Elevation (ft)	Boring Depth (ft)	Water Depth (ft)	Water El. (ft)	Fill Depth (ft)	Bot Fill Elevation (ft)
	Longitude	Latitude						
BH 101	2,378,995.7	403,252.7	189.0	35	23.5	165.5	7.0	182.0
BH 102	2,379,108.1	403,247.7	187.7	25	23.5	164.2	16.0	171.7
BH 103	2,379,224.8	403,271.2	188.3	25	14.5	173.8	16.0	172.3
BH 104	2,379,327.5	403,286.0	189.2	25	17.75	171.4	16.0	173.2
BH 105	2,379,430.1	403,300.8	190.0	35	24.5	165.5	16.0	174.0
BH 106	2,379,520.2	403,315.7	190.5	25	17.8	172.7	8.0	182.5
BH 107	2,379,607.5	403,335.4	191.2	25	17.8	173.4	8.0	183.2
BH 108	2,379,684.7	403,384.8	191.5	25	23.5	168.0	8.0	183.5
BH 109	2,379,799.9	403,422.9	192.3	35	28.5	163.8	8.0	184.3

NOTES:

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**TABLE-2: SUMMARY OF FIELD AND LABORATORY TEST DATA**

BORING NO	SAMPLE NO	DEPTH* (FEET)	SPT $N_{60}$ -Value (blf)	NATURAL MOISTURE CONTENT(%)	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)	GRAIN SIZE DISTRIBUTION			STANDARD PROCTOR		CBR AT 95% MDD	USCS CLASSIFICATION
								GRAVEL (%)	SAND (%)	SILT/CLAY (%)	OPTIMUM MOISTURE (%)	MAXIMUM DRY DENSITY (PCF)		
BH-101	S-1	1.0	2.5	9	10.6									FILL
	S-2	3.5	5.0	23	9.9									FILL
	S-3	6.0	7.5	36	6.1									FILL
	S-4	8.5	10.0	18	10.7	34	21	13						FILL
	S-5	13.5	15.0	13	12.4									SC
	S-6	18.5	20.0	12	26.3									SM
	S-7	23.5	25.0	13	25.0									SM
	S-8	28.5	30.0	21	23.6				0.3	60.4	39.3			SM
	S-9	33.5	35.0	24	25.3									SC-SM
BH-102	S-1	1.0	2.5	11	24.4									FILL
	S-2	3.5	5.0	8	18.0									FILL
	S-3	6.0	7.5	3	12.7									FILL
	S-4	8.5	10.0	2	21.2	35	23	12						FILL
	S-5	13.5	15.0	5	19.1									FILL
	S-6	18.5	20.0	7	19.7	38	20	18	15.6	33.7	50.7			CL
	S-7	23.5	25.0	12	25.7									SM
	BAG	1.0	10.0								8.4	125.7	2.8	BAG
BH-103	S-1	1.0	2.5	11	7.8									FILL
	S-2	3.5	5.0	10	11.9									FILL
	S-3	6.0	7.5	13	12.3	47	26	21						FILL
	S-4	8.5	10.0	10	16.5									FILL
	S-5	13.5	15.0	4	15.9									FILL
	S-6	18.5	20.0	11	20.0									ML
	S-7	23.5	25.0	10	25.0				0.3	54	45.7			SM



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**TABLE 2: SUMMARY OF FIELD AND LABORATORY TEST DATA**

BORING NO	SAMPLE NO	DEPTH* (FEET)	SPT N <sub>m</sub> -Value (blps)	NATURAL MOISTURE CONTENT(%)	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)	GRAIN SIZE DISTRIBUTION			STANDARD PROCTOR		CBR AT 95% MDD	USCS CLASSIFICATION
								GRAVEL (%)	SAND (%)	SILT/CLAY (%)	OPTIMUM MOISTURE (%)	MAXIMUM DRY DENSITY (PCF)		
BH-104	S-1	1.0	2.5	15	15.5									FILL
	S-2	3.5	5.0	11	17.4	37	28	9						FILL
	S-3	6.0	7.5	11	14.2									FILL
	S-4	8.5	10.0	9	16.5									FILL
	S-5	13.5	15.0	12	16.6									FILL
	S-6	18.5	20.0	29	5.9				20.3	45.8	21			SM
	S-7	23.5	25.0	26	22.8									SM
BH-105	S-1	1.0	2.5	11	13.1									FILL
	S-2	3.5	5.0	18	8.3									FILL
	S-3	6.0	7.5	6	18.1									FILL
	S-4	8.5	10.0	12	13.8									FILL
	S-5	13.5	15.0	4	21.3	54	32	22	14.2	53.1	32.8			FILL
	S-6	18.5	20.0	13	32.1				2.7	81.3	16.0			SM
	S-7	23.5	25.0	7	25.0									SC
	S-8	28.5	30.0	10	23.4									SM
	S-9	33.5	35.0	19	28.8									SM
BH-106	S-1	1.0	2.5	10	11.6									FILL
	S-2	3.5	5.0	7	15.1									FILL
	S-3	5.5	7.0	18	17.2									FILL
	S-4	8.5	10.0	16	24.6	53	37	16						ML
	S-5	10.0	11.5	16	22.6									SM
	S-6	15.0	16.5	12	13.9				19.7	58.9	21.4			SM
	S-7	20.0	21.5	25	9.3									SM
	S-8	23.5	25.0	9	29.6									SM

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**TABLE 2: SUMMARY OF FIELD AND LABORATORY TEST DATA**

BORING NO	SAMPLE NO	DEPTH* (FEET)	SPT N <sub>m</sub> -Value (bpf)	NATURAL MOISTURE CONTENT(%)	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)	GRAIN SIZE DISTRIBUTION			STANDARD PROCTOR OPTIMUM MOISTURE (%)	MAXIMUM DRY DENSITY (pcf)	CBR AT 95% MDD	USCS CLASSIFICATION
								GRAVEL (%)	SAND (%)	SILT/CLAY (%)				
BH-107	S-1	1.0 - 2.5	9	9.1										FILL
	S-2	3.5 - 5.0	11	14.9										FILL
	S-3	5.5 - 7.0	19	14.5	32	20	12							FILL
	S-4	8.5 - 10.0	20	18.8										SM
	S-5	13.5 - 15.0	10	14.1										SM
	S-6	18.5 - 20.0	18	11.1										SM
	S-7	23.5 - 25.0	11	25.4					0.0	54.8	45.2	9.0	131.6	21.9
	BAG													BAG
BH-108	S-1	1.0 - 2.5	9	9.2										FILL
	S-2	3.5 - 5.0	6	27.4	37	29	8							FILL
	S-3	6.0 - 7.5	19	11.4										FILL
	S-4	8.5 - 10.0	13	20.9										SM
	S-5	13.5 - 15.0	15	13.8										SM
	S-6	18.5 - 20.0	26	14.7				7.4	38.4	33.2				SM
	S-7	23.5 - 25.0	12	26.6				0	59.3	40.7				SC-SM
BH-109	S-1	1.0 - 2.5	16	8.9										FILL
	S-2	3.5 - 5.0	17	13.1										FILL
	S-3	6.0 - 7.5	9	14.3										FILL
	S-4	8.5 - 10.0	10	16.1				3.3	61.5	35.1				SC-SM
	S-5	13.5 - 15.0	5	13.4										SC-SM
	S-6	18.5 - 20.0	6	18.0										SC-SM
	S-7	23.5 - 25.0	13	24.2										SM
	S-8	28.5 - 30.0	21	23.6				0.4	66.7	32.9				SM
	S-9	33.5 - 35.0	32	19.8										SM

<b>Table 3. Engineering Properties of Soil<sup>(1)</sup></b>			
<b>Parameter</b>	<b>STRATUM</b>		<b>Granular Backfill behind Retaining</b>
	<b>Stratum I - Existing Fill</b>	<b>Stratum II - Silty SAND</b>	
USCS group symbol	-	SC/SM	SM/GM/SP/GP
Total unit weight (g) pcf	125	125	125
Natural moisture content, %	-	23	-
Atterberg Limits			
Liquid Limit (LL), %	-	-	-
Plastic Limit (PL), %	-	-	-
Plasticity Index (PI), %	-	-	NP
SPT N-value, bpf	8	13	-
Shear Strength			
Undrained shear strength ( $c_u$ ), ksf	-	0.0	0.0
Internal friction angle ( $\phi$ ), degrees	-	34	34
Elastic modulus (high strain) ( $E_s$ ), ksf	-	468	-
Coefficient of Sliding ( $\phi$ ) <sup>(2)</sup>	-	0.35	0.35
Poisson's ratio ( $\mu$ )	-	0.35	0.35
Static earth pressure coefficients			
Active ( $k_a$ )	0.5	0.28	0.28
Passive ( $k_p$ )	2.0	3.54	3.54
At-rest ( $k_o$ )	0.5	0.47	0.47

**Notes.**

1. The values tabulated above are for use as a design guideline only. Reference should be made to specific boring and laboratory test results for appropriate modifications at specific design locations.
2. Values are for coefficients of sliding or friction between mass concrete and the various soil types.

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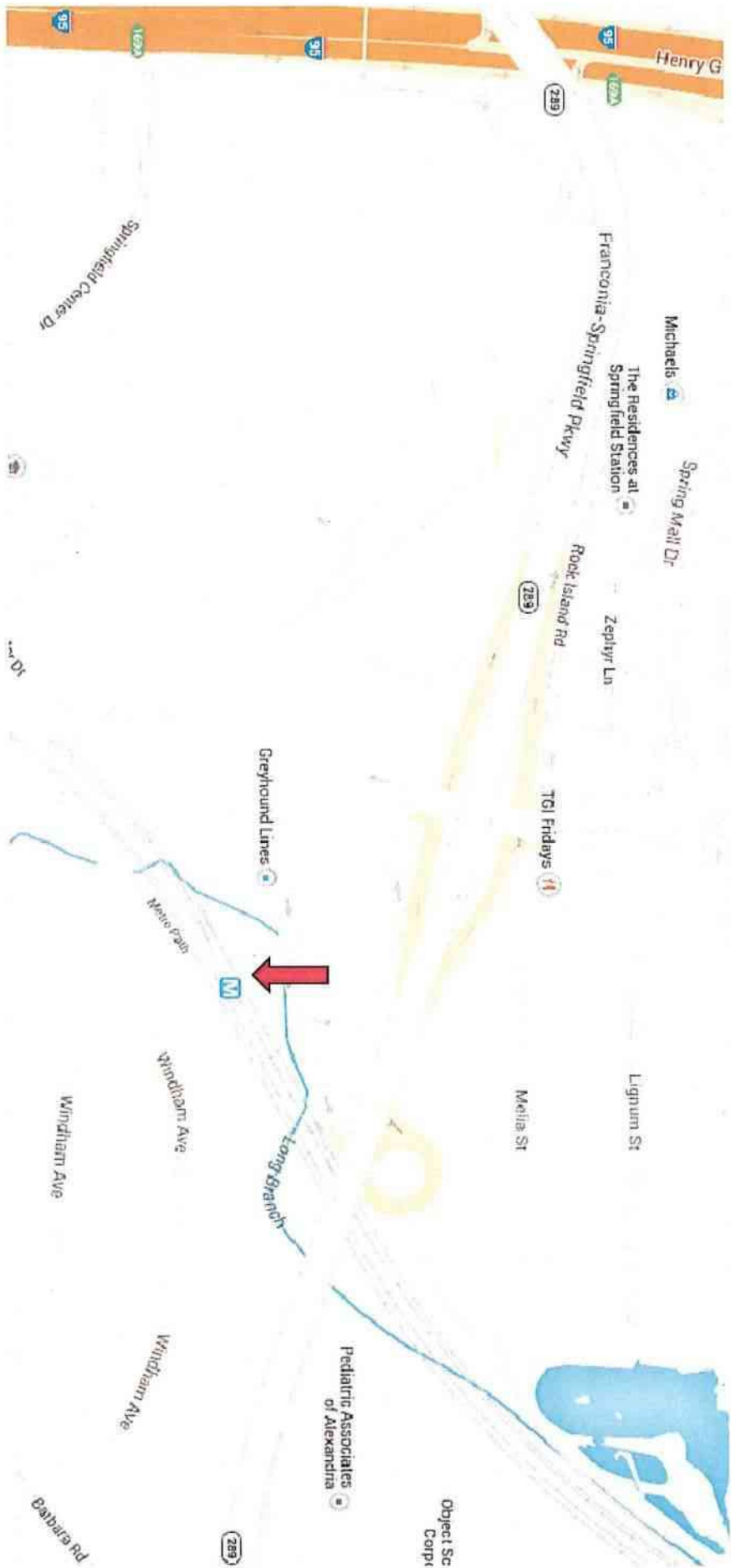
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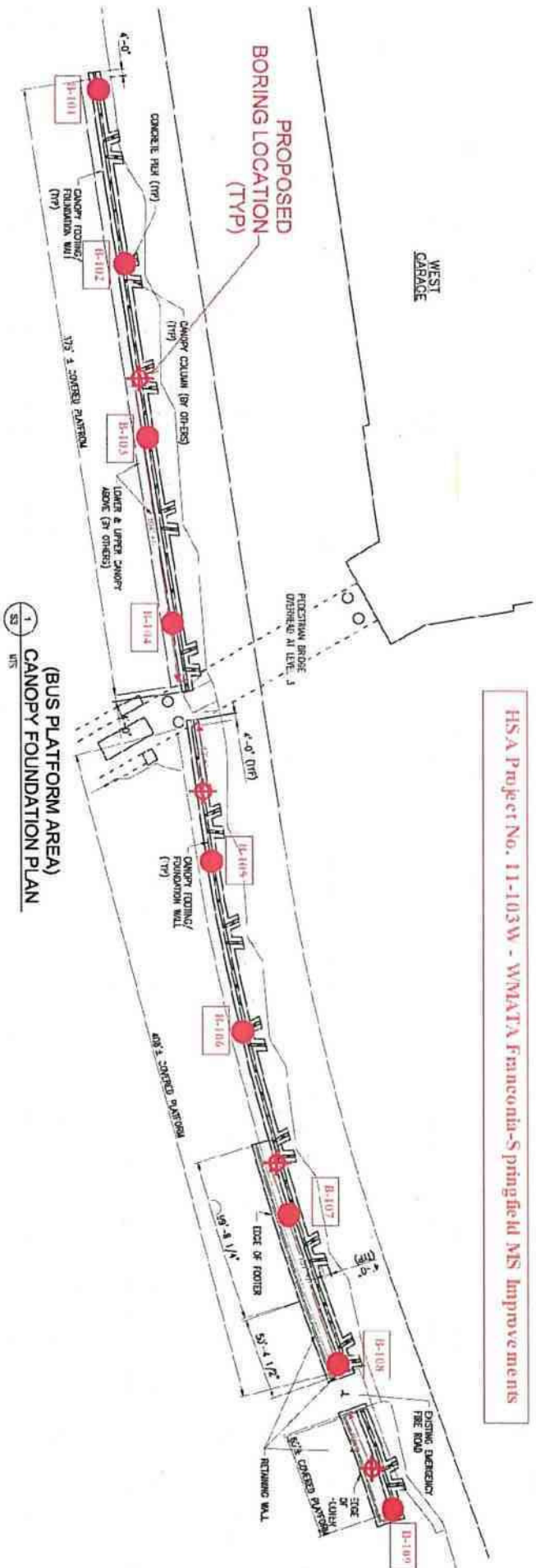
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## FIGURES



Reference: Google Maps

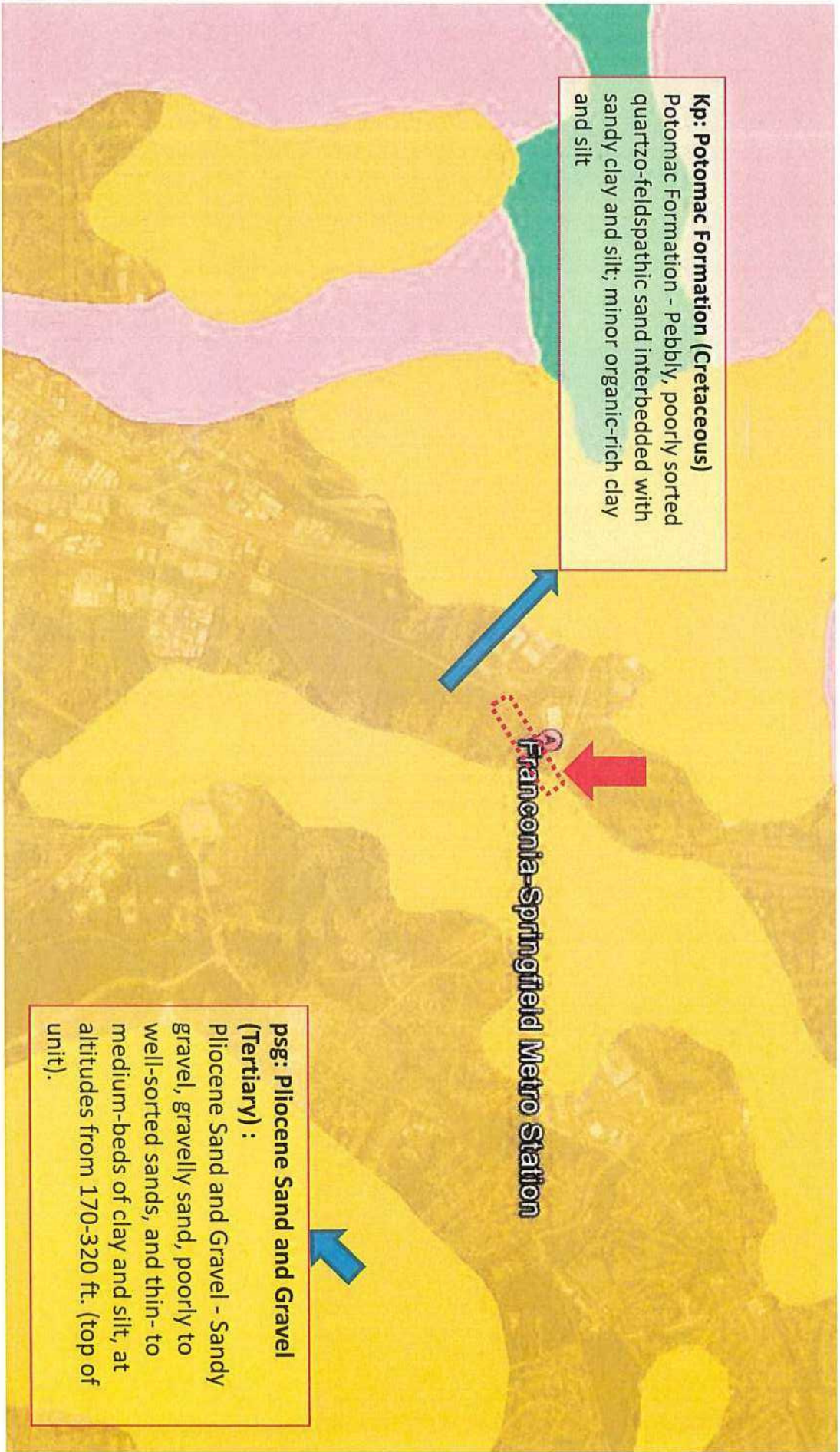
<b>HSA, Inc.</b>	
<b>WMATA Springfield - Franconia Bus Canopy</b>	
<b>Site Vicinity Map</b>	
<b>11-103W</b>	<b>Figure 1</b>



HSA Project No. 11-103W - WMATA Franconia-Springfield MS Improve ments

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WMATA Springfield - Franconia Bus Canopy	
Boring Location Plan	
11-103W	Figure 2

Reference: Google Maps



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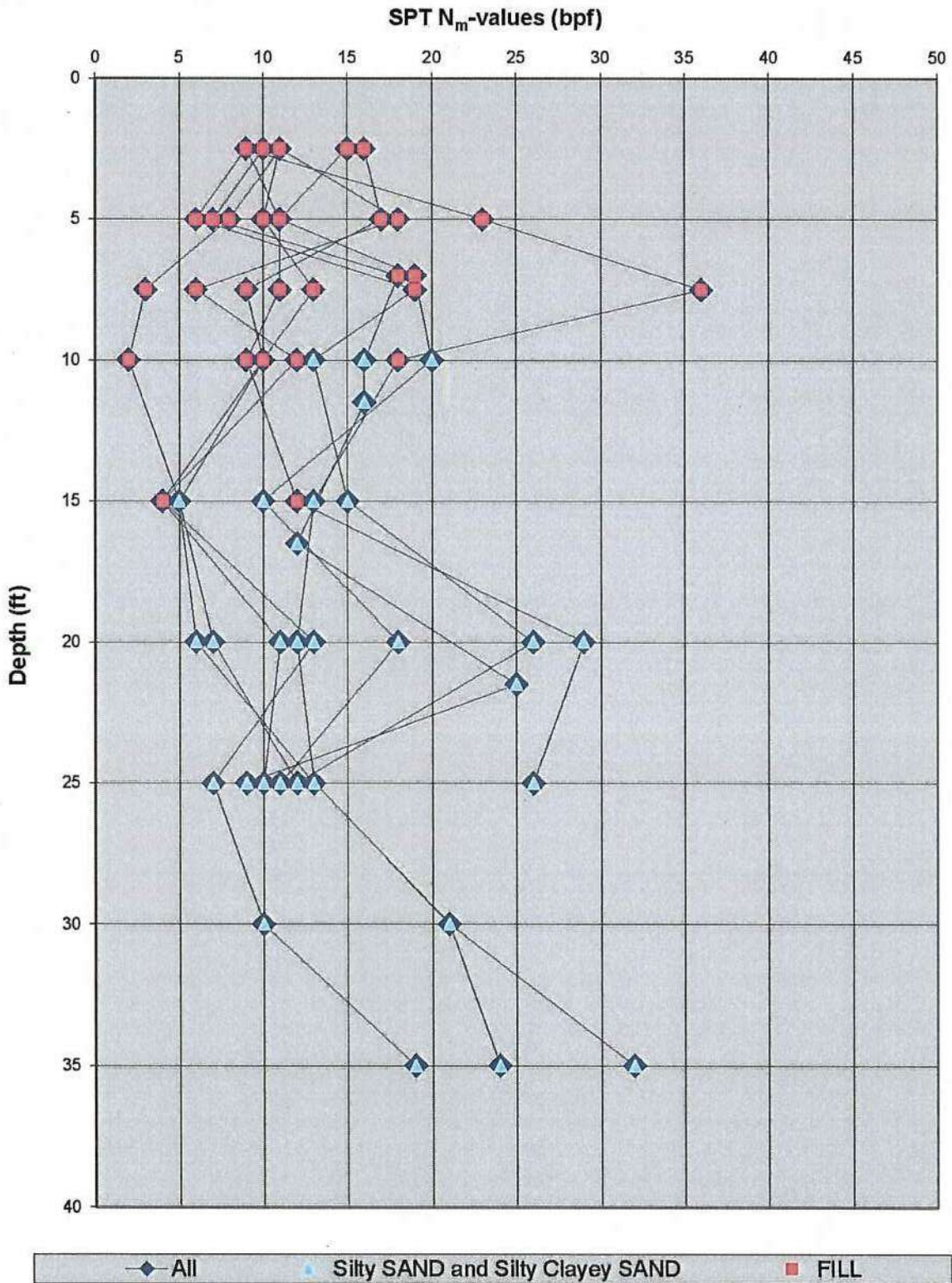
WMATA Franconia-Springfield Metro Station Bus Canopy Project

Site Geology Map

11-103W

Figure 3

**Figure 4 - SPT  $N_m$ -Values vs. Depth**



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WMATA Franconia – Springfield  
Bus Canopy Project

SPT vs. Depth

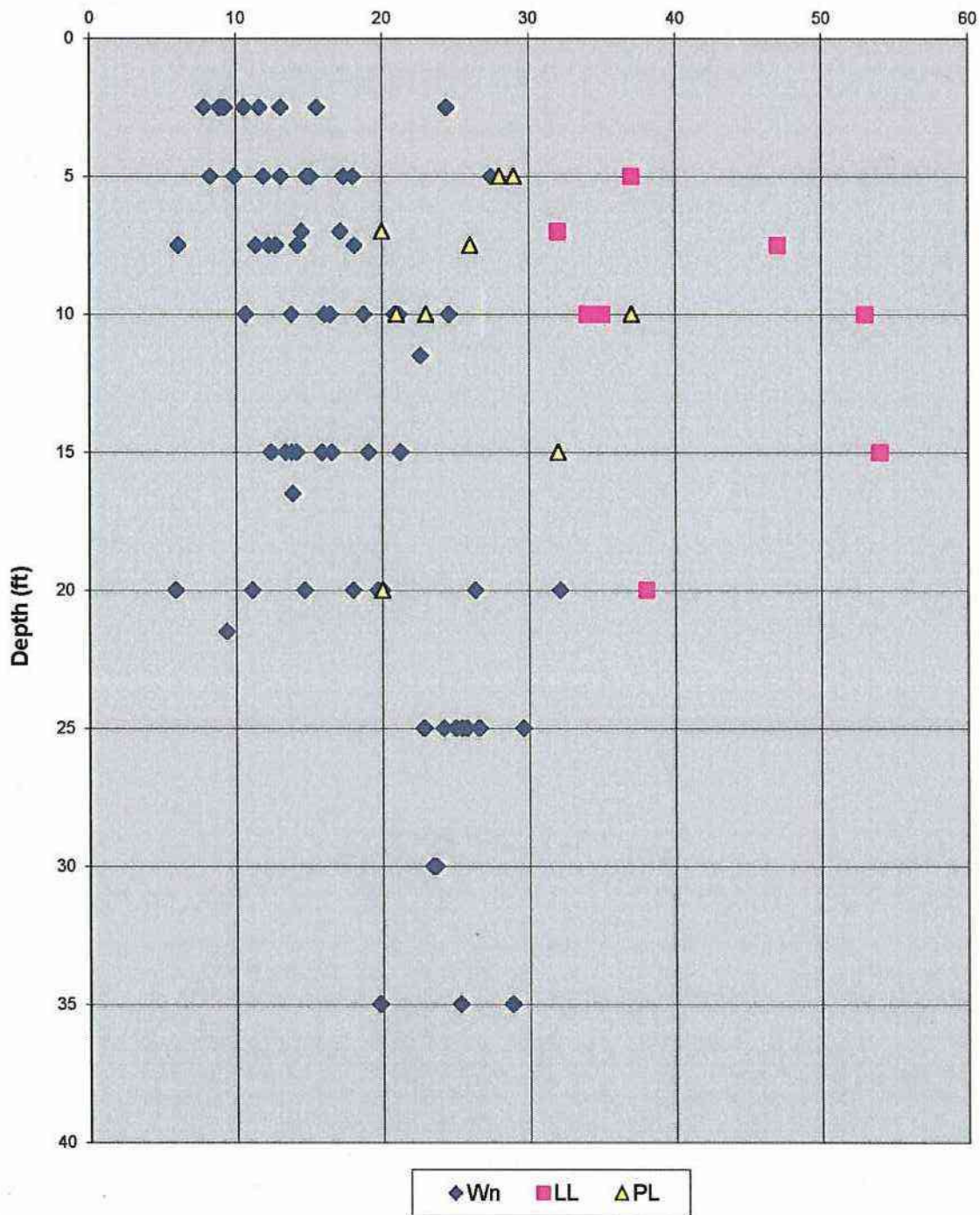
11-103W

Figure 4



Figure 5 - AL and Moisture Content vs. Depth

AL, Moisture Content (%)



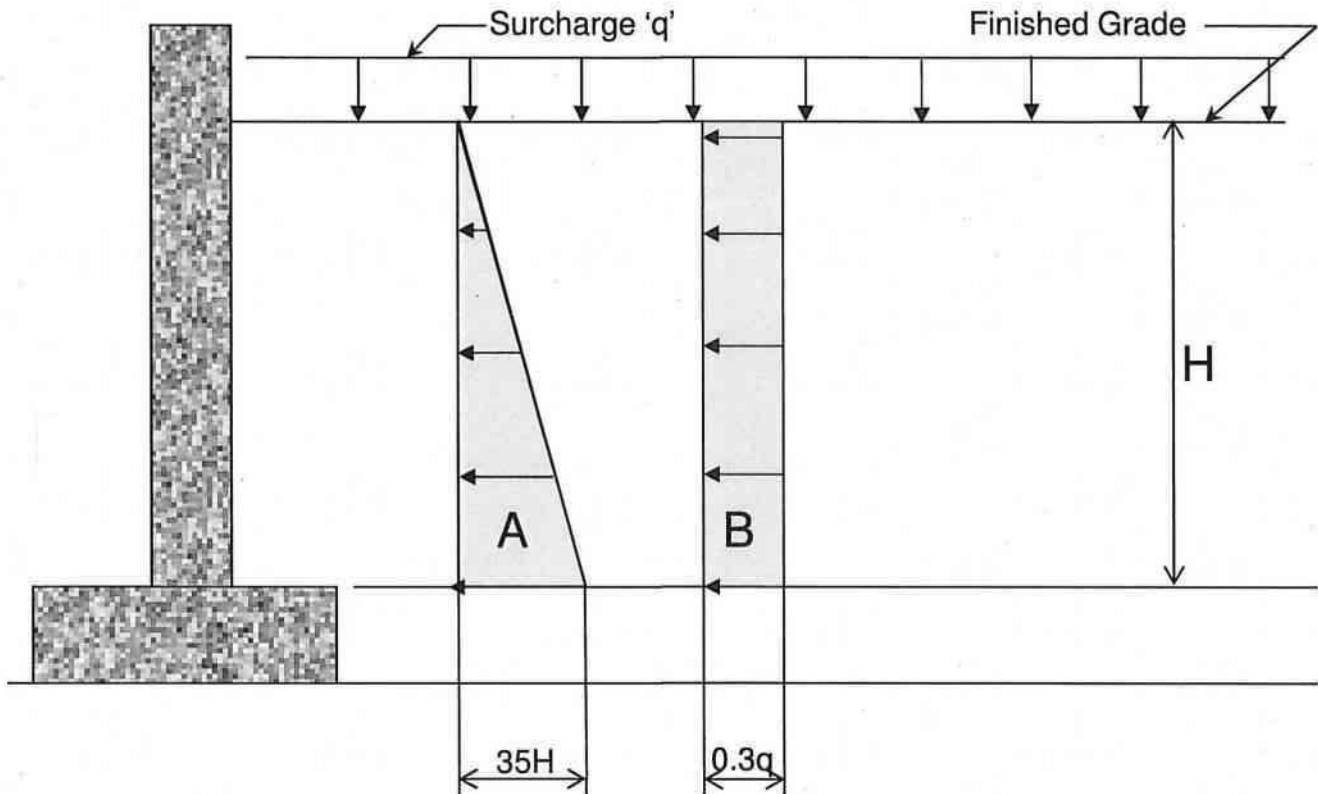
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WMATA Franconia Springfield  
Bus Canopy Project

Atterberg Limits and  
Moisture content vs Depth

11-103W

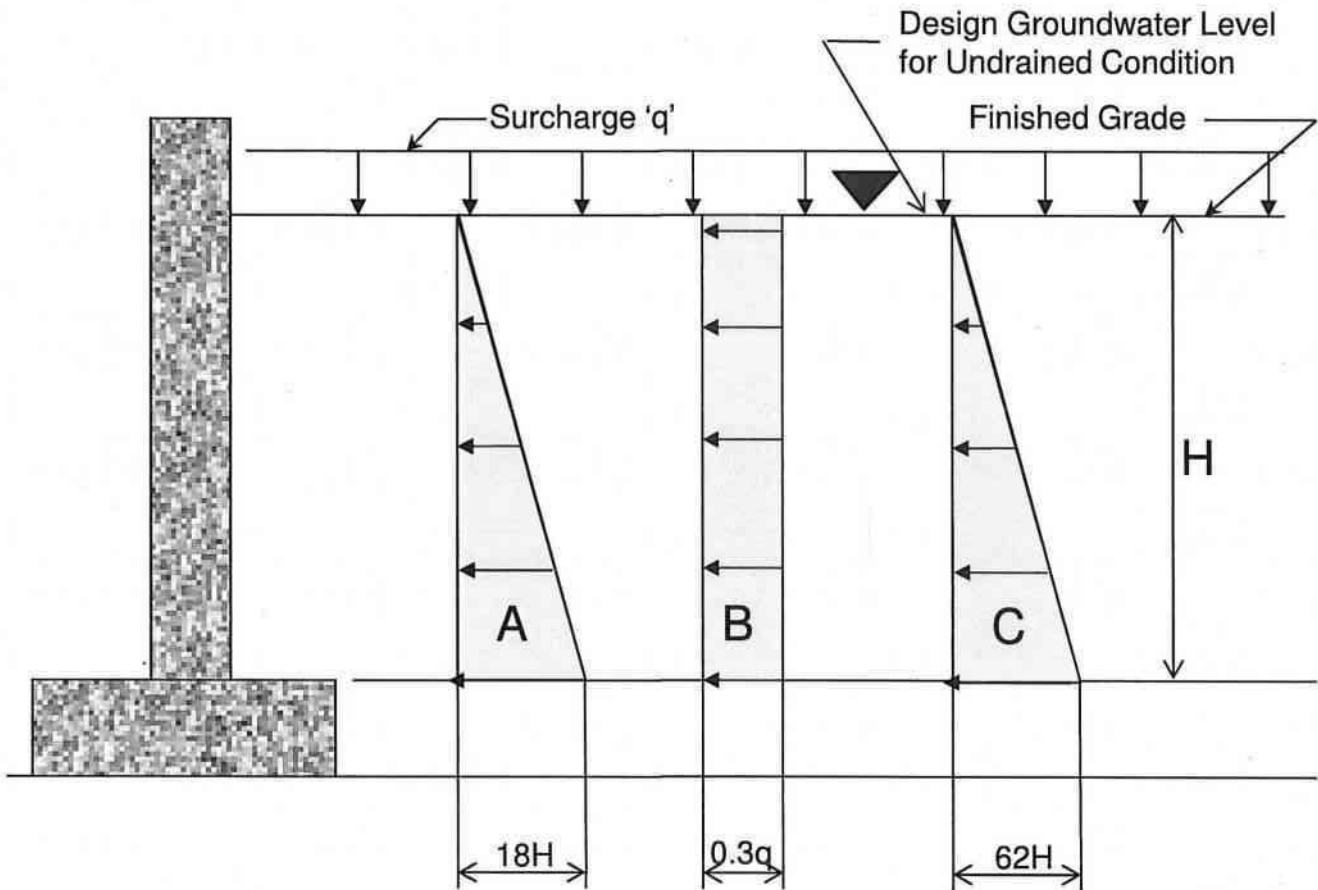
Figure 5



A – Lateral Pressure due to Soil  
 B – Lateral Pressure due to Surcharge

1. Pressure diagram assumes active soil pressures.
2. Pressure diagram includes only loads resulting from backfills and surcharges.
3. Use granular backfill material.
4. Compact backfill in maximum 10-inch loose lifts to 92 percent of maximum dry density per ASTM D1557.
5. Use only light-duty hand operated compaction equipment within 10 feet of walls.
6. For surcharge  $q$ , consider the greater of the maximum expected construction equipment live loads or permanent structure dead and live loads.

**Figure 6: Active Lateral Pressures on Below Grade Walls  
 – Drained Condition**



A – Lateral Pressure due to Soil  
 B – Lateral Pressure due to Surcharge  
 C – Lateral Pressure due to Water

1. Pressure diagram assumes active soil pressures.
2. Pressure diagram includes only loads resulting from backfills and surcharges.
3. Use granular backfill material.
4. Compact backfill in maximum 10-inch loose lifts to 92 percent of maximum dry density per ASTM D1557.
5. Use only light-duty hand operated compaction equipment within 10 feet of walls.
6. For surcharge  $q$ , consider the greater of the maximum expected construction equipment live loads or permanent structure dead and live loads.

**Figure 7: Active Lateral Pressures on Below Grade Walls  
 – Undrained Condition**

# HSA, Inc.

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Email: [Harish.Senapathy@hsainc.biz](mailto:Harish.Senapathy@hsainc.biz)

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## **APPENDIX**

# HSA, Inc.

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## **BORING LOGS**

# HSA, Inc.

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Phone: 202-269-6110 Fax: 202-280-1171

## Subsurface Investigation Procedures

### 1. Hand Augers

The hand auger consists of extendable steel rods, rotated by a handle. A number of different steel augers (drill bits) can be attached at the bottom end of the drill rods. The augers are rotated into the ground until they are filled, and then lifted out of the borehole to be emptied.

### 2. Test Boring – Hollow Stem Augers

The borings are advanced by turning an auger with a center opening of 2-¼ inches. A plug device blocks off the center opening while augers are advanced. Cuttings are brought to the surface by the auger flights. Sampling is performed through the center opening in the hollow stem auger, by standard methods, after removal of the plug.

### 3. Standard Penetration Tests

Standard penetration tests are performed by driving a 2-inch O.D., 1-¾ inch I.D. sampling spoon with a 140-pound hammer falling 30 inches, according to ASTM D-1586. After an initial 6 inches penetration to assure the sampling spoon is in undisturbed material, the number of blows required to drive the sampler an additional 12 inches is generally taken as the N value. If the required number of blows is more than 100 blows over any 6-inch interval, the sample driving operation is terminated and the depth of penetration is recorded.

### 4. Rock Coring

Rock coring was performed using a 2-inch double-tube NX core barrel system. The outer barrel is rotated with a diamond drill bit to cut into the rock with an inner non-rotating barrel to collect the core sample.

# HSA, Inc.

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## Visual Description of Soils

### 1. Estimated percentages of soil constituents

- Trace - 0 to 10% by weight
- Little - 10 to 20%
- Some - 20 to 30%
- And - 30 to 50%

### 2. Soil Strength Assessment

- Cohesionless Soils

Classification	SPT-N value (bpf)	Relative Density (%)
Very Loose	< 4	0 – 15
Loose	4 – 10	15 – 35
Medium Dense	10 – 30	35 – 65
Dense	30 – 50	65 – 85
Very Dense	> 50	85 - 100

- Cohesive Soils

Classification	SPT-N value (bpf)	Cohesion (psf)
Very Soft	< 2	0 – 250
Soft	2 – 4	250 – 500
Medium Stiff	4 – 8	500 – 1000
Stiff	8 – 15	1000 – 2000
Very Stiff	15 – 30	2000 – 4000
Hard	> 30	4000 - 8000

# HSA, Inc.

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Phone: 202-269-6110 Fax: 202-280-1171

## Rock Descriptions

### **Color:**

- Based on wetted core.

### **Hardness:**

- Soft: Easily gouged by knife or screw driver.
- Medium Soft: Slightly gouged by knife or screw driver.
- Medium Hard: Easily scratched by knife or screw driver.
- Hard: Difficult to scratch with knife or screw driver.
- Very Hard: Cannot be scratched by knife or screw driver.

### **Bedding:**

- Very Thin: Less than 2 inches.
- Thin: 2 inches to 1 foot.
- Medium: 1 foot to 3 feet.
- Thick: 3 feet to 10 feet.
- Very Thick: Greater than 10 feet.

### **Foliation:**

- General orientation of mineral grains resulting from segregation by metamorphic forces.

### **Weathering:**

- Fresh: No visible signs of alteration in the rock, but fracture/joint planes may be stained or discolored.
- Slightly Weathered: Fracture/joint planes are stained or discolored, up to 1 inch into the rock, and may contain a thin coating of altered material.
- Moderately Weathered: Staining or discoloration of fracture/joint planes generally extends to include the greater part of the rock. Planes may contain filling of altered material.
- Highly Weathered: Discoloration extends throughout the rock. Surface of the rock may be friable or pitted. Original texture of the rock has mainly been preserved.
- Decomposed: Rock is totally discolored and appearance ins that of a soil. Original texture of the rock is partly preserved.



# HSA, Inc.

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## Fracturing:
















- Crushed: Soil texture to less than 1 inch.
- Very Close: 1 to 2 inches.
- Close: 2 to 6 inches.
- Moderate: 6 inches to 1 foot.
- Slightly: 1 foot to 3 feet.
- Massive: Greater than 3 feet.

# HSA, Inc.

1818 New York Avenue NE, Suite 106  
Washington, DC 20002

# UNIFIED SOIL CLASSIFICATION SYSTEM

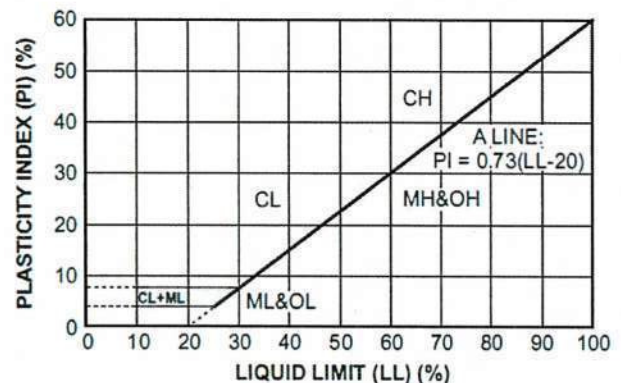
## UNIFIED SOIL CLASSIFICATION AND SYMBOL CHART

COARSE-GRAINED SOILS (more than 50% of material is larger than No. 200 sieve size.)		
Clean Gravels (Less than 5% fines)		
<b>GRAVELS</b> More than 50% of coarse fraction larger than No. 4 sieve size	 GW Well-graded gravels, gravel-sand mixtures, little or no fines	
	 GP Poorly-graded gravels, gravel-sand mixtures, little or no fines	
	Gravels with fines (More than 12% fines)	
	 GM Silty gravels, gravel-sand-silt mixtures	
 GC Clayey gravels, gravel-sand-clay mixtures		
Clean Sands (Less than 5% fines)		
<b>SANDS</b> 50% or more of coarse fraction smaller than No. 4 sieve size	 SW Well-graded sands, gravelly sands, little or no fines	
	 SP Poorly graded sands, gravelly sands, little or no fines	
	Sands with fines (More than 12% fines)	
	 SM Silty sands, sand-silt mixtures	
 SC Clayey sands, sand-clay mixtures		
FINE-GRAINED SOILS (50% or more of material is smaller than No. 200 sieve size.)		
<b>SILTS AND CLAYS</b> Liquid limit less than 50%	 ML Inorganic silts and very fine sands, rock flour, silty of clayey fine sands or clayey silts with slight plasticity	
	 CL Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	
	 OL Organic silts and organic silty clays of low plasticity	
<b>SILTS AND CLAYS</b> Liquid limit 50% or greater	 MH Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	
	 CH Inorganic clays of high plasticity, fat clays	
	 OH Organic clays of medium to high plasticity, organic silts	
<b>HIGHLY ORGANIC SOILS</b>	 PT Peat and other highly organic soils	

## 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 P.I. less than 4
GC	Atterberg limits above "A" line with P.I. greater than 7
Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols	
SW	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{D_{30}}{D_{10} \times D_{60}}$ between 1 and 3
SP	Not meeting all gradation requirements for GW
SM	Atterberg limits below "A" line or P.I. less than 4
SC	Atterberg limits above "A" line with P.I. greater than 7
Limits plotting in shaded zone with P.I. between 4 and 7 are borderline cases requiring use of dual symbols.	
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 ..... Borderline cases requiring dual symbols	

## PLASTICITY CHART



CLIENT Gannett Fleming Parsons JV (GFP) PROJECT NAME WMATA Franconia Springfield Metro Station Project  
 PROJECT NUMBER 11-103W PROJECT LOCATION Springfield, VA  
 DATE STARTED 6/10/14 COMPLETED 6/10/14 GROUND ELEVATION 189.01 ft HOLE SIZE 7" inches  
 DRILLING CONTRACTOR HSA, Inc. GROUND WATER LEVELS:  
 DRILLING METHOD HSA ∇ AT TIME OF DRILLING 23.50 ft / Elev 165.51 ft  
 LOGGED BY Ali Sheikhbahaei CHECKED BY Ali Sheikhbahaei AT END OF DRILLING ---  
 NOTES Borehole backfilled at completion AFTER DRILLING ---

GEO TECH BH PLOTS - GINT STD US LAB.GDT - 10/3/14 21:05 - C:\USERS\ALI\_2\GOOGLE DRIVE\HSA SHARED FOLDER\GINT\PROJECTS\11-103W - FRANCONIA SPRINGFIELD METRO STATION.GPJ

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ SPT N VALUE ▲			
								PL	MC	LL	
								□ FINES CONTENT (%) □			
								20	40	60	80
0		Surficial Organic soil FILL: Loose moist brown SAND and little to some Gravel (SW)	SS S-1		4-5-4 (9)						
5		FILL: Medium dense moist brown fine to medium Silty SAND and little coarse Gravel (SM)	SS S-2		4-10-13 (23)						
		FILL: Dense moist light brown to brown Silty SAND and trace coarse Gravel (SM)	SS S-3		6-14-22 (36)						
10		FILL: Very stiff moist gray medium plastic Silty Clay and trace Gravel (CL-ML)	SS S-4		3-8-10 (18)						
15		Medium dense moist brown Clayey SAND and one coarse Gravel - residual - (SC)	SS S-5		4-5-8 (13)						
20		Medium dense wet light brown fine to medium SAND and little reddish Silt (SM)	SS S-6		3-5-7 (12)						
25	∇	Mix layers of medium dense wet light brown fine to medium SAND and little to some reddish Silt (SM)	SS S-7		3-5-8 (13)						
30		Same as above	SS S-8		4-8-13 (21)						
35		Mix layers of medium dense wet light brown fine to medium SAND and moist dark gray, little Clay and little Organic Soil, (SC-SM)	SS S-9		5-11-13 (24)						

Bottom of borehole at 35.0 feet.

CLIENT Gannett Fleming Parsons JV (GFP) PROJECT NAME WMATA Franconia Springfield Metro Station Project  
 PROJECT NUMBER 11-103W PROJECT LOCATION Springfield, VA  
 DATE STARTED 6/10/14 COMPLETED 6/10/14 GROUND ELEVATION 187.66 ft HOLE SIZE 7" inches  
 DRILLING CONTRACTOR HSA, Inc. GROUND WATER LEVELS:  
 DRILLING METHOD HSA ∇ AT TIME OF DRILLING 23.50 ft / Elev 164.16 ft  
 LOGGED BY Ali Sheikhabahaei CHECKED BY Ali Sheikhabahaei AT END OF DRILLING ---  
 NOTES Bag sample obtained from depth 1 -10 feet , Backfilled at completion AFTER DRILLING ---

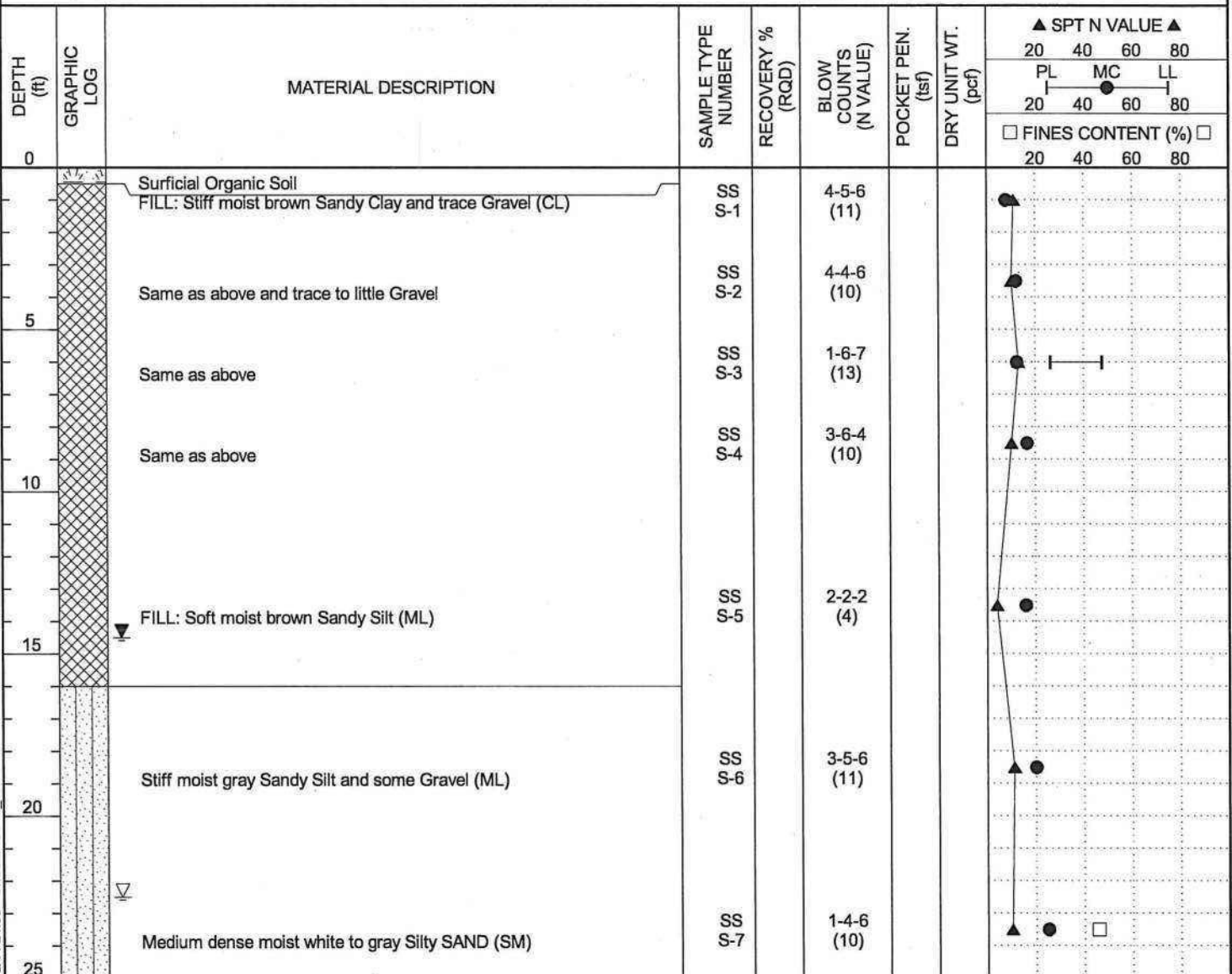
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DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ SPT N VALUE ▲			
								20	40	60	80
								PL	MC	LL	
								20	40	60	80
								□ FINES CONTENT (%) □			
								20	40	60	80
0		Surficial Organic soil	SS		2-5-6 (11)						
		FILL: Medium dense moist dark brown Silty SAND and little coarse Gravel and little to some Organic (SM)	S-1								
5		FILL: Loose moist dark brown Silty SAND and little to some Organic (SW-SM)	SS		5-4-4 (8)						
		FILL: Soft moist brown fine to medium Sandy Silt and little Gravel - residual - (ML)	SS		2-1-2 (3)						
		FILL: Soft moist brown Sandy Lean Clay with Gravel (CL)	SS		1-1-1 (2)						
10			S-4								
15		FILL: Medium Stiff moist brown Sandy Silt and little coarse Gravel (ML)	SS		1-2-3 (5)						
			S-5								
20		Medium stiff moist to wet light gray medium plastic Clay with trace Gravel (CL)	SS		2-3-4 (7)						
			S-6								
25		Medium dense moist brown fine to medium Silty SAND and one coarse Gravel (SM)	SS		6-8-4 (12)						
			S-7								

Bottom of borehole at 25.0 feet.

CLIENT Gannett Fleming Parsons JV (GFP) PROJECT NAME WMATA Franconia Springfield Metro Station Project  
 PROJECT NUMBER 11-103W PROJECT LOCATION Springfield, VA  
 DATE STARTED 6/12/14 COMPLETED 6/13/14 GROUND ELEVATION 188.33 ft HOLE SIZE 7" inches  
 DRILLING CONTRACTOR HSA, Inc. GROUND WATER LEVELS:  
 DRILLING METHOD HSA ▽ AT TIME OF DRILLING 22.50 ft / Elev 165.83 ft  
 LOGGED BY Ali Sheikhbahaei CHECKED BY Ali Sheikhbahaei ▽ AT END OF DRILLING 14.50 ft / Elev 173.83 ft  
 NOTES Borehole backfilled at completion AFTER DRILLING ---

GEOTECH BH PLOTS - GINT STD US LAB.GDT - 10/3/14 21:05 - C:\USERS\ALI\_2\GOOGLE DRIVE\HSA SHARED FOLDER\GINT\PROJECTS\11-103W - FRANCONIA SPRINGFIELD METRO STATION.GPJ



Bottom of borehole at 25.0 feet.

CLIENT Gannett Fleming Parsons JV (GFP) PROJECT NAME WMATA Franconia Springfield Metro Station Project  
 PROJECT NUMBER 11-103W PROJECT LOCATION Springfield, VA  
 DATE STARTED 6/12/14 COMPLETED 6/13/14 GROUND ELEVATION 189.16 ft HOLE SIZE 7" inches  
 DRILLING CONTRACTOR HSA, Inc. GROUND WATER LEVELS:  
 DRILLING METHOD HSA ▽ AT TIME OF DRILLING 22.00 ft / Elev 167.16 ft  
 LOGGED BY Ali Sheikhabahaei CHECKED BY Ali Sheikhabahaei ▽ AT END OF DRILLING 17.75 ft / Elev 171.41 ft  
 NOTES Borehole backfilled at completion AFTER DRILLING --

GEOTECH BH PLOTS - GINT STD US LAB.GDT - 10/3/14 21:05 - C:\USERS\ALI\_2\GOOGLE DRIVE\HSA SHARED FOLDER\GINT\PROJECTS\11-103W - FRANCONIA SPRINGFIELD METRO STATION.GPJ

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ SPT N VALUE ▲			
								20	40	60	80
								PL	MC	LL	
								20	40	60	80
								□ FINES CONTENT (%) □			
								20	40	60	80
0		Surficial Organic Soil									
		FILL: Medium dense moist brown fine to medium Silty SAND (SM)	SS S-1		2-5-10 (15)						
		Same as above	SS S-2		3-3-8 (11)						
5		Same as above	SS S-3		2-4-7 (11)						
		FILL: Loose moist brown Silty Sand and some Gravel (SM)	SS S-4		4-4-5 (9)						
10											
		FILL: Medium dense moist brown Clayey SAND (SC)	SS S-5		3-5-7 (12)						
15											
		Medium dense moist gray Silty SAND and trace Gravel (SM)	SS S-6		11-15-14 (29)						
20											
		Medium dense moist gray to gray brown Silty SAND (SM)	SS S-7		11-17-9 (26)						
25											

Bottom of borehole at 25.0 feet.



HSA  
 1818 New York Ave  
 Washington DC  
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# BORING NUMBER BH 105

CLIENT Gannett Fleming Parsons JV (GFP) PROJECT NAME WMATA Franconia Springfield Metro Station Project  
 PROJECT NUMBER 11-103W PROJECT LOCATION Springfield, VA  
 DATE STARTED 6/10/14 COMPLETED 6/10/14 GROUND ELEVATION 189.98 ft HOLE SIZE 7" inches  
 DRILLING CONTRACTOR HSA, Inc. GROUND WATER LEVELS:  
 DRILLING METHOD HSA ∇ AT TIME OF DRILLING 24.50 ft / Elev 165.48 ft  
 LOGGED BY Ali Sheikhbahaei CHECKED BY Ali Sheikhbahaei AT END OF DRILLING ---  
 NOTES Borehole backfilled at completion AFTER DRILLING ---

GEO TECH BH PLOTS - GINT STD US LAB.GDT - 10/3/14 21:05 - C:\USERS\ALI\_2\GOOGLE DRIVE\HSA\_SHARED FOLDER\GINT\PROJECTS\11-103W - FRANCONIA SPRINGFIELD METRO STATION.GPJ

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ SPT N VALUE ▲			
								PL	MC	LL	
								□ FINES CONTENT (%) □			
								20	40	60	80
0		Surficial Organic soil	SS		3-4-7 (11)						
		FILL: Medium dense moist dark brown Silty SAND and trace to little Gravel (SW-SM)	S-1								
5		FILL: Very stiff moist brown Sandy Silt and little to some coarse Gravel - Residual - (ML)	SS		6-13-5 (18)						
		FILL: Loose moist brown fine to medium Silty SAND and little to some Gravel (SW-SM)	S-2								
		FILL: Loose moist brown fine to medium Silty SAND and little to some Gravel (SW-SM)	SS		2-2-4 (6)						
		FILL: Medium dense moist light brown fine to medium Silty SAND and trace to little Clayey SAND (SC-SM)	S-3								
10			SS		4-4-8 (12)						
		FILL: Loose moist reddish brown fine to medium Silty SAND (SM)	S-4								
15			SS		2-3-1 (4)						
			S-5								
20		Medium dense moist dark gray Silty SAND and little Organic soil (SM)	SS		1-3-10 (13)						
			S-6								
25		Loose wet dark gray Clayey SAND and some coarse Gravel (SC)	SS		1-1-6 (7)						
			S-7								
30		Medium dense wet light brown to gray fine to medium SAND and trace to little reddish Silt (SM)	SS		4-4-6 (10)						
			S-8								
35		Same as above	SS		5-8-11 (19)						
			S-9								

Bottom of borehole at 35.0 feet.

CLIENT Gannett Fleming Parsons JV (GFP) PROJECT NAME WMATA Franconia Springfield Metro Station Project  
 PROJECT NUMBER 11-103W PROJECT LOCATION Springfield, VA  
 DATE STARTED 6/12/14 COMPLETED 6/13/14 GROUND ELEVATION 190.49 ft HOLE SIZE 7" inches  
 DRILLING CONTRACTOR HSA, Inc. GROUND WATER LEVELS:  
 DRILLING METHOD HSA ▽ AT TIME OF DRILLING 18.90 ft / Elev 171.59 ft  
 LOGGED BY Ali Sheikhbahaei CHECKED BY Ali Sheikhbahaei ▽ AT END OF DRILLING 17.80 ft / Elev 172.69 ft  
 NOTES Borehole backfilled at completion AFTER DRILLING ---

GEOTECH BH PLOTS - GINT STD US LAB.GDT - 10/3/14 21:05 - C:\USERS\ALI\_2\GOOGLE\_DRIVE\HSA\_SHARED\_FOLDER\GINT\PROJECTS\11-103W - FRANCONIA SPRINGFIELD METRO STATION.GPJ

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ SPT N VALUE ▲					
								20	40	60	80		
0		Concrete Sidewalk											
		FILL: Medium dense moist gray fine to medium SAND and some Gravel (SW)	SS S-1		6-5-5 (10)								
		FILL: Loose moist brown fine to medium SAND and little Gravel (SW)	SS S-2		3-4-3 (7)								
5		FILL: Medium dense moist brown fine to medium Silty SAND (SW-SM)	SS S-3		4-6-12 (18)								
		Very stiff moist brown medium plastic Sandy Silt (ML)	SS S-4		6-8-8 (16)								
10		Medium dense moist reddish brown fine to medium Silty SAND (SM)	SS S-5		6-8-8 (16)								
		Medium dense moist gray fine to medium Silty SAND and some fine Gravel (SM)	SS S-6		4-5-7 (12)								
15													
20		Same as above	SS S-7		16-15-10 (25)								
		Loose moist to wet brown fine to medium Silty SAND (SM)	SS S-8		3-4-5 (9)								
25													

Bottom of borehole at 25.0 feet.



CLIENT Gannett Fleming Parsons JV (GFP) PROJECT NAME WMATA Franconia Springfield Metro Station Project  
 PROJECT NUMBER 11-103W PROJECT LOCATION Springfield, VA  
 DATE STARTED 6/12/14 COMPLETED 6/13/14 GROUND ELEVATION 191.16 ft HOLE SIZE 7" inches  
 DRILLING CONTRACTOR HSA, Inc. GROUND WATER LEVELS:  
 DRILLING METHOD HSA ▽ AT TIME OF DRILLING 21.10 ft / Elev 170.06 ft  
 LOGGED BY Ali Sheikhabahaei CHECKED BY Ali Sheikhabahaei ▽ AT END OF DRILLING 17.80 ft / Elev 173.36 ft  
 NOTES Bag sample obtained from depth 1 -10 feet , Backfilled at completion AFTER DRILLING ---

GEOTECH BH PLOTS - GINT STD US LAB.GDT - 10/3/14 21:05 - C:\USERS\ALI\_2\GOOGLE DRIVE\HSA SHARED FOLDER\GINT\PROJECTS\11-103W - FRANCONIA SPRINGFIELD METRO STATION.GPJ

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ SPT N VALUE ▲			
								PL	MC	LL	
								□ FINES CONTENT (%) □			
								20	40	60	80
0		Concrete Sidewalk									
0-5		FILL: Loose moist brown fine to medium SAND and little to some fine Gravel (SW)	SS S-1		7-3-6 (9)						
5-8		FILL: Medium dense moist brown fine to medium Silty SAND and little to some fine Gravel (SW-SM)	SS S-2		4-5-6 (11)						
8-10		FILL: Medium dense moist brown fine to medium Clayey SAND and little to some fine Gravel (SC)	SS S-3		4-11-8 (19)						
10-15		Medium dense moist brown fine to medium Silty SAND and trace fine Gravel (SM)	SS S-4		9-10-10 (20)						
15-20		Medium dense moist gray fine to medium Silty SAND and little fine Gravel (SM)	SS S-5		4-5-5 (10)						
20-22		Medium dense moist brown Silty SAND and trace Gravel - Residual - (SM)	SS S-6		7-8-10 (18)						
22-25		Medium dense moist to wet reddish brown fine to medium Silty SAND and trace Clay (SC-SM)	SS S-7		5-5-6 (11)						

Bottom of borehole at 25.0 feet.

# HSA

HSA  
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 Washington DC  
 Telephone: 2022696110  
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## BORING NUMBER BH 108

PAGE 1 OF 1

CLIENT Gannett Fleming Parsons JV (GFP) PROJECT NAME WMATA Franconia Springfield Metro Station Project  
 PROJECT NUMBER 11-103W PROJECT LOCATION Springfield, VA  
 DATE STARTED 6/10/14 COMPLETED 6/10/14 GROUND ELEVATION 191.54 ft HOLE SIZE 7" inches  
 DRILLING CONTRACTOR HSA, Inc. GROUND WATER LEVELS:  
 DRILLING METHOD HSA ∇ AT TIME OF DRILLING 23.50 ft / Elev 168.04 ft  
 LOGGED BY Ali Sheikhabahai CHECKED BY Ali Sheikhabahai AT END OF DRILLING ---  
 NOTES Borehole backfilled at completion AFTER DRILLING ---

GEOTECH BH PLOTS - GINT STD US LAB.GDT - 10/3/14 21:06 - C:\USERS\ALI\_2\GOOGLE DRIVE\HSA SHARED FOLDER\GINT\PROJECTS\11-103W - FRANCONIA SPRINGFIELD METRO STATION.GPJ

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ SPT N VALUE ▲				
								20	40	60	80	
0		Concrete Sidewalk										
0-5	[Cross-hatched pattern]	FILL: Mixed layers of loose moist Silty SAND and some coarse Gravel (SM)	SS S-1		3-5-4 (9)							
5-10	[Dotted pattern]	FILL: Mixed layers of medium stiff moist brown Sandy Silt and trace Clay - Residual - (CL-ML)	SS S-2		3-3-3 (6)							
10-15	[Dotted pattern]	FILL: Medium dense moist light brown fine to medium Sandy Silt and little to some Gravel (ML)	SS S-3		3-8-11 (19)							
15-20	[Dotted pattern]	Medium dense moist brown fine to medium Silty SAND and little Gravel (SM)	SS S-4		4-6-7 (13)							
20-25	[Dotted pattern]	Same as above	SS S-5		5-9-6 (15)							
25	[Dotted pattern]	Medium dense moist brown Silty SAND and trace Gravel - Residual - (SM)	SS S-6		25-16-10 (26)							
25	∇	Medium dense moist to wet reddish brown fine to medium Silty SAND and trace Clay (SC-SM)	SS S-7		4-5-7 (12)							

Bottom of borehole at 25.0 feet.

<b>CLIENT</b> <u>Gannett Fleming Parsons JV (GFP)</u>	<b>PROJECT NAME</b> <u>WMATA Franconia Springfield Metro Station Project</u>
<b>PROJECT NUMBER</b> <u>11-103W</u>	<b>PROJECT LOCATION</b> <u>Springfield, VA</u>
<b>DATE STARTED</b> <u>6/10/14</u> <b>COMPLETED</b> <u>6/10/14</u>	<b>GROUND ELEVATION</b> <u>192.3 ft</u> <b>HOLE SIZE</b> <u>7" inches</u>
<b>DRILLING CONTRACTOR</b> <u>HSA, Inc.</u>	<b>GROUND WATER LEVELS:</b>
<b>DRILLING METHOD</b> <u>HSA</u>	▽ <b>AT TIME OF DRILLING</b> <u>28.50 ft / Elev 163.80 ft</u>
<b>LOGGED BY</b> <u>Ali Sheikhbahaei</u> <b>CHECKED BY</b> <u>Ali Sheikhbahaei</u>	<b>AT END OF DRILLING</b> <u>---</u>
<b>NOTES</b> <u>Borehole backfilled at completion</u>	<b>AFTER DRILLING</b> <u>---</u>

GEOTECH BH PLOTS - GINT STD US LAB.GDT - 10/9/14 21:06 - C:\USERS\ALI\_2\GOOGLE DRIVE\HSA SHARED FOLDER\GINT\PROJECTS\11-103W - FRANCONIA SPRINGFIELD METRO STATION.GPJ

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ SPT N VALUE ▲			
								PL	MC	LL	
								□ FINES CONTENT (%) □			
								20	40	60	80
0		Surficial Organic soil	SS S-1		3-8-8 (16)						
		FILL: Medium dense moist brown Silty SAND, little coarse Gravel and little Organic (SM)									
5		FILL: Medium dense moist dark brown Silty SAND and little coarse Gravel (Organic) (SM)	SS S-2		3-9-8 (17)						
		FILL: Loose Moist dark brown Silty SAND and little coarse Gravel and trace Clayey SAND (SC-SM)	SS S-3		3-4-5 (9)						
10		Medium dense moist reddish brown fine to medium Silty SAND, trace Clay and trace fine Gravel - Residual - (SC-SM)	SS S-4		3-5-5 (10)						
15		Same as above, Loose	SS S-5		2-3-2 (5)						
20		Layers of loose moist reddish brown to brown loose Silty SAND and Clayey SAND and one coarse Gravel (SC-SM)	SS S-6		1-3-3 (6)						
25		Medium dense moist reddish brown fine to medium Silty SAND (SM)	SS S-7		5-6-7 (13)						
30	▽	Medium dense moist to wet light brown fine to medium Silty SAND (SM)	SS S-8		5-9-12 (21)						
35		Dense moist to wet light brown to yellowish brown fine to medium Silty SAND (SM)	SS S-9		9-14-18 (32)						

Bottom of borehole at 35.0 feet.

# HSA, Inc.

1818 New York Avenue NE, Suite 106, Washington DC 20002

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Email: [harish.senapathy@hsainc.biz](mailto:harish.senapathy@hsainc.biz)

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## LABORATORY TESTS RESULTS



HSA  
 1818 New York Ave  
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# SUMMARY OF LABORATORY RESULTS

CLIENT Gannett Fleming Parsons JV (GFP)

PROJECT NAME WMATA Franconia Springfield Metro Station Project

PROJECT NUMBER 11-103W

PROJECT LOCATION Springfield, VA

Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	Classification	Water Content (%)	Dry Density (pcf)	Saturation (%)	Void Ratio
BH 101	1.0							10.6			
BH 101	3.5							9.9			
BH 101	6.0							6.1			
BH 101	8.5	34	21	13				10.7			
BH 101	13.5							12.4			
BH 101	18.5							26.3			
BH 101	23.5				19	39		25.0			
BH 101	28.5							23.6			
BH 101	33.5							25.3			
BH 102	1.0							24.4			
BH 102	3.5							18.0			
BH 102	6.0							12.7			
BH 102	8.5	35	23	12	19	51	CL	21.2			
BH 102	13.5							19.1			
BH 102	18.5	38	20	18				19.7			
BH 102	23.5							25.7			
BH 103	1.0							7.8			
BH 103	3.5							11.9			
BH 103	6.0	47	26	21				12.3			
BH 103	8.5							16.5			
BH 103	13.5							15.9			
BH 103	18.5							20.0			
BH 103	23.5				19	46		25.0			
BH 104	1.0							15.5			
BH 104	3.5	37	28	9				17.4			
BH 104	6.0							14.2			
BH 104	8.5							16.5			
BH 104	13.5							16.6			
BH 104	18.5				19	21		5.9			
BH 104	23.5							22.8			
BH 105	1.0							13.1			
BH 105	3.5							8.3			
BH 105	6.0							18.1			
BH 105	8.5							13.8			
BH 105	13.5	54	32	22	19	33	SM	21.3			
BH 105	18.5							32.1			
BH 105	23.5							25.0			
BH 105	28.5							23.4			
BH 105	33.5				19	16		28.8			
BH 106	1.0							11.6			
BH 106	3.5							15.1			
BH 106	5.5							17.2			
BH 106	8.5	53	37	16				24.6			

LAB SUMMARY - GINT STD US LAB.GDT - 10/3/14 21:10 - C:\USERS\ALI\_2\GOOGLE DRIVE\HSA\_SHARED\FOLDER\GINT\PROJECTS\11-103W - FRANCONIA SPRINGFIELD METRO STATION.GPJ



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# SUMMARY OF LABORATORY RESULTS

CLIENT Gannett Fleming Parsons JV (GFP)

PROJECT NAME WMATA Franconia Springfield Metro Station Project

PROJECT NUMBER 11-103W

PROJECT LOCATION Springfield, VA

Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	Classification	Water Content (%)	Dry Density (pcf)	Saturation (%)	Void Ratio
BH 106	10.0							22.6			
BH 106	15.0				19	21		13.9			
BH 106	20.0							9.3			
BH 106	23.5							29.6			
BH 107	1.0							9.1			
BH 107	3.5							14.9			
BH 107	5.5	32	20	12				14.5			
BH 107	8.5							18.8			
BH 107	15.0							14.1			
BH 107	20.0							11.1			
BH 107	23.5				4.76	45		25.4			
BH 108	1.0							9.2			
BH 108	3.5	37	29	8				27.4			
BH 108	6.0							11.4			
BH 108	8.5							20.9			
BH 108	13.5							13.8			
BH 108	18.5				19	33		14.7			
BH 108	23.5				4.76	41		26.6			
BH 109	1.0							8.9			
BH 109	3.5							13.1			
BH 109	6.0							14.3			
BH 109	8.5				19	35		16.1			
BH 109	13.5							13.4			
BH 109	18.5							18.0			
BH 109	23.5							24.2			
BH 109	28.5				19	33		23.6			
BH 109	33.5							19.8			

LAB SUMMARY - GINT STD US LAB.GDT - 10/3/14 21:11 - C:\USERS\ALI\_2\GOOGLE DRIVE\HSA\_SHARED\_FOLDER\GINT\PROJECTS\11-103W - FRANCONIA SPRINGFIELD METRO STATION.GPJ



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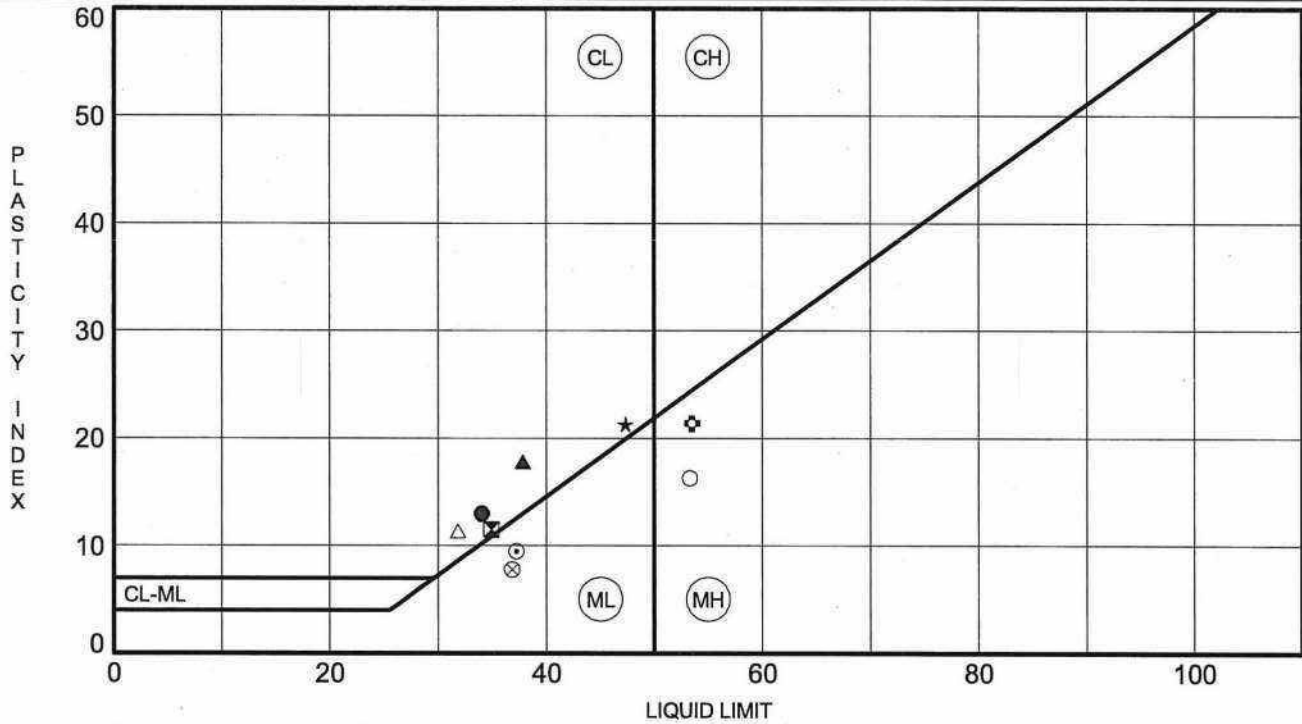
# ATTERBERG LIMITS' RESULTS

CLIENT Gannett Fleming Parsons JV (GFP)

PROJECT NAME WMATA Franconia Springfield Metro Station Project

PROJECT NUMBER 11-103W

PROJECT LOCATION Springfield, VA



BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
● BH 101	8.5	34	21	13		
⊠ BH 102	8.5	35	23	12	51	SANDY LEAN CLAY with GRAVEL(CL)
▲ BH 102	18.5	38	20	18		
★ BH 103	6.0	47	26	21		
⊙ BH 104	3.5	37	28	9		
⊕ BH 105	13.5	54	32	22	33	SILTY SAND(SM)
○ BH 106	8.5	53	37	16		
△ BH 107	5.5	32	20	12		
⊗ BH 108	3.5	37	29	8		

ATTERBERG LIMITS - GINT STD US LAB.GDT - 10/1/14 20:38 - C:\USERS\VAL\_2\GOOGLE\_DRIVE\HSA\_SHARED\FOLDER\GINT\PROJECTS\11-103W - FRANCONIA SPRINGFIELD METRO STATION.GPJ



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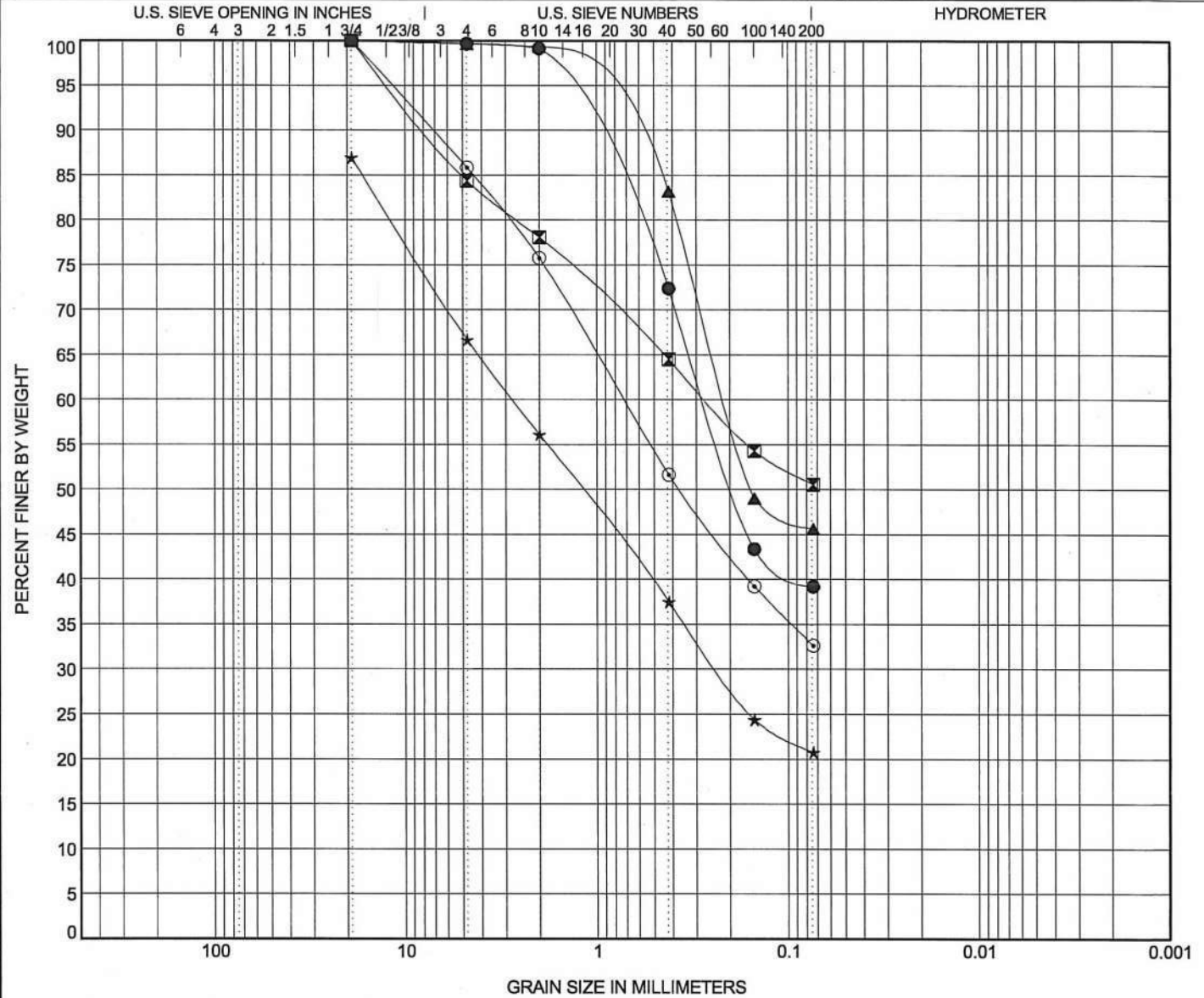
# GRAIN SIZE DISTRIBUTION

CLIENT Gannett Fleming Parsons JV (GFP)

PROJECT NAME WMATA Franconia Springfield Metro Station Project

PROJECT NUMBER 11-103W

PROJECT LOCATION Springfield, VA



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	Classification					LL	PL	PI	Cc	Cu
● BH 101	23.5	SANDY LEAN CLAY with GRAVEL(CL)					35	23	12		
☒ BH 102	8.5										
▲ BH 103	23.5										
★ BH 104	18.5	SILTY SAND(SM)					54	32	22		
◎ BH 105	13.5										
BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay		
● BH 101	23.5	19	0.27			0.3	60.4		39.3		
☒ BH 102	8.5	19	0.267			15.6	33.7		50.7		
▲ BH 103	23.5	19	0.209			0.3	54.0		45.7		
★ BH 104	18.5	19	2.751	0.233		20.3	45.8		20.8		
◎ BH 105	13.5	19	0.721			14.2	53.1		32.8		

GRAIN SIZE - GINT STD US LAB.GDT - 10/1/14 20:39 - C:\USERS\ALI\_2\GOOGLE DRIVE\HSA SHARED FOLDER\GINT\PROJECTS\11-103W - FRANCONIA SPRINGFIELD METRO STATION.GPJ





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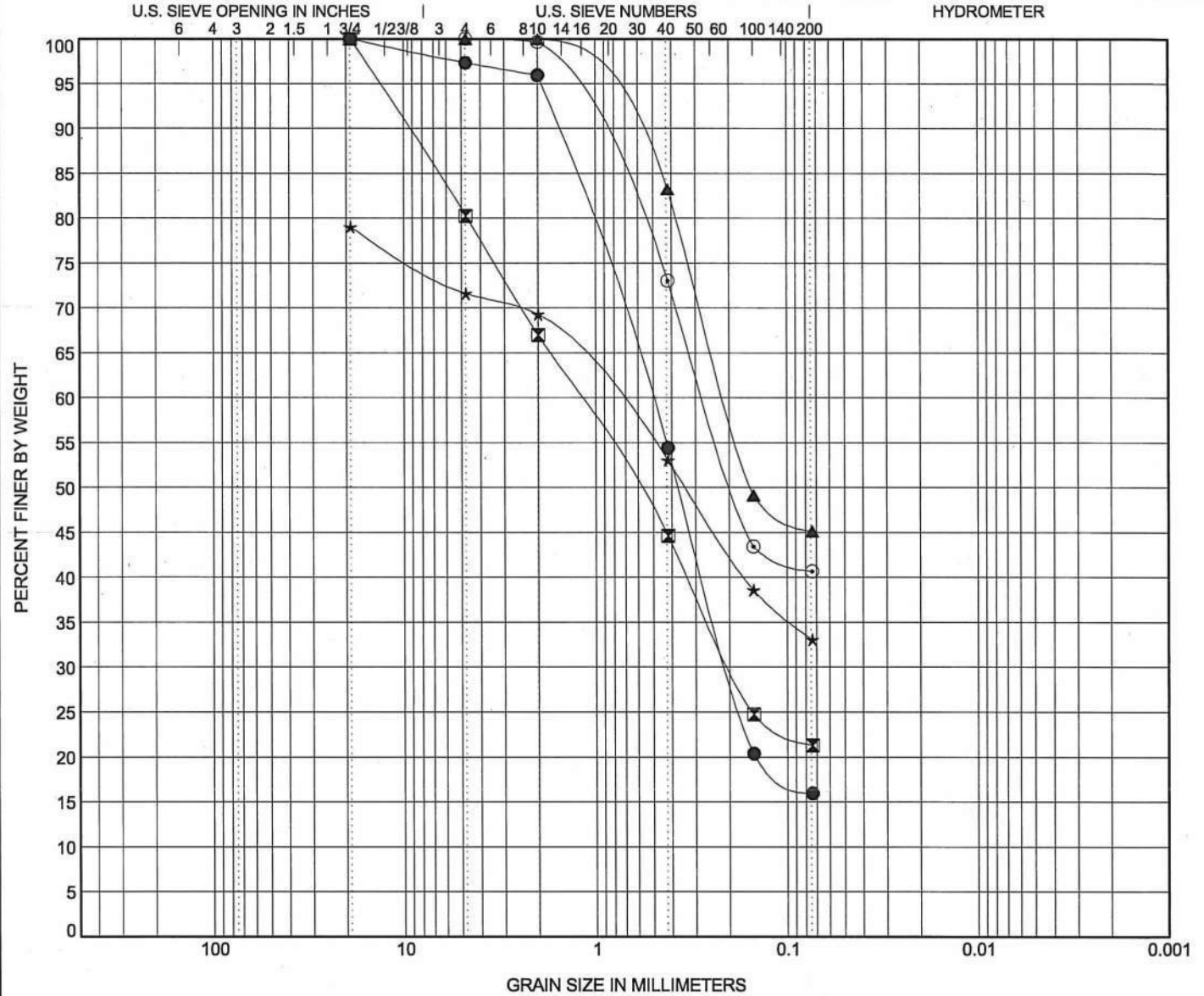
# GRAIN SIZE DISTRIBUTION

CLIENT Gannett Fleming Parsons JV (GFP)

PROJECT NAME WMATA Franconia Springfield Metro Station Project

PROJECT NUMBER 11-103W

PROJECT LOCATION Springfield, VA



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	Classification					LL	PL	PI	Cc	Cu
● BH 105	33.5										
☒ BH 106	15.0										
▲ BH 107	23.5										
★ BH 108	18.5										
⊙ BH 108	23.5										
BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay		
● BH 105	33.5	19	0.518	0.201		2.7	81.3	16.0			
☒ BH 106	15.0	19	1.228	0.197		19.7	58.9	21.4			
▲ BH 107	23.5	4.76	0.208			0.0	54.8	45.2			
★ BH 108	18.5	19	0.818			7.4	38.4	33.2			
⊙ BH 108	23.5	4.76	0.267			0.0	59.3	40.7			

GRAIN SIZE - GINT STD US LAB.GDT - 10/1/14 20:39 - C:\USERS\ALI\_2\GOOGLE DRIVE\HSA\_SHARED\FOLDER\GINT\PROJECTS\11-103W - FRANCONIA SPRINGFIELD METRO STATION.GPJ



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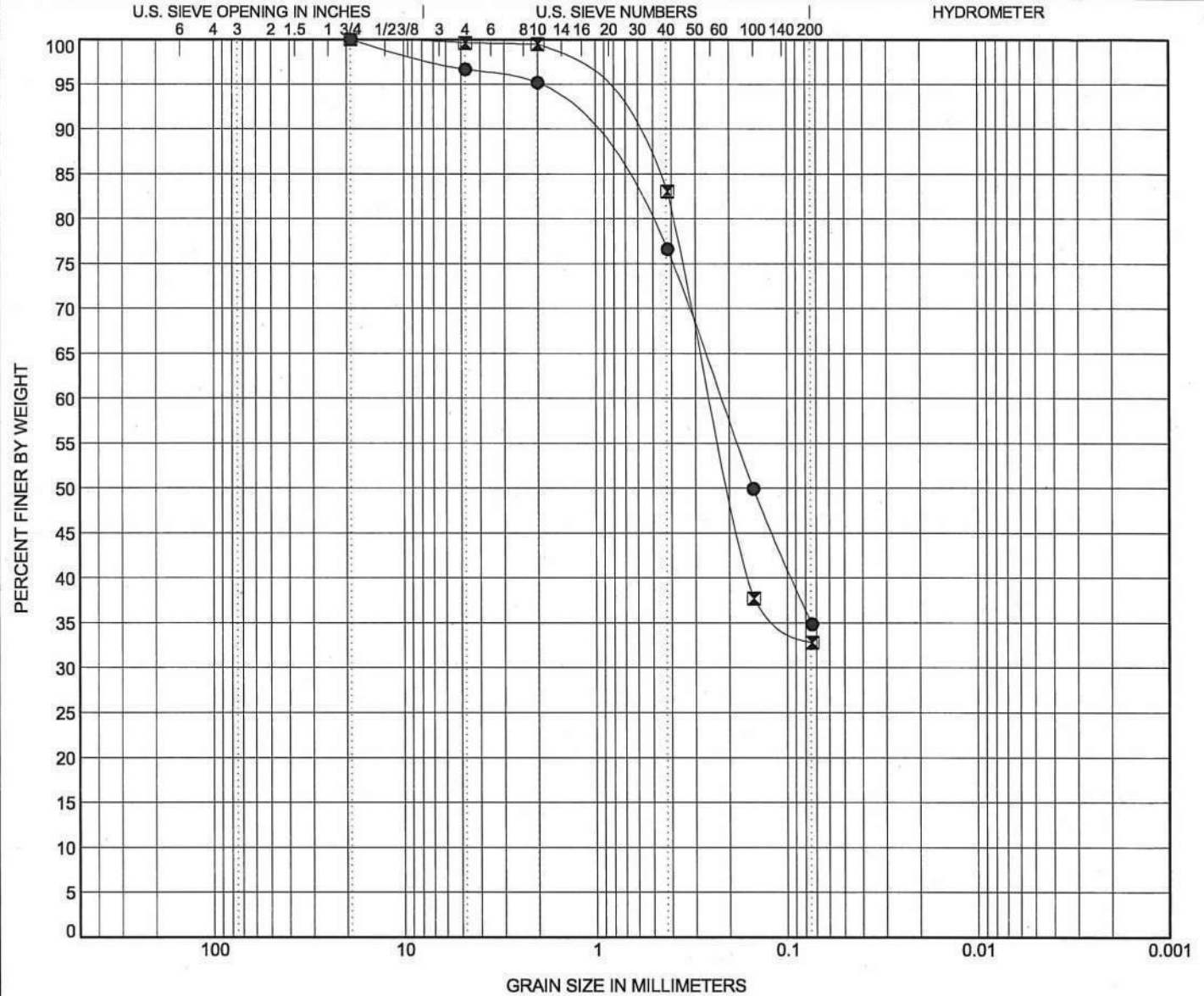
# GRAIN SIZE DISTRIBUTION

CLIENT Gannett Fleming Parsons JV (GFP)

PROJECT NAME WMATA Franconia Springfield Metro Station Project

PROJECT NUMBER 11-103W

PROJECT LOCATION Springfield, VA



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	Classification					LL	PL	PI	Cc	Cu
● BH 109	8.5										
☒ BH 109	28.5										
BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay		
● BH 109	8.5	19	0.221			3.3	61.5	35.1			
☒ BH 109	28.5	19	0.249			0.4	66.7	32.9			

GRAIN SIZE - GINT STD US LAB.GDT - 10/1/14 20:39 - C:\USERS\VALI\_2\GOOGLE DRIVE\HSA\_SHARED\_FOLDER\GINT\PROJECTS\11-103W - FRANCONIA SPRINGFIELD METRO STATION.GPJ

**FRANCONIA SPRINGFIELD METRO STATION**

BORING: B-102  
 SAMPLE: Bulk  
 DEPTH:

PROJECT #: 11-103W  
 SAMPLED: -  
 LOCATION: -

**JAY KAY TESTING**  
 5233 Lehman Road, Suite 110  
 Spring Grove, PA 17362  
 Phone: (410) 259-5101

**MODIFIED PROCTOR TEST RESULTS**

TEST METHOD: AASHTO T-180 (C)

Maximum Dry Unit Weight

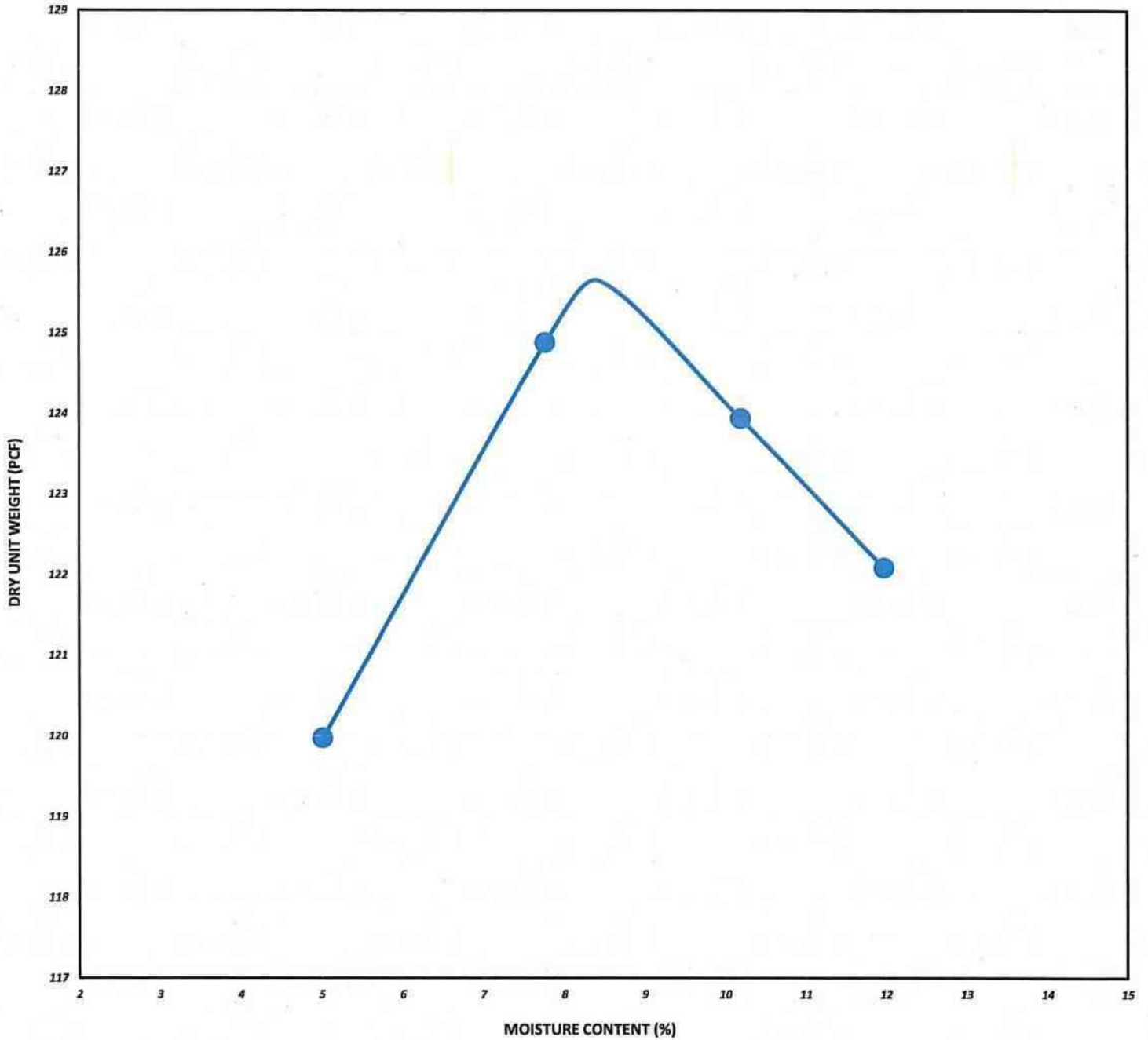
**125.7**

PCF

Optimum Moisture Content

**8.4**

%



MC	LL	PL	PI	USCS	AASHTO	FINES	VISUAL SOIL DESCRIPTION
----	----	----	----	------	--------	-------	-------------------------

-	-	-	-	-	-	-	Light brown sandy clay with gravel
---	---	---	---	---	---	---	------------------------------------

BORING: B-107  
SAMPLE: Bulk  
DEPTH:

PROJECT #: 11-103W  
SAMPLED: -  
LOCATION: -

JAY KAY TESTING  
5233 Lehman Road, Suite 110  
Spring Grove, PA 17362  
Phone: (410) 259-5101

### MODIFIED PROCTOR TEST RESULTS

TEST METHOD: AASHTO T-180 (C)

Maximum Dry Unit Weight

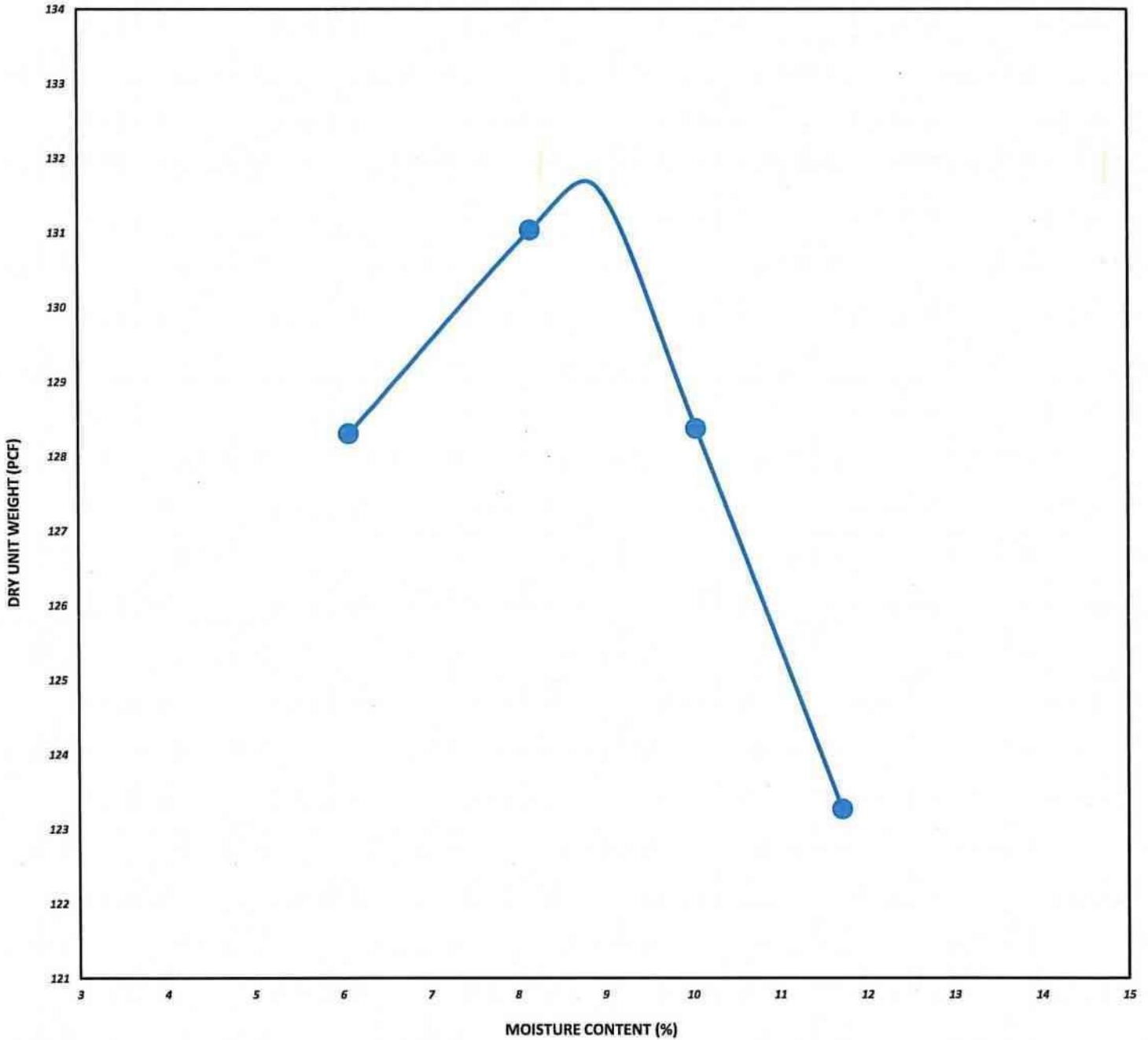
**131.6**

PCF

Optimum Moisture Content

**9.0**

%



MC	LL	PL	PI	USCS	AASHTO	FINES	VISUAL SOIL DESCRIPTION
-	-	-	-	-	-	-	Brown clayey sand with gravel

**FRANCONIA SPRINGFIELD METRO STATION**

BORING: B-102  
 SAMPLE: Bulk  
 DEPTH:

PROJECT #: 11-103W  
 SAMPLED: -  
 LOCATION: -

**JAY KAY TESTING**  
 5233 Lehman Road, Suite 110  
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**CALIFORNIA BEARING RATIO TEST RESULTS**

METHOD: AASHTO T-193, COMPACTION: AASHTO T-180 (C)

SURCHARGE: 75 PSF

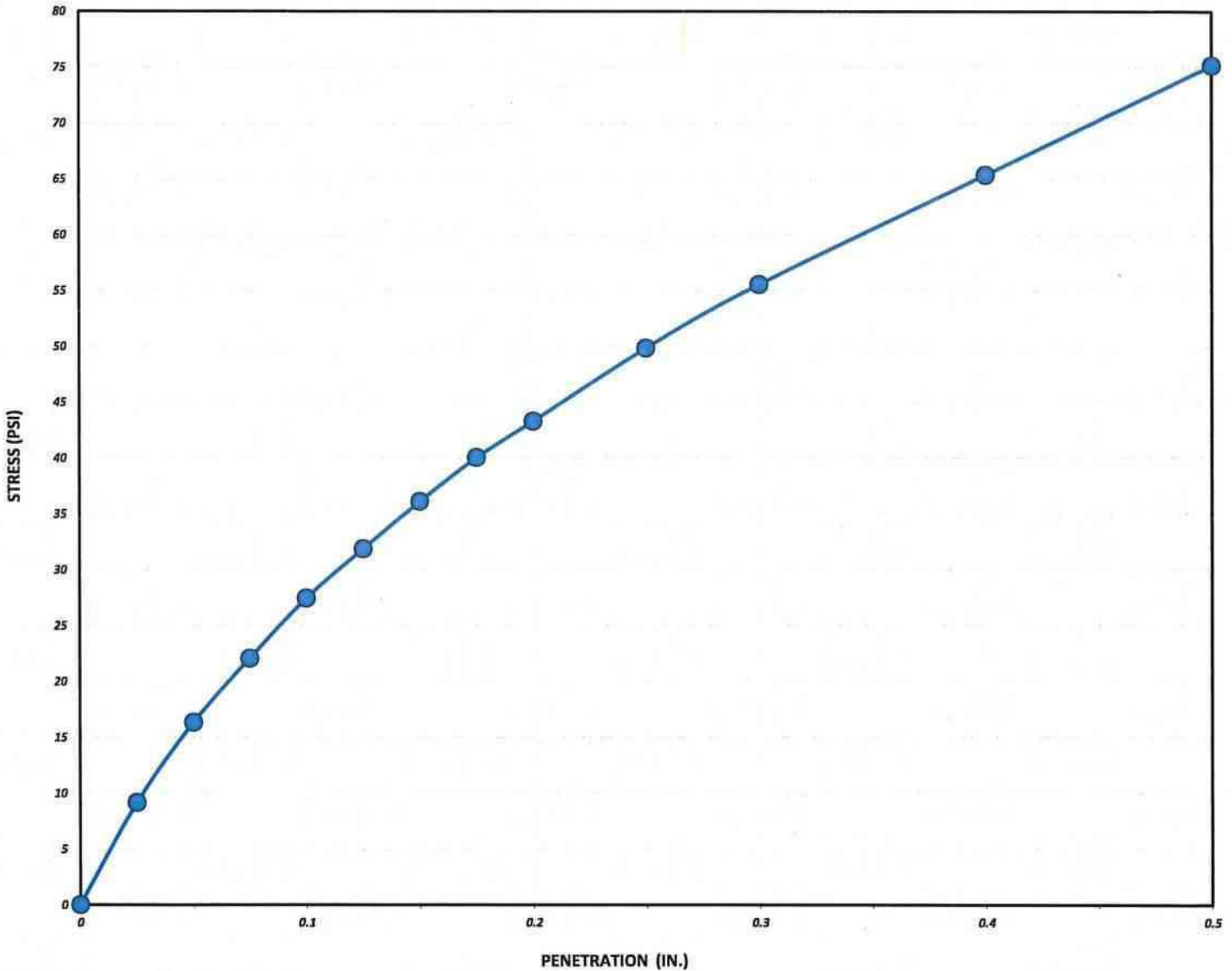
CBR AT 0.1"

**2.7**

CBR AT 0.2"

**2.9**

	DRY UNIT WEIGHT (PCF)	MOISTURE CONTENT (%)	COMPACTION (%)	SWELL (%)
<i>As Molded</i>	117.1	8.5	93.2	-
<i>After Soak</i>	111.0	17.9	88.3	5.20



MC LL PL PI USCS AASHTO FINES VISUAL SOIL DESCRIPTION

Light brown sandy clay with gravel

**FRANCONIA SPRINGFIELD METRO STATION**

BORING: B-102  
 SAMPLE: Bulk  
 DEPTH:

PROJECT #: 11-103W  
 SAMPLED: -  
 LOCATION: -

**JAY KAY TESTING**  
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**CALIFORNIA BEARING RATIO TEST RESULTS**

METHOD: AASHTO T-193, COMPACTION: AASHTO T-180 (C)

SURCHARGE: 75 PSF

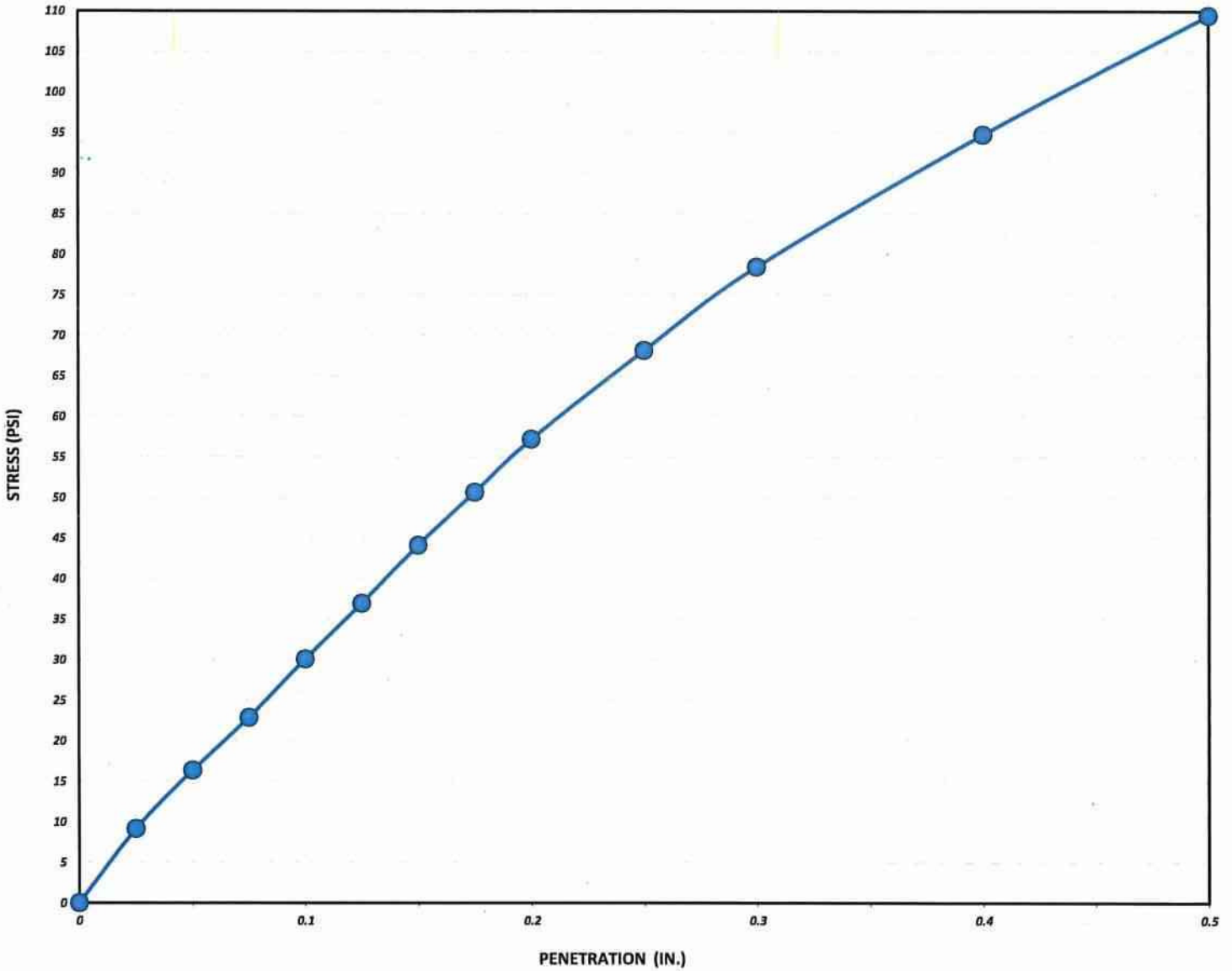
CBR AT 0.1"

**3.0**

CBR AT 0.2"

**3.8**

	DRY UNIT WEIGHT (PCF)	MOISTURE CONTENT (%)	COMPACTION (%)	SWELL (%)
<i>As Molded</i>	121.8	8.5	97.0	-
<i>After Soak</i>	114.8	16.0	91.4	6.14



MC	LL	PL	PI	USCS	AASHTO	FINES	VISUAL SOIL DESCRIPTION
-	-	-	-	-	-	-	Light brown sandy clay with gravel

**FRANCONIA SPRINGFIELD METRO STATION**

BORING: B-107  
 SAMPLE: Bulk  
 DEPTH:

PROJECT #: 11-103W  
 SAMPLED: -  
 LOCATION: -

**JAY KAY TESTING**  
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**CALIFORNIA BEARING RATIO TEST RESULTS**

METHOD: AASHTO T-193, COMPACTION: AASHTO T-180 (C)

SURCHARGE: 75 PSF

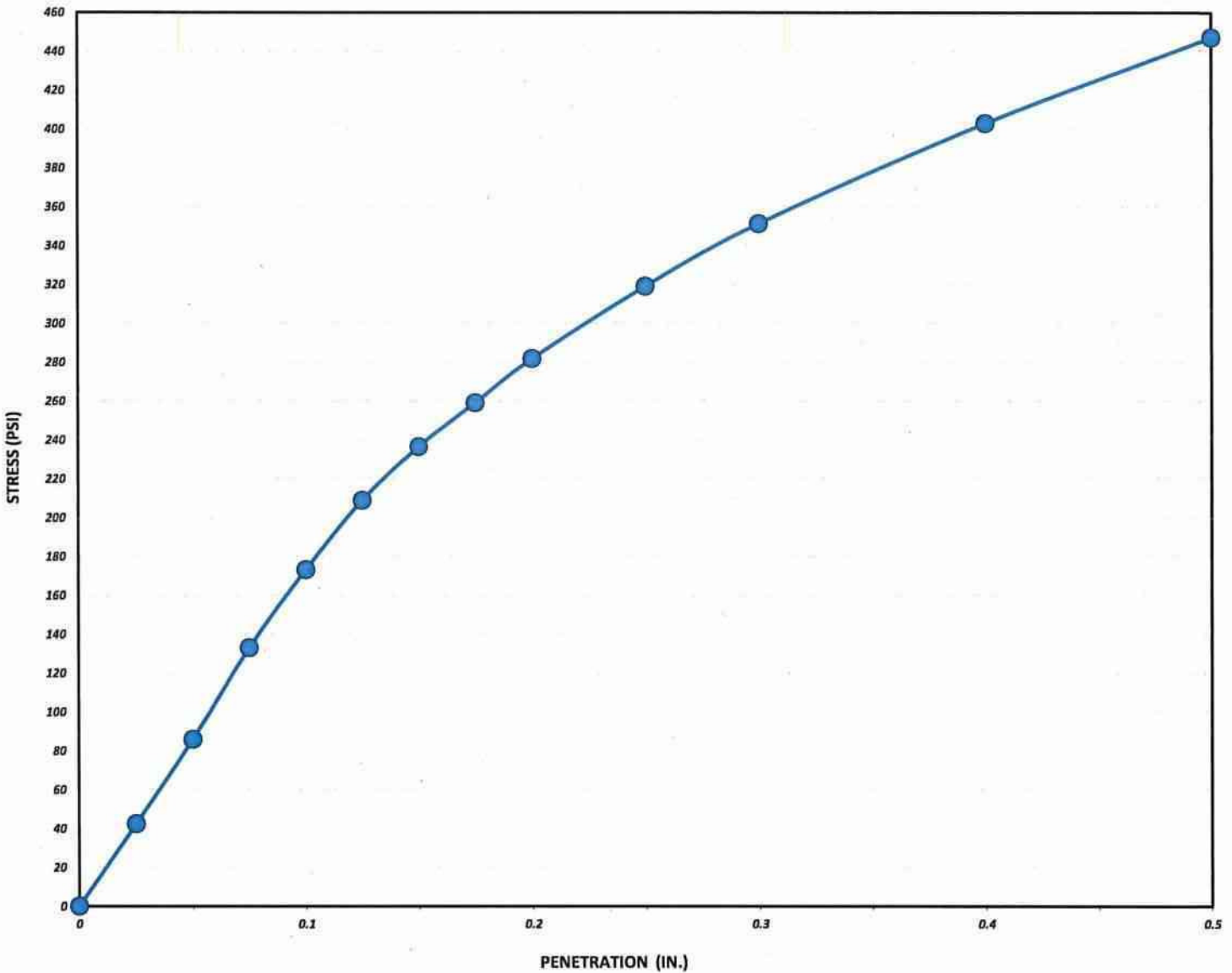
CBR AT 0.1"

**17.3**

CBR AT 0.2"

**18.8**

	DRY UNIT WEIGHT (PCF)	MOISTURE CONTENT (%)	COMPACTION (%)	SWELL (%)
<i>As Molded</i>	123.0	9.5	93.4	-
<i>After Soak</i>	122.2	12.8	92.9	1.16



MC LL PL PI USCS AASHTO FINES VISUAL SOIL DESCRIPTION

Brown clayey sand with gravel

**FRANCONIA SPRINGFIELD METRO STATION**

BORING: B-107  
 SAMPLE: Bulk  
 DEPTH:

PROJECT #: 11-103W  
 SAMPLED: -  
 LOCATION: -

**JAY KAY TESTING**  
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**CALIFORNIA BEARING RATIO TEST RESULTS**

CORRECTED CBR AT 0.1"

CORRECTED CBR AT 0.2"

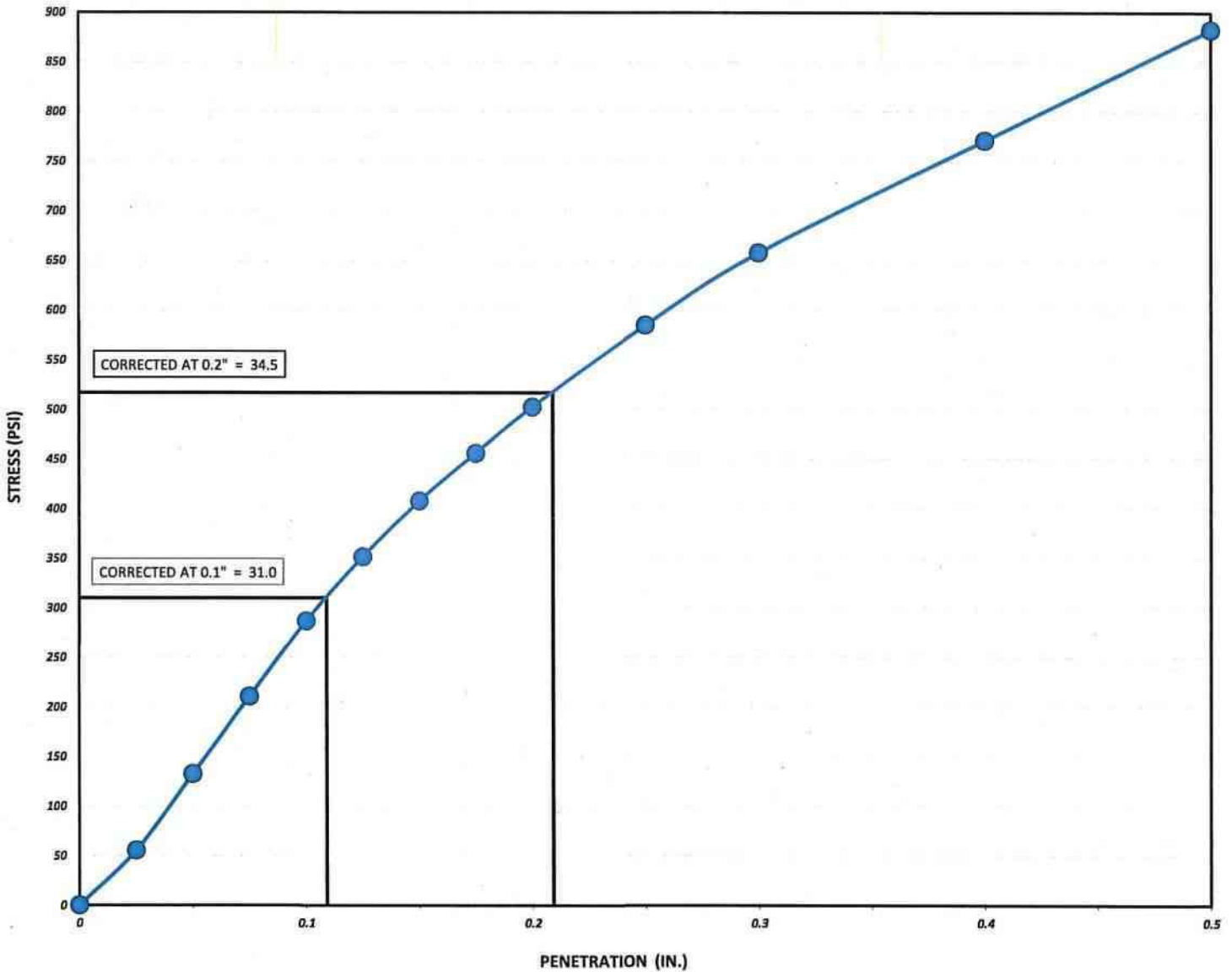
METHOD: AASHTO T-193, COMPACTION: AASHTO T-180 (C)

**31.0**

**34.5**

SURCHARGE: 75 PSF

	DRY UNIT WEIGHT (PCF)	MOISTURE CONTENT (%)	COMPACTION (%)	SWELL (%)
<i>As Molded</i>	129.1	9.3	98.1	-
<i>After Soak</i>	128.4	10.6	97.6	0.74



MC	LL	PL	PI	USCS	AASHTO	FINES	VISUAL SOIL DESCRIPTION
-	-	-	-	-	-	-	Brown clayey sand with gravel



**FRANCONIA SPRINGFIELD METRO STATION**

BORING: B-102  
 SAMPLE: Bulk  
 DEPTH:

PROJECT #: 11-103W  
 SAMPLED: -  
 LOCATION: -

**JAY KAY TESTING**  
 5233 Lehman Road, Suite 110  
 Spring Grove, PA 17362  
 Phone: (410) 259-5101

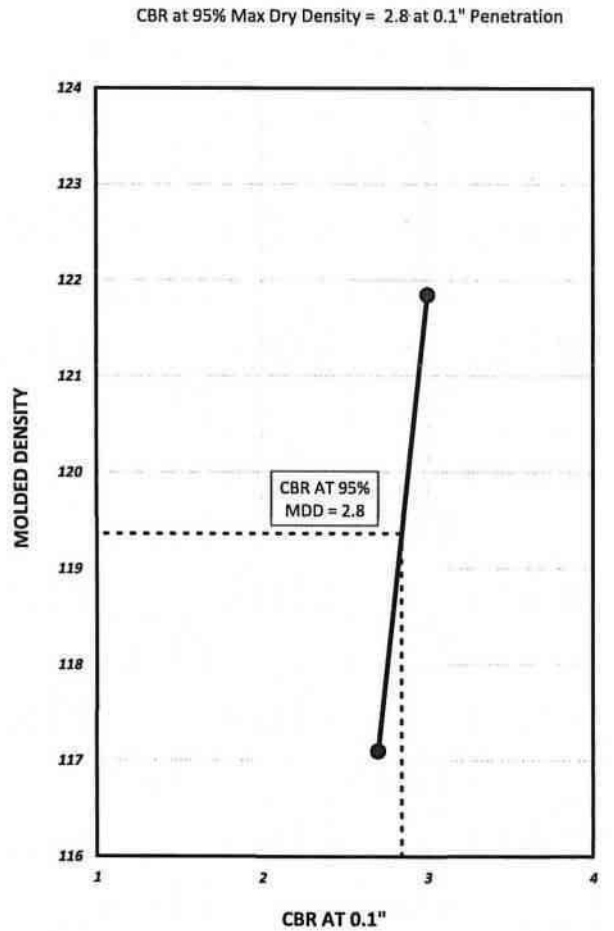
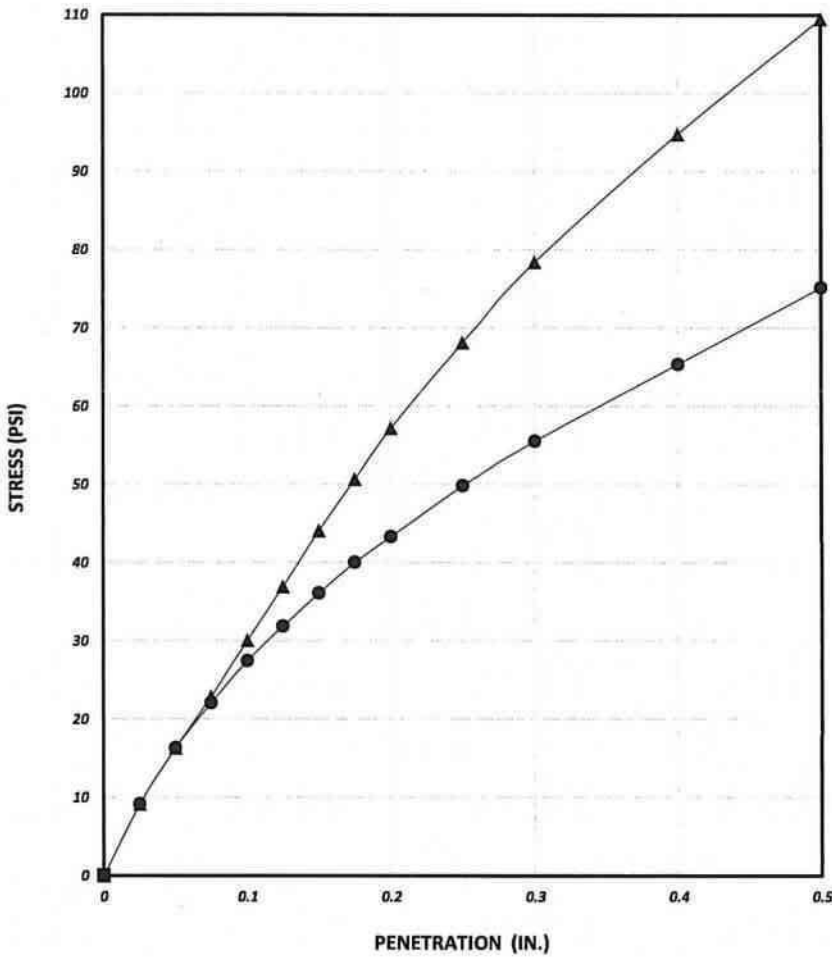
**CALIFORNIA BEARING RATIO TEST RESULTS**

MAXIMUM DRY DENSITY: 125.7 PCF

OPTIMUM MOISTURE CONTENT: 8.4 %

METHOD: AASHTO T-193, COMPACTION: AASHTO T-180 (C)

	AS MOLDED			AFTER SOAK			SURCHARGE: 75 PSF			
	Compaction	Density	Moisture	Compaction	Density	Moisture	CBR at 0.1"	CBR at 0.2"	Blows	Swell
●	93.2	117.1	8.5	88.3	111.0	17.9	2.7	2.9	15	5.20
▲	97.0	121.8	8.5	91.4	114.8	16.0	3.0	3.8	40	6.14
■	-	-	-	-	-	-	-	-	-	-
	%	PCF	%	%	PCF	%				%



MC LL PL PI USCS AASHTO FINES

VISUAL SOIL DESCRIPTION

Light brown sandy clay with gravel

# FRANCONIA SPRINGFIELD METRO STATION

BORING: B-107  
 SAMPLE: Bulk  
 DEPTH:

PROJECT #: 11-103W  
 SAMPLED: -  
 LOCATION: -

JAY KAY TESTING  
 5233 Lehman Road, Suite 110  
 Spring Grove, PA 17362  
 Phone: (410) 259-5101

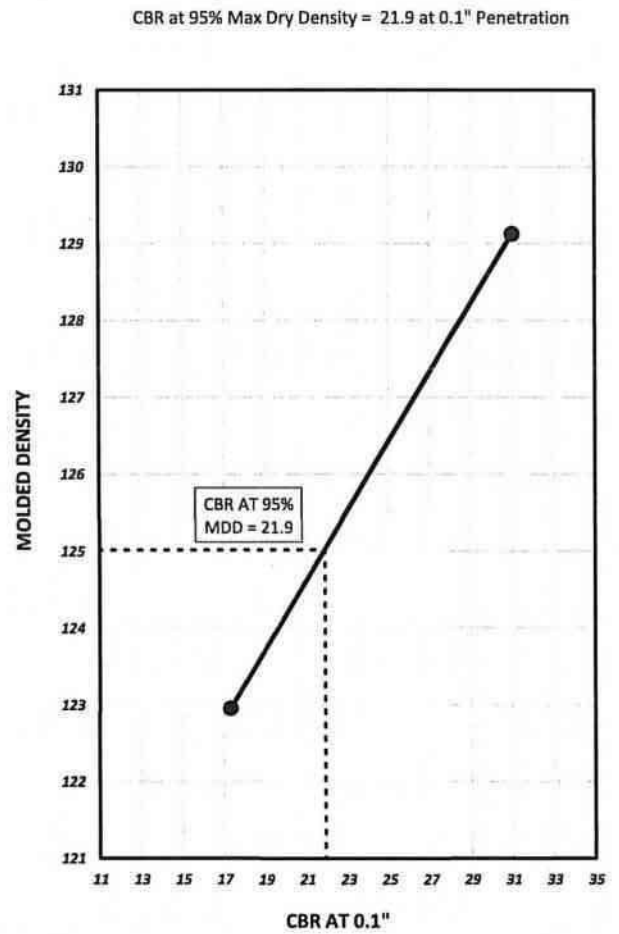
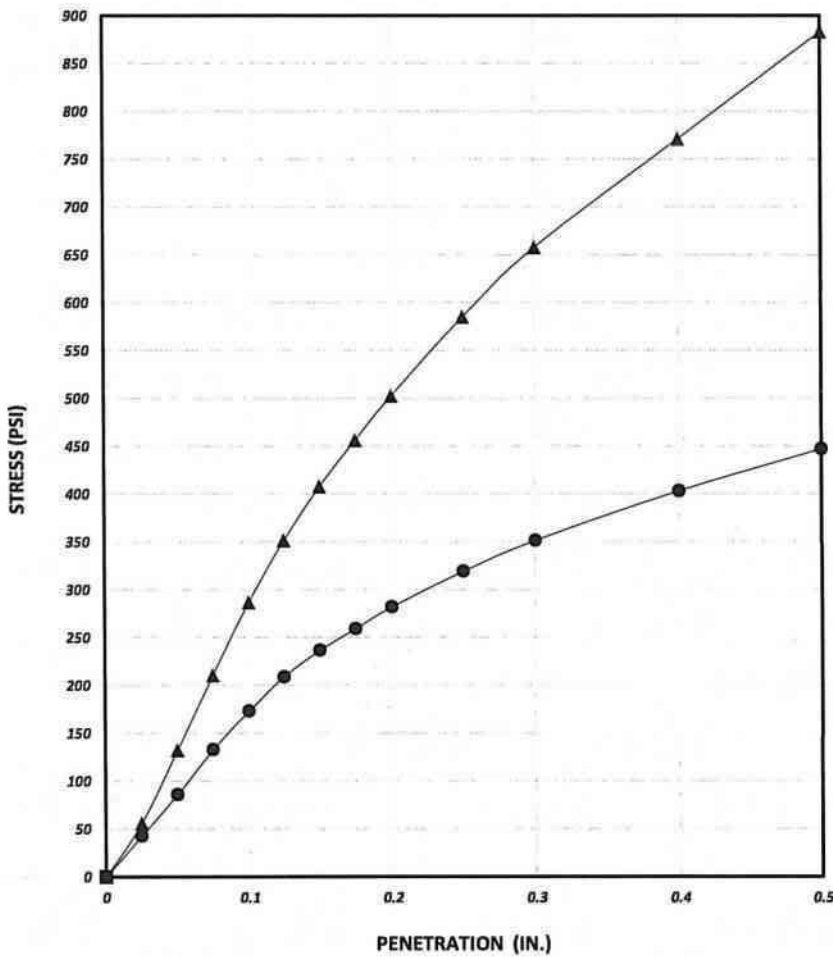
## CALIFORNIA BEARING RATIO TEST RESULTS

MAXIMUM DRY DENSITY: 131.6 PCF

OPTIMUM MOISTURE CONTENT: 9.0 %

METHOD: AASHTO T-193, COMPACTION: AASHTO T-180 (C)

	AS MOLDED			AFTER SOAK			SURCHARGE: 75 PSF			
	Compaction	Density	Moisture	Compaction	Density	Moisture	CBR at 0.1"	CBR at 0.2"	Blows	Swell
●	93.4	123.0	9.5	92.9	122.2	12.8	17.3	18.8	15	1.16
▲	98.1	129.1	9.3	97.6	128.4	10.6	31.0*	34.5*	40	0.74
■	-	-	-	-	-	-	-	-	-	-
	%	PCF	%	%	PCF	%	*DENOTES CORRECTED VALUE			%



MC LL PL PI USCS AASHTO FINES

VISUAL SOIL DESCRIPTION

Brown clayey sand with gravel

## Section 00800

### SUPPLEMENTARY CONDITIONS

This Section includes Modifications to the Section 00700, GENERAL CONDITIONS, for requirements unique to a specific project and is hereby incorporated into the General Conditions by reference. This Section 00800, SUPPLEMENTARY CONDITIONS, which specifies modifications to the General Conditions, shall be read in conjunction with Section 00700, GENERAL CONDITIONS, and which will be cited in Section 00700, GENERAL CONDITIONS, using the same last two digits of the Section number; i.e., a modification to Section 00724, COMMENCING THE WORK, is indicated as Section 00824, COMMENCING THE WORK.

#### 00810 WORKS BY CONTRACTOR

Modify Section 00710, WORK BY CONTRACTOR, to delete Paragraph A. and substitute the following Paragraph:

- A. The Contractor shall perform, with its own organization, work equivalent to at least 20% of the value for the construction work.

#### 00824 PERIOD OF PERFORMANCE AND PROJECT SCHEDULE

Modify Section 00724, PERIOD OF PERFORMANCE AND PROJECT SCHEDULE, to delete Paragraph A and substitute the following Paragraph and subparagraphs:

- A. The Contractor shall perform, complete, and advance all Work under this Contract in accordance with the schedule set out:
  1. Interim & Final Work Completion:
    - a. Milestone 1: Canopy Shop Drawing Submittal (PE stamped and sealed) – Complete all calculations, design and shop drawings, Notice to Proceed + 40 Days
    - b. Milestone 2: All Work Completion – Perform, complete and advanced all work including final completion and close out under this Contract, Notice to Proceed + 275 Days
- B. The Authority may modify the Contract, pursuant to Section 00748, CHANGES, to extend the Period of Performance as often and in time periods as deemed necessary until completion of the Work under this Contract.
- C. Early Completion: If the Contractor submits, in accordance with Section 01332, CONTRACT PROGRESS REPORTING, a schedule or expresses an intention to complete the Work earlier than any required Milestone, interim, or Final Completion date, the Authority shall not be

liable for any costs incurred because of delay or hindrance should the Contractor be unable to complete the Work before such Milestone, interim or Final Completion date. The duties, obligations, and warranties of the Authority to the Contractor shall be consistent with and applicable only to the completion of the Work and completion dates set forth in this Contract.

#### 00833 AUTHORITY-FURNISHED PROPERTY

Modify Section 00733, AUTHORITY-FURNISHED PROPERTY, to delete Paragraphs A through D and substitute the following Paragraph:

- A. The Authority will not furnish property, real or otherwise, through the terms of this Contract. The Contractor is required to purchase or lease any property needed for, but not limited to, laydown, storage, or employee parking in its obligations to comply with the Project requirements.

#### 00841 CONSIDERATION AND BASIS OF PAYMENT

Modify Section 00741, CONSIDERATION AND BASIS OF PAYMENT, in its entirety, and substitute the following:

- A. In consideration of its undertaking under this Contract, the Contractor will be paid the sums set forth in this Contract, which shall constitute complete payment for all work and services required to be performed under this Contract and for all expenditures, which may be made and expenses incurred. The basis of payment will be the Contract Price, as shown on Section 00510, CONSTRUCTION CONTRACT FORM, and which shall constitute complete compensation for performance of all work required by the Contract.
- B. Standby cost for delayed or cancelled Site access: In the event the Contractor is delayed in the performance of the Work due to Authority delayed or cancelled Site access, the following basis of payment shall apply:
  - 1. The "Hours of Work" is the period during which the Contractor has use of the work area. The "Hours of Work" will exclude the periods required by the Authority to safely secure the work area before the start of the "Hours of Work" and to restore the work area to an operational state after completion of the "Hours of Work".
  - 2. Delay will be measured relative to "Hours of Work" only. The "Hours of Work" shall be determined based upon weekly coordination between the Contracting Officer Representative (COR) and the Contractor as defined in Section 01141, ACCESS TO SITE. If the Authority delays the "Access to Site Time", but is also able to delay the "Off Site Time", as defined in Table 01141-01 to Section 01141 ACCESS TO SITE, and the Contractor is able to work for a number of hour's equivalent to the Hours of Work, this will not constitute a delay. If the Contractor is not given the access for a number of hour's equivalent to the Hours of Work, only the differential between the hours the Contractor was given the access and the Hours of Work will constitute a Delay.

3. Delays caused by actions of the Authority may occur at the start of the “Hours of Work”, during the “Hours of Work”, or at the end of the “Hours of Work.”
  - a. A delay at the start of the “Hours of Work” occurs when the Authority does not grant access to the work area by the scheduled start time. A delay at the start of the “Hours of Work” will be measured from the scheduled start of the “Hours of Work” until the time the Contractor is granted access to the work area.
  - b. A delay during the “Hours of Work” occurs when the Authority requests the Contractor to vacate the work area and the Contractor is later allowed to return to the work area. A delay during the “Hours of Work” will begin when the Contractor is directed to stop work to vacate the work area and will end when the Contractor returns to the work area and resumes work.
  - c. A delay at the end of the “Hours of Work” occurs when the Authority requests the Contractor to vacate the work area early. A delay at the end of the “Hours of Work” will be measured from the time the Contractor is directed to vacate the work area until the scheduled end of the “Hours of Work”.
4. The Contractor will be compensated for the direct labor costs incurred for the aggregate of delays that exceed 30 minutes relative to the “Hours of Work”. For payment purposes, delays will be rounded to the nearest 30 minutes provided the Contractor remains mobilized until granted access or until the Contractor elects to cancel the work, or the Contracting Officer Representative cancels access for the period. However if the Contractor elects to cancel work due to a lack of time remaining in the “Hours of Work” period to complete the planned work element, as verified by the Period of Delay form, the Contractor will be compensated for the aggregate of delays that exceed 30 minutes rounded to the nearest 30 minutes from the time access was cancelled to the scheduled end of the “Hours of Work” period.
5. When access to the work area is cancelled by the Contracting Officer Representative with less notice than noted below, the Authority will pay standby cost of not more than the scheduled “Hours of Work” period.
  - a. Weeknights: Twenty-four before the planned start time of the scheduled “Hours of Work.”
  - b. Weekdays: Twenty-four hours before the planned start time of the scheduled “Hours of Work.”
  - c. Weekends: No compensation will be provided for cancellation of planned work.
6. No payment will be made in those cases where:
  - a. A delay at the start of the “Hours of Work” is less than 1 hour and the Authority grants access but the Contractor elects to cancel work, except that payment for

delay cost will be made in accordance with Paragraph B.4 above if the scheduled "Hours of Work" period is 3 hours or less.

- b. A delay at the start of the "Hours of Work" is less than 1 hour and the Authority grants access and the Contractor proceeds working and then elects to cease working and leaves the worksite prior to the scheduled end of the "Hours of Work".
7. Prior to the completion of each shift, the Contractor and the Contracting Officer Representative or designee shall sign a Period of Delay form, which shall document the work start and completion times, the duration of the delay, the reason for the delay, the reason for the Contractor leaving the Site prior to the scheduled end of the "Hours of Work" period, and the names of the crew members present, including foremen, but excluding salaried supervision. The Contractor shall not be entitled to compensation for equipment, overhead, profit or extended overhead costs under this Section; however, this Section does not prohibit the Contractor from seeking an equitable adjustment for equipment costs under other sections of the Contract and access delays may provide a basis to grant a non-compensable extension to the Period of Performance. Certified payrolls shall establish the hourly rates of the crewmembers. All requests for payment for delay costs shall be submitted to the Contracting Officer Representative with the next progress payment or within 30 Days, whichever is longer. The Contractor waives any right to delay costs where the delays are not documented prior to the completion of the shift and the request for payment is not submitted to the Contracting Officer Representative with the next progress payment or within 30 Days, whichever is longer.

#### 00844 METHOD OF PAYMENT

Modify Section 00744, METHOD OF PAYMENT, to add Paragraphs M and N:

- M. As a condition of Final Payment, in addition to the retainage specified in Section 00744, Method of Payment, **\$10,000** will be withheld until approved As-built Project Schedule is delivered to the Contracting Officer Representative and is determined to be complete and accurate.
- N. As a condition of Final Payment, in addition to the retainage specified in this Section, \$25,000 will be withheld until Operation and Maintenance Training is complete and accepted.

#### 00865 DISADVANTAGED BUSINESS ENTERPRISE

Modify Section 00765, DISADVANTAGED BUSINESS ENTERPRISE, to delete Paragraph B and substitute the following:

The goal of DBE participation established for this Contract is **18%** percent of the Contract Price.

#### 00878 LIQUIDATED DAMAGES

Modify Section 00778, LIQUIDATED DAMAGES, to delete Paragraph A. and substitute the following Paragraph and subparagraphs:

- A. The Contractor understands that if it fails to complete portions of or all of the Work as described in Section 00824, PERIOD OF PERFORMANCE AND PROJECT SCHEDULE, the Authority will suffer damages, which have been estimated and are as specified below:
  - 1. Milestone 1: Canopy Drawing Submittal (PE stamped and sealed) – Complete all calculations, design and shop drawings, Notice to Proceed + 40 Days: \$600 per day.
  - 2. Milestone 2: All Work Completion – Perform, complete and advanced all work including final completion and close out under this Contract, Notice to Proceed + 275 Days: \$1,800 per day.

#### 00891 LIVING WAGE

- A. This Contract is subject to the Authority's Living Wage Policy and implementing regulations. The Living Wage provision is required in all contracts for services (including construction) awarded in an amount that exceeds \$100,000 in a 12-month period.
  - 1. The Authority Living Wage Rate is \$13.46 per hour, and may be reduced by the Contractor's per-employee cost for health insurance.
  - 2. The Contractor shall:
    - a. Pay, at a minimum, the Authority Living Wage Rate, effective during the time the work is performed, to all employees who perform work under this contract, except as otherwise provided in paragraph (d) below;
    - b. Include the Living Wage clause in all Subcontractors that exceed \$15,000 in a 12-month period awarded under this Contract;
    - c. Maintain payroll records, in accordance with the retention and examination of records requirements in the General Conditions, and shall include a similar provision in affected Subcontracts that requires the Subcontractor to maintain its payroll records for the same length of time; and
    - d. Submit records with each monthly invoice supporting payment of the Living Wage Rate.
  - 3. The Contractor shall not split or subdivide a contract, pay an employee through a third party, or treat an employee as a Subcontractor or independent contractor to avoid compliance with the Living Wage provisions.
  - 4. Exemptions to the Living Wage provisions include:

- a. Contracts and agreements with higher negotiated wage rates;
  - b. Contracts that are subject to higher wage rates required by federal law or collective bargaining agreements (e.g., Davis Bacon);
  - c. Contracts or agreements for regulated utilities;
  - d. Emergency services to prevent or respond to a disaster or imminent threat to public health and safety; and
  - e. Contractors who employ fewer than ten employees
5. The Authority may adjust the Living Wage rate effective in January of each year. The adjustment will reflect the average Living Wage Rate among Metro's Compact Jurisdictions with Living Wage provisions. If after Contract award the Living Wage Rate increases, the Contractor is entitled to an equitable adjustment to the rate in the amount of the increase for employees who are affected by the escalated wage.
  6. Failure to comply with the Authority's Living Wage provisions shall result in the Authority's right to exercise available Contract remedies, including Contract termination or debarment from future contracts.

#### 00892 NOTIFICATION OF FEDERAL PARTICIPATION

- A. This Project is being funded in whole or part with Federal Funds.

#### 00893 WHISTLEBLOWER PROTECTIONS

- A. The Contractor and all Subcontractors are prohibited from discharging, demoting, or otherwise discriminating against an employee as a reprisal for disclosing, including a disclosure made in the ordinary course of an employee's duties, information that the employee reasonably believes is evidence of reports of fraud, waste, gross mismanagement, abuse of authority, violations of law, and threats to health, safety, and security.
  1. Under the National Transit Systems Security Act (NTSSA), 6 U.S.C. §1142, employees of Metro contractors or subcontractors may file a complaint of discrimination with the U.S. Department of Labor, for lawfully and in good faith:
    - a. reporting a hazardous safety or security condition;
    - b. refusing to work when a hazardous safety or security condition presents an imminent danger of death or serious injury; there is no reasonable alternative to refusal; there is not sufficient time to eliminate the danger in absence of refusal; and the individual, where possible, has notified the Metro contractor or subcontractor of the condition and of the intent to not perform work;
    - c. refusing to authorize the use of any safety or security related equipment, track or structures, if the individual is responsible for their inspection or repair and



reasonably believes they are in a hazardous safety or security condition; there is no reasonable alternative to refusal; there is not sufficient time to eliminate the danger in absence of refusal; and the individual, where possible, has notified the Metro contractor or subcontractor of the condition and of the intent not to authorize use of hazardous equipment or infrastructure unless corrected;

- d. providing information for or directly assisting in an investigation of conduct that the individual reasonably believes to be in violation of Federal law regarding safety, security, or fraud, waste, or abuse of funds intended for safety or security;
  - e. refusing to violate or assist in violation of Federal safety or security law;
  - f. cooperating with a safety or security investigation by the U.S. Secretary of Transportation, U.S. Secretary of Homeland Security, or the National Transportation Safety Board;
  - g. furnishing information to law enforcement agencies relating to an accident or incident resulting in damage to property, injury, or death; or
  - h. filing a complaint under the NTSSA or testifying regarding such complaint.
2. Under the American Recovery and Reinvestment Act (ARRA), Public Law 111-5, § 1553, employees of Metro contractors or subcontractors may file a complaint of discrimination with the Inspector General of the appropriate federal agency for reporting to supervisors and other authorized individuals and agencies evidence that the individual reasonably believes demonstrates:
- a. gross mismanagement of an ARRA project;
  - b. gross waste of ARRA funds;
  - c. a substantial and specific danger to public health and safety related to an ARRA project;
  - d. violation of law relating to ARRA funds or an ARRA project; or
  - e. abuse of authority related to the implementation of ARRA funds.
- B. The Contractor will be required to post a notice of the rights and remedies provided to employees under Section 1553 of the American Recovery and Reinvestment Act of 2009. The Contractor also agrees to include these requirements in each Subcontract financed in whole or in part with Covered Funds. The notice must substantially comply with the sample notice, which may be downloaded at:

<http://www.recovery.gov/sites/default/files/Whistleblower+Poster.pdf>

00894 COMMUNITY OUTREACH

- A. The Authority will establish a program of public contact for conducting effective relationships with communities and businesses in proximity to the construction areas. Do not initiate contact with the public without Contracting Officer Representative approval.
- B. The Authority will contact those residents and business owners who might reasonably be expected to be affected by the construction and make known to them the name of the Authority's representative on the worksite with responsibility for community outreach and explain to them the means by which the representative can be contacted expeditiously.
- C. Contractor shall designate an on-Site, community outreach liaison with 24-hour, on-call availability for the duration of the Contract. Community outreach liaison duties include:
  - 1. Staying informed of problems caused by the construction.
  - 2. Assisting the Authority in notifying adjacent owners of upcoming work
  - 3. Preparing and posting advance notice signs as necessary to inform public and surrounding businesses of upcoming construction activities.
  - 4. Assisting the Authority in responding to complaints
  - 5. Attending public outreach meetings, as necessary: Meetings can include regular construction information meetings, quarterly open houses, media inquiries, tours, ground breaking, and other milestone events.
  - 6. Accommodating Site tours: Tours shall be arranged through the Contracting Officer Representative.

Appendix D - Wage Determination of the Secretary of Labor

END OF SECTION

SECTION 02750

CONCRETE PAVEMENT

PART 1 GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing Portland cement concrete pavements complete in place as shown.
- B. Related Work Specified Elsewhere:
  - 1. Base for Pavements: Section 02720.
  - 2. Concrete Formwork: Section 03100.
  - 3. Concrete Reinforcement: Section 03200.
  - 4. Cast-in-Place Structural Concrete: Section 03300.

1.02 SUBMITTALS:

- A. Submit the following for approval in accordance with the General Requirements with the additional requirements as specified for each:
  - 1. Shop Drawings:
    - a. Joint devices.
  - 2. Certification: As specified in Section 03300, Cast-in-Place Structural Concrete, including design mixes.
  - 3. Certifications:
    - a. Buy America Act Certification

1.03 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards, and Specifications:
  - 1. Comply with codes and regulations of the jurisdictional authorities.
  - 2. American Association of State Highway and Transportation Officials (AASHTO): M33, M74, M81, M148, M153, M171, M182, M194, M220, M227, T51 T148.
  - 3. FS: SS-S-164, SS-S-195, TT-P-86, TT-S-00227.
  - 4. ASTM International (ASTM):
    - a. ASTM A185, Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
    - b. ASTM A370, Standard Test Methods and Definitions for Mechanical Testing of Steel Products.
    - c. ASTM A615, Standard Specification for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement.
    - d. ASTM C33, Standard Specification for Concrete Aggregates.
    - e. ASTM C294, Standard Descriptive Nomenclature for Constituents of Concrete Aggregates.
    - f. ASTM C920, Standard Specification for Elastomeric Joint Sealants.
  - 5. Buy American Act:
    - a. Except for those products which are exempt under the specific statutory waivers stipulated in 49 CFR 661, all other products supplied under this Section must comply with the requirements of the Buy American Act.
- B. Concrete: Conform to quality assurance requirements as specified in Section 03300, Cast-in-Place Structural Concrete and this section.

- C. Testing: Subject concrete for pavements to test procedures specified in Section 03300, Cast-in-Place Structural Concrete.

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING:

- A. Aggregates and Cement: As specified in Section 03300, Cast-in-Place Structural Concrete.

1.05 JOB CONDITIONS:

- A. Environmental Requirements:
  - 1. Do not place concrete on frozen soil base.
  - 2. Apply joint sealer when the air temperature is 50°F or higher.
- B. Refrain from placing concrete while the temperature is lower than 40F or when by the National Weather Service forecast it may be expected to reach 40F or lower during the 24-hour period following placement of concrete.

PART 2 PRODUCTS

2.01 MATERIALS:

- A. Subgrade Paper: AASHTO M74.
- B. Polyethylene sheet and tape: AASHTO M171, white opaque for curing.
- C. Welded Wire Fabric: Welded steel-wire fabric, ASTM A185.
- D. Bituminous Paint: AASHTO M81, Grade RC-250.
- E. Joint Devices: Use joint devices which are so designed that, when under the load of fresh concrete, the parts will deviate no more than 1/4 inch from the position shown and not more than 1/8 inch from the specified tolerances, and that the finish joints can be constructed to these same tolerances. Provide joint devices complete with accessories, approved supporting devices, and installing devices and equipment.
  - 1. Tie bars: ASTM A615, Grade 60.
  - 2. Tie rod assemblies: Tensile requirements of AASHTO M227, Grade 80 based on measured cross-sectional area of unthreaded portion of bar when tested in assembled condition in accordance with ASTM A370.
  - 3. Dowels:
    - a. Plain round bars, AASHTO M227, Grade 80 coated with paint, FS TT-P-86, Type I.
    - b. Dowel sleeves in accordance with the following:
      - 1) Snug fit with dowel bar.
      - 2) Closed end.
      - 3) Limit stop for dowel approximately one inch from closed end.
      - 4) Sufficient rigidity to prevent entry of fresh concrete and collapse during construction.
  - 4. Grease for Dowels: Approved water-resistant graphite grease.
  - 5. Preformed joint fillers: AASHTO M153, Type II.
  - 6. Preformed Plank: Rigid plank of asphalt hardboard or similar material approved by the Engineer.
- F. Joint Sealer Materials:

1. Joint sealing compound: Materials so proportioned that joints will be satisfactorily sealed from moisture and other foreign matter. Add appropriate tinting during manufacture, if necessary, to produce a black color.
  - a. Hot-poured joint sealing compound for joints in concrete pavement: FS SS-S-164 except the use of ground rubber scrap is prohibited. Ductility of not less than 40 centimeter in accordance with AASHTO T51; flow at 140F not greater than 1.0 centimeter.
  - b. Cold-applied joint sealing compound for joints in concrete pavement: FS SS-S-195.
  - c. Joint sealing compound for joints between concrete pavement and other structures: FS TT-S-00227.
  
- G. Preformed joint seals: AASHTO M220.
  
- H. Burlap: AASHTO M182, Class 3.
  
- I. Waterproof paper: AASHTO M171.
  
- J. White burlap-polyethylene sheet shall conform to AASHTO Designation M171.
  
- K. Liquid Membrane Forming Curing Compounds: AASHTO M148, Type 1, resin base, wax-free.
  
- L. Concrete: Section 03300, Cast-in-Place Structural Concrete, **Class 4000**, air-entrained, amended as follows:
  1. Portland cement: Type I.
  2. Minimum cement content: Six bags per cubic yard of concrete.
  3. Maximum water content: 0.45 maximum water cement ratio.
  4. Air content: 6-1/2 percent plus-or-minus 1-1/2 percent by volume.
  5. Slump: 2-1/2 inches plus-or-minus 1/2 inch.
  6. Water reducing admixture: AASHTO M194, Type A or D as directed.
  7. Coarse aggregate:
    - a. Size: ASTM C33 Size No. 67 or a combination of Size No. 4 and Size No. 67.
    - b. Deleterious materials: Maximum amount of soft fragments, 2.0 percent by weight; maximum amount of coal and lignite 0.25 percent by weight; and material passing Size 200 sieve 0.5 percent by weight.
    - c. Maximum abrasion loss: 40 percent by weight.
  8. Fine aggregate:
    - a. Deleterious material: Maximum amount of friable particles, 0.5 percent by weight; maximum amount of coal and lignite 0.25 percent by weight; material passing Size 200 sieve three percent maximum by weight.
  
- M. High-Early-Strength Concrete: As specified for concrete and modified to produce high-early-strength concrete by one or a combination of the following methods.
  1. Substitution of Type III or Type I cement in approved mix.
  2. Addition of Type I cement to the approved mix, but so that the total cement does not exceed eight bags per cubic yard of concrete.
  3. Addition of an approved accelerating admixture to approved mix as specified in Section 03300, Cast-in-Place Structural Concrete.

PART 3 EXECUTION

3.01 EQUIPMENT:

- A. General: See General Provision's Article on equipment.
  - 1. Provide suitable equipment in sufficient quantity and sizes to perform work as specified and shown.
  - 2. Maintain machinery and equipment on site in first class working condition. Provide necessary tools and supplies for maintenance.
  - 3. The term EQUIPMENT includes such specialized devices and tools that are customarily used in the construction of concrete pavements. The requirements for equipment given are not intended to be complete; rather, the intent is that characteristic equipment be used to produce certain of the required results. The suitability of the equipment is a determination made by the Engineer that the equipment will produce the required results.
  
- B. Concrete Spreading Machines: Power driven spreaders capable of spreading concrete to the full width and depth specified as it is delivered and as follows:
  - 1. Standard-width machines with adjustments up to five feet.
  - 2. Controls conveniently grouped in easy reach of the operator.
  - 3. Multiple speeds in both reverse and forward gear.
  - 4. Capable of spreading concrete to both the depth specified for reinforcement and the full thickness of the slab, without segregation and without interfering with the joints or reinforcement.
  - 5. Not disturbing the forms due to lateral pressure of the spreading operation; the weight of the machines of such amount and so distributed as not to cause settlement of the forms.
  - 6. Equipped with dismountable rims to be used when operating on concrete.
  - 7. Provided with suitable means to keep material off the wheel and the top of the forms or slab.
  - 8. Spreading accomplished by either a screw, blade, or other suitable device of the reversing type, followed by a strike-off screed; the strike-off screed adjustable to the specified crown and section.
  
- C. Internal Vibrators Operated Independently of Spreading or Finishing Machines: Use approved type of internal vibrators such as the spud-type, for compacting pavement concrete at joints and edges, operating at a frequency capable of producing at least 5,000 pulsations per minute, and with sufficient cable to permit being moved to any location directed by the Engineer. Do not use vibrators of such weight as to be unwieldy in application.
  
- D. Concrete Finishing Machines:
  - 1. Power-driven and of the transverse-screed type.
  - 2. Equipped with traction wheel or wheels with dismountable rims to be used when operating on concrete.
  - 3. Equipped with two screeds, maintained in the best possible condition and adjustment throughout their use: Front screed used for striking off excess concrete to exact grade and crown; the rear screed used for finishing and smoothing operation.
  - 4. Screeds constructed of steel, be capable of being adjusted to the specified cross section, and be of such rigidity as to produce the specified crown and cross section.
  - 5. Each screed of the floating or suspended type, at least 1-1/2 feet longer than the width between the forms, and easily and quickly adjustable to the width required.

6. Both machine and screeds are to have variable speeds and independently controlled.
7. The weight of the machines of such amount and so distributed as not to cause settlement of the forms upon which operated.
8. Provided with suitable means to keep material off the wheel and the top of the forms or slab.

E. Straightedges: Ten feet long, made of metal with handles suitable for ease of use, and rigidly constructed so that there will be no deflection exceeding 1/32 inch.

F. Templates: Constructed to extend from form to form and to ride on the form, equipped with adjustable tines spaced at six-inch intervals, and rigidly constructed that there will be no deflection exceeding 1/32 inch.

3.02 BASE:

- A. Base Preparation: In accordance with Section 02720, Base for Pavements.
- B. Check previously placed base for grade and crown with templates and straightedges for compliance with tolerances specified in Section 02720, Base for Pavements.
- C. Correct deficiencies in grade, contour and compaction.
- D. Obtain approval of base prior to placing forms and impervious material.

3.03 SETTING FORMS:

- A. Unless concrete is placed against abutting structures, use steel forms to maintain concrete within required tolerance and to support paving equipment.
- B. Use flexible steel forms for curve radii less than 250 feet. For small radius curves and non-standard closures, use approved wood forms. Provide properly drilled forms to accommodate tie rod assemblies.
- C. Set forms accurately and firmly to line and grade throughout entire length of approved base.
- D. Set forms sufficiently ahead of other work to avoid conflict during operations.
- E. Concurrent with setting of forms, cover base with layer of impervious material of either subgrade paper or polyethylene sheet.
  1. Subgrade paper: Overlap adjacent strips at least four inches and ends not less than 12 inches.
  2. Polyethylene sheet: Overlap sides at least 12 inches.
  3. Maintain cover intact until concrete is placed.
- F. Apply one coat of bituminous paint to contact areas of abutting structures and previously placed slabs.

3.04 FIELD QUALITY CONTROL:

- A. Allowable Tolerances:
  1. Joints and joint devices: Maximum deviation of 1/4 inch from position shown and 1/8 inch from ten-foot steel straightedge.
  2. Dowels: Aligned to tolerance of not more than 1/8 inch in 12 inches.

3. Fabric reinforcement:
  - a. Clearance from vertical surfaces and joints: Minus 1/4 inch or plus 1/2 inch.
  - b. Clearance from top and bottom surfaces: Plus-or-minus 1/4 inch.
  - c. Clearance from top surface of additional reinforcing at penetrating structures: Plus-or-minus 1/8 inch.
4. Top surface of concrete: Maximum deviation of 1/8 inch from ten-foot steel straightedge and within plus-or-minus 1/8 inch of the required elevation.
5. Grooves for joints: Within minus 1/16 inch or plus zero inch of dimensions shown.
6. Thickness of concrete pavement: Within minus 1/8 inch of the thickness shown, in accordance with AASHTO T148.

B. Testing of Concrete:

1. Conform to requirements specified in Section 03300, Cast-in-Place Structural Concrete.

3.05 JOINT DEVICES:

A. General:

1. Place and secure joint devices to ensure that deviation does not exceed specified tolerances. Finish joints to such tolerances.
2. Provide acceptable means of splicing.
3. Provide satisfactory gages for checking position of joint devices.
4. Where joints are to be completed after placing concrete, mark location of joint devices so as to permit installation of joint to tolerances specified.
5. Where options for construction are permitted, use approved method.
6. Do not disturb joint devices. Do not permit workers to step on joint devices. Realign devices immediately if displaced.
7. Hold initial installation of devices firmly in place by tap bolts installed in holes drilled in forms. If holes in forms have been formed by method other than drilling, use steel washers in addition to tap bolts. After removal of forms replace tap bolts until adjoining subgrade is ready for concrete placement. Remove tap bolts and install remainder of tie devices prior to placing adjoining slab. Apply heavy coating of bituminous paint prior to placing concrete for adjacent slab.

B. Construction.

1. Longitudinal: The longitudinal joint at a previously placed slab and the joint between a slab and abutting curb and gutter are longitudinal construction joints.
  - a. For these joints, with the exception of the ones at the curb and gutter sections, use a tongue-and-groove joint of an isosceles trapezoidal section one inch in height with the bases two inches and 2-1/2 inches, respectively; with the groove located as shown.
  - b. Tie the separately constructed slab sections together by the installation of longitudinal tie devices.
  - c. The groove for concrete pavement for surface course may be made by forming or sawing as specified below, or by preformed plank left in place.
  - d. Coat edges of the slab first constructed with heavy coat of bituminous paint prior to placing concrete for the adjacent slab.
2. Transverse joints: Make transverse construction joints only at a planned transverse expansion or contraction joint. Accordingly, have transverse construction joint devices conform to the requirements for the particular type of joint.



- C. Contraction Joints:
  - 1. Provide longitudinal contraction joints between previously placed slabs and new slabs and between slabs and abutting curbs and gutters.
    - a. Tie longitudinal contraction joints together by installation of 1/2-inch tie rods or tie-rod assemblies 30 inches long placed across longitudinal contraction joint and spaced as shown. Do not install tie rods or tie-rod assemblies closer than 18 inches to transverse joints.
    - b. Make groove for contraction joints by formwork, sawing or leaving filler in place.
  
- D. Expansion Joints and Joint Filler:
  - 1. Make grooves for expansion joints by forming. Where grooves are made by device, use approved device of such design that work can be properly performed.
    - a. Prepare preformed expansion joint filler in greatest length possible and no less than ten feet.
    - b. Cut filler for joints transverse to the slab in a single piece of the required shape.
    - c. Cut pieces for curb and gutter as directed to exact size, from larger pieces.
    - d. When splicing joint filler, butt tightly to prevent penetration of concrete between adjacent strips of joint filler.
    - e. For longitudinal joints, except at curb and gutter sections, use preformed tongue and groove filler as shown.
    - f. Where dowels or other approved load-transfer devices have to penetrate joint filler, properly locate and drill holes of correct size or diameter through filler at required intervals to receive bars and to achieve tight fit.
    - g. Make groove for cement pavement for surface course by forming, sawing, or leaving preformed joint in place.
    - h. Protect preformed joint filler during placing of concrete.

3.06 PLACING REINFORCEMENT:

- A. Install welded steel wire fabric in flat sheets where shown in accordance with Section 03200, Concrete Reinforcement.
- B. Unless otherwise noted, use wire fabric as follows:

Slab Thickness (Inches)	Roadway Width	
	Equal to or less than 24'-0"	Greater than 24'-0"
	Pounds/100 Square Feet	Pounds/100 Square Feet
6	44	46
8	51	54
10	61	69

- C. Place wire fabric to clear vertical surfaces and joints by two inches and within tolerances specified. Lap sheets distance equal to spacing of wires and tie securely.

- D. Place two layers of wire fabric in concrete pavements over trench cuts, each layer to be of weight and type as specified for thickness of concrete. Position each layer two inches clear of top and bottom surfaces of slab and within tolerance specified. Extend each layer nine inches beyond sides of trench.
- E. Where other structures, such as manholes, penetrate concrete pavements, place wire fabric on one inch centers in each direction so that there is a minimum of two feet of fabric extending horizontally around perimeter of structure. Install layer of fabric one inch clear of top surface of slab and within tolerance specified.
- F. In surface courses, place wire fabric two inches clear of top surface of slab and within tolerance specified.
- G. Install layer of wire fabric to serve as top layer over trenches. Install additional fabric around penetrations.
- H. Except for pavements over trench cuts and around penetrations, do not place wire fabric in base course.

3.07 PLACING CONCRETE:

- A. Supply and place Portland cement concrete as specified in Section 03300, Cast-in-Place Structural Concrete, with the following additional requirements:
  - 1. Place concrete only during daylight unless otherwise approved. If placement is authorized during darkness, provide adequate lighting system.
  - 2. Do not place concrete at temperatures below 40F unless otherwise approved; nor place concrete on a frozen base.
  - 3. Prior to placing concrete around poles, manholes or other structures projecting through pavement, coat such structures heavily with bituminous paint.
  - 4. Place concrete to the full thickness, deposited in successive batches for full width of slab by means of discharging device which does not cause segregation of materials.
  - 5. Compact concrete thoroughly during placement.
  - 6. Place concrete mechanical spreaders except where hand methods for spreading are approved. When spreading by hand, employ sufficient work force for leveling, spading and spreading concrete in front of screed. Do not use rakes for handling concrete.
  - 7. Deposit concrete as near as practicable to joints but not touching expansion and contraction joint devices. Shovel concrete to height approximately two inches more than depth of the joint. As soon as forms are removed, clean ends of expansion joints of concrete and expose full width of preformed joint filler for full depth of slab. Place concrete against previously constructed slabs only after ends of preformed joint filler have been so cleaned and ends of performed joint filler in slab being poured have been neatly and firmly butted.
  - 8. Where wire fabric is required, place concrete in layers so that wire fabric may be properly placed. Requirements for machine placing and for vibration apply for each layer. Place layers and wire fabric, large wires running in longitudinal direction in such rapid sequence that monolithic slab will result.
  - 9. Compact concrete both by internal and surface vibration. Vibrators may be combined with spreading and finishing machines. Compact concrete adjacent to forms, joints, existing concrete or other structures by use of spud vibrator. Insert vibrator in concrete and work along entire length. Avoid contact with joint devices or underlying base. Evidence of honeycomb or lack

of compaction constitute basis for rejection of concrete pavement as deficient.

10. Construction Joints:

- a. Form construction joints where it is necessary and approved to stop concreting for 30 minutes or longer, by staking in a bulkhead and finishing the concrete to the bulkhead.
- b. If, due to an emergency, concreting must be stopped within less than ten feet of a previously formed joint of any type, remove the concrete to the joint prior to resuming the placing of the slab.

3.08 INITIAL FINISHING, FLOATING, AND FINAL FINISHING:

- A. Give concrete initial finish by use of finishing machines operated so as to minimize formation of laitance and to give required uniformity of surface and compaction. Remove laitance in approved manner.
- B. Avoid prolonged operation over a given area. Operate the machine over each area of pavement as directed and only as many times and at such intervals as required to give the proper compaction and uniformity of surface.
- C. Keep tops of forms clean to permit true and accurate movement of machine.
- D. On completion of screeding, bring surface to smooth finish by use of floats, eight inches wide and a minimum of four feet long, with handles at least four feet longer than width of slab and not less than 16 feet long.
- E. Operate float transversely with combined longitudinal and transverse motion for sufficient number of passes to smooth ridges and fill depressions.
- F. On completion of floating operations, screed top surface of concrete with deviation not exceeding 1/8 inch from straightedge and within tolerance specified for required elevation. Correct deficiencies by handwork if approved.
- G. After floating and verifying that surface is within specified tolerances, drag surface in longitudinal direction with longitudinal and crosswise motions using burlap so to prevent edges digging into surface of concrete or working crown out of pavement.
- H. Brooming:
  1. Upon completion of burlap dragging, broom finish top surface of pavement. Use street brooms made for the purpose with split bamboo bristles or metal bristles.
    - a. Broom width: 14 inches.
    - b. Broom handle: At least one-half slab width.
  2. In general make brooming perpendicular to centerline of paving unless otherwise shown. Prior to brooming, obtain the Engineer's approval of the direction of brooming for each area.
  3. Pull broom gently over surface of pavement from edge to edge walking back and forth on bridge over pavement, holding handle almost vertical and allowing broom to drag lightly over surface without interruption, leaving slight ridges in concrete perpendicular to centerline of pavement.
  4. Overlap ridging. Ridging not more than 1/8 inch in depth with corrugations of uniform character and width.
  5. Complete brooming before rounding edges of pavement and joints.
- I. Round joints and edges to ¼-inch radius unless shown otherwise on the drawings.

- J. To form flow line for gutters, trowel smooth 12-inch width of pavement adjacent to curbs unless otherwise shown.
- K. Joint Work and Edging: Where there is an option of method for doing joint work, secure approval for the method elected and use only that method.
  - 1. Perform joint work and edging when condition of concrete permits.
  - 2. Ensure that joints are within tolerances specified and that there is no perceptible lip or depression other than rounding.
  - 3. Prepare clean grooves rounded to 1/4-inch radius with smooth even walls.
  - 4. Make grooves for expansion joints by forming. See requirements above for expansion joints.
  - 5. For joints to be sealed with poured sealer, prepare grooves with dimensions as shown and within tolerance specified. For joints to be sealed with preformed elastomeric seals, leave grooves of dimensions and within tolerances shown. Provide suitable gauges for checking dimensions.
  - 6. Where joints in surface course are sealed with cold-poured joint sealer, break bottom bond by placing polyethylene tape full width of groove, laid flat along top of preformed joint filler prior to joint sealing.
  - 7. When using hot-poured or cold-applied joint sealer, use only equipment designed for purpose. Hand-pouring pots are prohibited. Maintain material within temperature range recommended by manufacturer. Apply sealer when air temperature is as specified. Construct so that resulting stripe is straight, neat, of uniform width and joint is filled to 1/4 inch from top surface of pavement.
  - 8. When placing elastomeric joint seals, use equipment and methods recommended by manufacturer.

3.09 CURING:

- A. Allow finished concrete to cure by one of the following methods for seven days or until concrete has developed flexural strength of 500 psi:
  - 1. Wet burlap: Cover pavement with double thickness of thoroughly wet burlap, overlapping adjacent sheets by at least six inches. Maintain burlap in saturated state by sprinkling until it is removed. Use only clean material free from holes.
  - 2. Waterproof paper, polyethylene sheet or white burlap-polyethylene sheet: Place material so that adjacent sheets overlap by at least 12 inches. Secure material alongside and ends so as to maintain reasonably airtight seal.
  - 3. Use approved liquid-membrane curing compounds as recommended by manufacturer, using equipment designed for purpose.
- B. Obtain approval of the Engineer for the curing method elected and use only that method.

3.10 REMOVAL OF FORMS:

- A. Remove forms as soon as condition of concrete permits, but in no case sooner than 12 hours after placement.
- B. When the temperature is below 40F, leave forms in place for at least 48 hours or as directed.

3.11 COLD WEATHER CONSTRUCTION:

- A. Whenever, by the National Weather Service forecast for the locality, the temperature may be expected to reach 50F or lower during the 24-hour period following placement concrete mix, include a Type C accelerating admixture in the concrete mix as specified in Section 03300, Cast-in-Place Structural Concrete. The accelerating admixture shall comply with AASHTO M 194, Type C, except that it shall contain no more than 500 parts per million chloride ion.
- B. Place concrete when temperature conditions are as specified, unless otherwise directed. If placing of concrete is so directed, in addition to adding an accelerator heat aggregates, water or both, so that mix when laid is not less than 55F nor more than 90F. Do not exceed 140°F for mixing water and 150F for aggregates.
- C. As soon as concrete has hardened sufficiently to prevent marring, cover pavement surface and edges with dry burlap, building paper or other approved material and subsequent layer of at least six inches of dry hay, straw, or other approved material. Maintain such protection for at least three days or until field tests indicate that concrete has attained required strength.
- D. During low temperatures, install truck-mixed concrete immediately upon delivery.
- E. When temperature by National Weather Service forecast will be 40F or lower during the 72-hour period following placement of concrete, do not use membrane curing compound.

3.12 HOT WEATHER CONSTRUCTION

- A. When by National Weather Service forecast, temperature will be 90F or higher during the 24-hour period following placement of concrete, cover pavement by wet-burlap method for first 24 hours, after which curing may be completed by one of the specified methods.

3.13 PROTECTION OF CONCRETE PAVEMENT

- A. Obtain approval prior to permitting use of completed pavement by public and construction traffic.

3.14 DEFICIENT PAVEMENT

- A. Where directed, remove and replace with new materials or correct concrete pavement that does not meet requirements.

END OF SECTION

## **SECTION 02764 - SITE FURNISHINGS**

### **1.1 GENERAL**

#### **A. Description Of Work**

1. This specification covers the furnishing and installation of materials for site furnishings. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

#### **B. Summary**

1. This Section includes the following:
  - a. Seating.
  - b. Tables.
  - c. Bicycle racks.
  - d. Bicycle lockers.
  - e. Trash receptacles.
  - f. Ash receptacles.
  - g. Planters.
  - h. Bollards.

#### **C. Submittals**

1. Product Data: For each type of product indicated.
2. Samples: For each type of exposed finish required.
3. Product Schedule: For site furnishings. Use same designations indicated on Drawings.
4. Material Certificates: For site furnishings, signed by manufacturers.
  - a. Wood Preservative Treatment: Include certification by treating plant stating type of preservative solution and pressure process used, net amount of preservative retained, and compliance with applicable standards.
  - b. Sustainably Harvested Wood: Include certification by manufacturer and from sources that participate in sustained yield programs.
  - c. Recycled plastic.
5. Maintenance Data: For site furnishings to include in maintenance manuals.

### **1.2 PRODUCTS**

#### **A. Materials**

1. Aluminum: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated; free of surface blemishes and complying with the following:
  - a. Rolled or Cold-Finished Bars, Rods, and Wire: ASTM B 211 (ASTM B 211M).
  - b. Extruded Bars, Rods, Wire, Profiles, and Tubes: ASTM B 221 (ASTM B 221M).
  - c. Structural Pipe and Tube: ASTM B 429.
  - d. Sheet and Plate: ASTM B 209 (ASTM B 209M).
  - e. Castings: ASTM B 26/B 26M.
2. Steel and Iron: Free of surface blemishes and complying with the following:
  - a. Plates, Shapes, and Bars: ASTM A 36/A 36M.
  - b. Steel Pipe: Standard-weight steel pipe complying with ASTM A 53, or electric-resistance-welded pipe complying with ASTM A 135.
  - c. Tubing: Cold-formed steel tubing complying with ASTM A 500.
  - d. Mechanical Tubing: Cold-rolled, electric-resistance-welded carbon or alloy steel tubing complying with ASTM A 513, or steel tubing fabricated from steel complying with ASTM A 1011/A 1011M and complying with dimensional tolerances in ASTM A 500; zinc coated internally and externally.

- e. Sheet: Commercial steel sheet complying with ASTM A 1011/A 1011M.
- f. Perforated Metal: From steel sheet not less than 0.0747-inch (1.9-mm) **OR** 0.0897-inch (2.3-mm) **OR** 0.1196-inch (3.0-mm), **as directed**, nominal thickness; manufacturer's standard perforation pattern.
- g. Expanded Metal: Carbon-steel sheets, deburred after expansion, and complying with ASTM F 1267.
- h. Malleable-Iron Castings: ASTM A 47/A 47M, grade as recommended by fabricator for type of use intended.
- i. Gray-Iron Castings: ASTM A 48/A 48M, Class 200.
- 3. Stainless Steel: Free of surface blemishes and complying with the following:
  - a. Sheet, Strip, Plate, and Flat Bars: ASTM A 666.
  - b. Pipe: Schedule 40 steel pipe complying with ASTM A 312/A 312M.
  - c. Tubing: ASTM A 554.
- 4. Wood: Surfaced smooth on four sides with eased edges; kiln dried, free of knots, solid stock of species indicated.
  - a. Wood Species: Manufacturer's standard.
    - 1) Douglas Fir: Clear Grade, vertical grain.
    - 2) Pine: Southern pine; No. 2 or better; preservative treated, kiln dried after treatment.
    - 3) Eastern White **OR** Red **OR** Yellow **OR** Cedar, **as directed**: Select Grade or better.
    - 4) Redwood: Clear all heart **OR** Construction heart or better, **as directed**, free-of-heart center.
    - 5) Teak (Tectona Grandis): Clear Grade. Provide wood obtained from sources that participate in a well-managed forest and chain-of-custody program certified by an independent agency accredited by FSC.
    - 6) Finish: Manufacturer's standard stain and transparent sealer **OR** transparent wood preservative treatment and sealer, **as directed**.
- 5. Fiberglass: Multiple laminations of glass-fiber-reinforced polyester resin with UV-light stable, colorfast, nonfading, weather- and stain-resistant, colored polyester gel coat, and manufacturer's standard finish.
- 6. Plastic: Color impregnated, color and UV-light stabilized, and mold resistant.
  - a. Polyethylene: Fabricated from virgin plastic HDPE resin.
  - b. Recycled Polyethylene: Fabricated from not less than 96 percent recycled, purified, fractional-melt plastic resin with not less than 90 percent recycled postconsumer waste by weight HDPE.
- 7. Anchors, Fasteners, Fittings, and Hardware: Stainless steel **OR** Brass **OR** Galvanized steel **OR** Zinc-plated steel **OR** Manufacturer's standard, corrosion-resistant-coated or noncorrodible materials, **as directed**; commercial quality, tamperproof, vandal and theft resistant **OR** concealed, recessed, and capped or plugged, **as directed**.
  - a. Angle Anchors: For inconspicuously bolting legs of site furnishings to on **OR** below, **as directed** -grade substrate; one per leg **OR** extent as indicated, **as directed**.
  - b. Antitheft Hold-Down Brackets: For securing site furnishings to substrate; two per unit **OR** extent as indicated on Drawings, **as directed**.
- 8. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107; recommended in writing by manufacturer, for exterior applications.
- 9. Erosion-Resistant Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with potable water at Project site to create pourable anchoring, patching, and grouting compound; resistant to erosion from water exposure without needing protection by a sealer or waterproof coating; recommended in writing by manufacturer, for exterior applications.
- 10. Galvanizing: Where indicated for steel and iron components, provide the following protective zinc coating applied to components after fabrication:
  - a. Zinc-Coated Tubing: External, zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. (0.27 kg/sq. m) of zinc after welding, a chromate conversion coating, and a clear,



polymer film. Internal, same as external or consisting of 81 percent zinc pigmented coating, not less than 0.3 mil (0.0076 mm) thick.

- b. Hot-Dip Galvanizing: According to ASTM A 123/A 123M, ASTM A 153/A 153M, or ASTM A 924/A 924M.

B. Seating And Tables

1. Frame: Cast aluminum **OR** Cast iron **OR** Steel **OR** Stainless steel **OR** Wrought iron **OR** Cedar **OR** Teak, **as directed**.
2. Seat **OR** Seat and Back, **as directed**:
  - a. Material:
    - 1) Aluminum Sheet: Perforated **OR** Expanded, **as directed**, metal.
    - 2) Steel **OR** Painted Steel, **as directed**: Perforated metal **OR** Expanded metal **OR** Evenly spaced, parallel flat straps or bars **OR** Evenly woven, flat straps or bars **OR** Edge framed, evenly spaced, parallel rods or rolled bars, **as directed**.
    - 3) Stainless Steel: Perforated metal **OR** Expanded metal **OR** Evenly spaced, parallel flat straps or bars **OR** Evenly woven, flat straps or bars **OR** Edge framed, evenly spaced, parallel rods or rolled bars, **as directed**.
    - 4) Wood: Douglas fir **OR** Pine **OR** Cedar **OR** Redwood **OR** Teak, **as directed**; formed into evenly spaced parallel slats **OR** planks, **as directed**.
    - 5) Recycled **OR** Plastic **OR** fiberglass, **as directed**, Planks: Evenly spaced, parallel.
    - 6) Recycled **OR** Plastic **OR** Fiberglass, **as directed**, Sheet: Solid **OR** Perforated, **as directed**.
  - b. Seat Height: As indicated.
  - c. Seat Surface Shape: Flat **OR** Contoured or dished, **as directed**.
  - d. Overall Height: As indicated.
  - e. Overall Width: As indicated.
  - f. Overall Depth: As indicated.
  - g. Arms: None **OR** One, as indicated **OR** Two, one at each end **OR** Three, one at each end and in center, **as directed**.
    - 1) Arm Material: Match frame **OR** seat, **as directed**.
  - h. Seating Configuration: Multiple units as indicated.
    - 1) Straight **OR** Angled **OR** Curved, **as directed**, shape.
    - 2) Closed hexagon **OR** circle **OR** shape indicated, **as directed**, around a tree trunk **OR** planter **OR** light post, **as directed**.
3. Table Top:
  - a. Material:
    - 1) Aluminum Sheet: Perforated **OR** Expanded, **as directed**, metal.
    - 2) Steel **OR** Painted Steel, **as directed**: Perforated metal **OR** Expanded metal **OR** Evenly spaced, parallel flat straps or bars **OR** Evenly woven, flat straps or bars **OR** Edge framed, evenly spaced, parallel rods or rolled bars, **as directed**.
    - 3) Stainless Steel: Perforated metal **OR** Expanded metal **OR** Evenly spaced, parallel flat straps or bars **OR** Evenly woven, flat straps or bars **OR** Edge framed, evenly spaced, parallel rods or rolled bars, **as directed**.
    - 4) Wood: Douglas fir **OR** Pine **OR** Cedar **OR** Redwood **OR** Teak, **as directed**; formed into evenly spaced parallel slats **OR** planks, **as directed**.
    - 5) Recycled **OR** Plastic **OR** Fiberglass, **as directed**, Planks: Evenly spaced, parallel.
    - 6) Recycled **OR** Plastic **OR** Fiberglass, **as directed**, Sheet: Solid **OR** Perforated, **as directed**.
  - b. Surface Shape: Round **OR** Hexagon **OR** Shape indicated, **as directed**.
  - c. Feature: Center umbrella hole.
4. Aluminum Finish: Mill finish **OR** Color coated, **as directed**.
  - a. Color: As selected from manufacturer's full range.
5. Steel Finish: Galvanized and color **OR** PVC-color, **as directed**, coated.
  - a. Color: As selected from manufacturer's full range.
6. Stainless-Steel Finish: Dull Satin No. 6.



7. Wood Finish: Unfinished **OR** Factory-applied transparent finish **OR** Factory-applied stain and transparent finish **OR** Factory-applied opaque finish **OR** Manufacturer's standard finish, **as directed**.
  - a. Stain: Manufacturer's standard.
8. Fiberglass **OR** HDPE, **as directed**, Color: As selected from manufacturer's full range.
9. Graphics: Surface-applied **OR** Engraved **OR** Attached brass plaque with engraved, **as directed**, copy, content, and style per manufacturer's standard **OR** as indicated on Drawings, **as directed**.

#### C. Bicycle Racks

1. Bicycle Rack Construction:
  - a. Frame: Aluminum **OR** Steel **OR** Galvanized steel **OR** Stainless steel **OR** Steel and redwood **OR** Steel and pine, **as directed**.
    - 1) Pipe **OR** Tubing, **as directed**, OD: Not less than 1-5/8 inches (41 mm) **OR** 2-3/8 inches (60 mm) **OR** 2-7/8 inches (73 mm) **OR** 4-1/2 inches (115 mm), **as directed**.
    - 2) Locking Bars: Solid round bar, not less than 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, in diameter.
  - b. Style: Single-side parking **OR** Double-side parking **OR** Bollard **OR** As indicated, **as directed**.
    - 1) Capacity: Designed to accommodate no fewer than two **OR** three **OR** four, **as directed**, bicycles.
  - c. Security: Designed to lock wheel and frame.
  - d. Accessories: Base covers for each pipe and tubing anchored end **OR** Wheel stops, **as directed**.
  - e. Installation Method: Freestanding **OR** Surface flange anchored at finished grade to substrate indicated **OR** Surface flange anchored below finished grade to substrate indicated **OR** Cast in concrete **OR** Bolted to cast-in anchor bolts **OR** Wall mounted **OR** As indicated, **as directed**.
2. Aluminum Finish: Mill finish **OR** Color coated, **as directed**.
  - a. Color: As selected from manufacturer's full range.
3. Steel Finish: Galvanized **OR** Color coated, **as directed**.
  - a. Color: As selected from manufacturer's full range.
4. Stainless-Steel Finish: Directional Satin No. 4.
5. Wood Finish: Unfinished **OR** Manufacturer's standard finish, **as directed**.

#### D. Bicycle Lockers

1. Bicycle Locker Construction:
  - a. Locker: Molded one-piece fiberglass **OR** Sheet steel, 0.053 inch (1.4 mm) thick, **OR** Sheet steel, 0.053 inch (1.4 mm) thick, with perforated metal sides, **as directed**, with welded tubular steel frame.
  - b. Door: Molded one-piece fiberglass **OR** Sheet steel, 0.053 inch (1.4 mm) thick, **as directed**, with tubular steel frame **OR** Match locker, **as directed**.
  - c. View Window **OR** Grille, **as directed**: Lexan, 12 inches (305 mm) square **OR** Perforated metal, **as directed**.
  - d. Lock: Manufacturer's standard **OR** Key lock with internal locking bar **OR** Coin/token lock, **as directed**.
    - 1) Provide four keys.
  - e. Overall Height: As indicated.
  - f. Overall Width: As indicated.
  - g. Overall Depth: As indicated.
  - h. Capacity: Designed to accommodate one **OR** two, **as directed**, bicycle(s).
  - i. Installation Method: Locker anchored at finished grade to substrate indicated **OR** Locker anchored below finished grade to substrate indicated **OR** As indicated, **as directed**.
  - j. Locker Configuration: Multiple **OR** Four, **as directed**, units as indicated, in straight row **OR** curved shape **OR** shape indicated, **as directed**.
2. Steel Finish: Color coated.



- a. Color: As selected from manufacturer's full range.
  3. Fiberglass Color: As selected from manufacturer's full range.
- E. Trash And Ash Receptacles
1. Aluminum Facing Surrounds: Aluminum sheet **OR** Perforated aluminum sheet **OR** Grid in tubular frame **OR** Evenly patterned, parallel flat aluminum straps, bars, or tubular shapes **OR** Match benches, **as directed**.
  2. Steel Facing Surrounds: Steel sheet **OR** Perforated-steel sheet **OR** Evenly patterned, parallel flat steel straps, bars, or tubular shapes **OR** Evenly patterned, parallel round steel rods, bars, or tubular shapes **OR** Grid in tubular frame **OR** Match benches, **as directed**.
  3. Stainless-Steel Facing Surrounds: Steel sheet **OR** Perforated-steel sheet **OR** Evenly patterned, parallel flat steel straps, bars, or tubular shapes **OR** Evenly patterned, parallel round steel rods, bars, or tubular shapes **OR** Grid in tubular frame **OR** Match benches, **as directed**.
  4. Wood Facing Surrounds: Evenly spaced, Douglas fir slats **OR** Evenly spaced pine slats **OR** Evenly spaced cedar slats **OR** Redwood panels **OR** Evenly spaced redwood slats **OR** Teak panels **OR** Evenly spaced teak slats **OR** Match benches, **as directed**.
  5. Fiberglass Facing Surrounds: Molded fiberglass shape.
  6. Plastic Facing Surrounds: Molded HDPE shape **OR** Evenly spaced HDPE slats **OR** Evenly spaced, recycled HDPE slats **OR** Match benches, **as directed**.
  7. Support Frames: Steel **OR** Galvanized steel, **as directed**; welded.
  8. Trash and Ash Receptacles:
    - a. Receptacle Shape and Form: Round cylinder **OR** Round cylinder with tapered funnel top **OR** Round, tapered column **OR** Square column **OR** Rectangular column **OR** As indicated, **as directed**; with opening for depositing trash in lid or top **OR** side of lid or top **OR** receptacle side, **as directed**.
    - b. Ash Receptacle Function: Uncovered receptacle with sand pan **OR** Uncovered receptacle with bowl and funnel **OR** Covered receptacle with sand pan **OR** Covered receptacle with bowl and screen **OR** Covered receptacle with slots **OR** Uncovered receptacle with sand pan attaching to side of trash receptacle, **as directed**, for depositing cigarette butts; fire-proof design; bowl and pan removable for cleaning.
    - c. Lids and Tops: Matching facing panels **OR** Aluminum **OR** Steel **OR** HDPE **OR** Recycled HDPE, **as directed**, secured by cable or chain, hinged, swiveled, or permanently secured.
      - 1) Description: Flat rim ring lid with center opening **OR** Dome top **OR** Arched top **OR** Elevated flat or shallow dome rain-cap lid **OR** Combination ash sand pan and rim lid **OR** Combination ash sand pan and dome top **OR** Combination ash sand pan and elevated flat or shallow dome rain-cap lid, **as directed**.
      - 2) Opening for depositing trash covered by self-closing, spring-loaded-hinged, push-in **OR** rotating, **as directed**, weather flap.
    - d. Inner Container: Aluminum **OR** Galvanized steel sheet **OR** Perforated-metal **OR** Fiberglass **OR** Rigid plastic, **as directed**, container with drain holes **OR** lift-out handles, **as directed**; designed to be removable and reusable.
    - e. Disposable Liners: Provide receptacle designed to accommodate disposable liners.
    - f. Capacity: Not less than 22 gal. (83 L) **OR** 28 gal. (106 L) **OR** 30 gal. (114 L) **OR** 32 gal. (121 L) **OR** 40 gal. (151 L) **OR** 55 gal. (208 L), **as directed**.
    - g. Service Access: Removable lid or top **OR** Fixed lid or top, side access, **as directed**; inner container and disposable liner lift or slide out for emptying; lockable with padlock hasps **OR** keyed lock with two keys per receptacle **OR** self-latching hinge, **as directed**.
    - h. Post Mount: Color-coated steel pipe; color to match receptacle **OR** Galvanized steel pipe **OR** Wood, **as directed**; for mounting one **OR** two **OR** three, **as directed**, receptacle(s).
    - i. Ash Receptacle Accessories: Sand sifter **OR** Butt stub-out, **as directed**.
  9. Aluminum Finish: Mill finish **OR** Color coated, **as directed**.
    - a. Color: As selected from manufacturer's full range.
  10. Steel Finish: Galvanized and color **OR** PVC-color, **as directed**, coated.
    - a. Color: As selected from manufacturer's full range.
  11. Stainless-Steel Finish: Dull Satin No. 6.

12. Wood Finish: Unfinished **OR** Factory-applied transparent finish **OR** Factory-applied stain and transparent finish **OR** Factory-applied opaque finish **OR** Manufacturer's standard finish, **as directed**.
  - a. Stain: Manufacturer's standard.
13. Fiberglass **OR** HDPE, **as directed**, Color: As selected from manufacturer's full range.
14. Graphics: Surface-applied **OR** Engraved **OR** Attached brass plaque with engraved, **as directed**, copy, content, and style per manufacturer's standard **OR** as indicated on Drawings, **as directed**.
  - a. Copy: Litter **OR** Trash **OR** Waste **OR** Recycle, **as directed**.

F. Planters

1. Aluminum Facing Surrounds: Aluminum sheet **OR** Perforated aluminum sheet **OR** Grid in tubular frame **OR** Evenly patterned, parallel flat aluminum, **as directed**, straps, bars, or tubular shapes **OR** Match benches, **as directed**.
2. Steel Facing Surrounds: Steel sheet **OR** Perforated-steel sheet **OR** Evenly patterned, parallel flat steel straps, bars, or tubular shapes **OR** Evenly patterned, parallel round steel rods, bars, or tubular shapes **OR** Grid in tubular frame **OR** Match benches, **as directed**.
3. Stainless-Steel Facing Surrounds: Steel sheet **OR** Perforated-steel sheet **OR** Evenly patterned, parallel flat steel straps, bars, or tubular shapes **OR** Evenly patterned, parallel round steel rods, bars, or tubular shapes **OR** Grid in tubular frame **OR** Match benches, **as directed**.
4. Wood Facing Surrounds: Evenly spaced, Douglas fir slats **OR** Evenly spaced pine slats **OR** Evenly spaced cedar slats **OR** Redwood panels **OR** Evenly spaced redwood slats **OR** Teak panels **OR** Evenly spaced teak slats **OR** Match benches, **as directed**.
5. Fiberglass Facing Surrounds: Molded fiberglass shape.
6. Plastic Facing Surrounds: Molded HDPE shape **OR** Evenly spaced HDPE slats **OR** Evenly spaced, recycled HDPE slats **OR** Match benches, **as directed**.
7. Support Frames: Steel **OR** Galvanized steel, **as directed**; welded.
8. Planter Shape and Form: Round cylinder **OR** Round cylinder with tapered funnel top **OR** Round, tapered column **OR** Square column **OR** Rectangular column **OR** As indicated, **as directed**.
9. Style: To match benches **OR** As indicated by manufacturer's designation, **as directed**.
10. Inner Container: Aluminum **OR** Galvanized steel sheet **OR** Fiberglass **OR** Rigid plastic, **as directed**, container with drain holes.
11. Capacity: Not less than 22 gal. (83 L) **OR** 28 gal. (106 L) **OR** 30 gal. (114 L) **OR** 32 gal. (121 L) **OR** 40 gal. (151 L) **OR** 55 gal. (208 L), **as directed**.
12. Installation Method: Freestanding **OR** Freestanding with weighted base **OR** Anchored to substrate indicated on Drawings **OR** Wall mounted **OR** Post mounted **OR** Mounted on elevated leg angles anchored at finished grade to substrate indicated on Drawings **OR** Mounted on elevated leg angles anchored below finished grade to substrate indicated on Drawings **OR** As indicated on Drawings, **as directed**.
  - a. Post Mount: Color-coated steel pipe; color to match receptacle **OR** Galvanized steel pipe **OR** Wood, **as directed**; for mounting one **OR** two **OR** three, **as directed**, planter(s).
13. Aluminum Finish: Color coated.
  - a. Color: As selected from manufacturer's full range.
14. Steel Finish: Galvanized and color **OR** PVC-color, **as directed**, coated.
  - a. Color: As selected from manufacturer's full range.
15. Stainless-Steel Finish: Dull Satin No. 6.
16. Wood Finish: Unfinished **OR** Factory-applied transparent finish **OR** Factory-applied stained and transparent finish, **as directed**.
17. Fiberglass **OR** HDPE, **as directed**, Color: As selected from manufacturer's full range.
  - a. Finish: Smooth **OR** Textured, **as directed**.

G. Bollards

1. Bollard Construction:
  - a. Pipe **OR** Tubing **OR** Cast, **as directed** OD: Not less than 4-1/2 inches (115 mm), fluted, **as directed**.
    - 1) Steel: Schedule 40 **OR** 80, **as directed**, pipe.

- 2) Aluminum: Extruded pipe and tubes **OR** Castings, **as directed**.
  - 3) Stainless Steel: Tubes **OR** Pipe, **as directed**.
  - 4) Cast Iron: Tapered **OR** As indicated, **as directed**.
  - b. Round **OR** Square, **as directed**, Wood: Cedar, 8 inches (203 mm) square **OR** 10 inches (254 mm) in diameter, **as directed**.
  - c. Style: Manufacturer's standard **OR** Chamfered top **OR** Dome top **OR** Ornamental cap **OR** As indicated, **as directed**.
  - d. Accessories: Eye bolts.
  - e. Installation Method: Surface flange anchored at finished grade to substrate indicated **OR** Surface flange anchored below finished grade to substrate indicated **OR** Cast in concrete **OR** Bolted to cast-in anchor bolts **OR** As indicated, **as directed**.
  2. Aluminum Finish: Mill finish **OR** Color coated, **as directed**.
    - a. Color: As selected from manufacturer's full range.
  3. Steel Finish: Galvanized **OR** Color coated, **as directed**.
    - a. Color: As selected from manufacturer's full range.
  4. Cast-Iron Finish: Manufacturer's standard **OR** Galvanized **OR** Color coated, **as directed**.
    - a. Color: As selected from manufacturer's full range.
  5. Stainless-Steel Finish: Directional Satin No. 4.
  6. Wood Finish: Unfinished **OR** Manufacturer's standard finish, **as directed**.
- H. Fabrication
1. Metal Components: Form to required shapes and sizes with true, consistent curves, lines, and angles. Separate metals from dissimilar materials to prevent electrolytic action.
  2. Welded Connections: Weld connections continuously. Weld solid members with full-length, full-penetration welds and hollow members with full-circumference welds. At exposed connections, finish surfaces smooth and blended so no roughness or unevenness shows after finishing and welded surface matches contours of adjoining surfaces.
  3. Pipes and Tubes: Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cylindrical cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of handrail and railing components.
  4. Preservative-Treated Wood Components: Complete fabrication of treated items before treatment if possible. If cut after treatment, apply field treatment complying with AWPA M4 to cut surfaces.
  5. Exposed Surfaces: Polished, sanded, or otherwise finished; all surfaces smooth, free of burrs, barbs, splinters, and sharpness; all edges and ends rolled, rounded, or capped.
  6. Factory Assembly: Assemble components in the factory to greatest extent possible to minimize field assembly. Clearly mark units for assembly in the field.
- I. Finishes, General
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
  2. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- J. Aluminum Finishes
1. Baked-Enamel, Powder-Coat Finish: Manufacturer's standard, baked, polyester, powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.
- K. Steel And Galvanized Steel Finishes
1. Baked-Enamel, Powder-Coat Finish: Manufacturer's standard, baked, polyester, powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.

2. PVC Finish: Manufacturer's standard, UV-light stabilized, mold-resistant, slip-resistant, matte-textured, dipped or sprayed-on, PVC-plastisol finish, with flame retardant added; complying with coating manufacturer's written instructions for pretreatment, application, and minimum dry film thickness.

L. Iron Finishes

1. Baked-Enamel, Powder-Coat Finish: Manufacturer's standard, baked, polyester, powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.

M. Stainless-Steel Finishes

1. Remove tool and die marks and stretch lines or blend into finish.
2. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.

1.3 EXECUTION

A. Installation, General

1. Comply with manufacturer's written installation instructions unless more stringent requirements are indicated. Complete field assembly of site furnishings where required.
2. Unless otherwise indicated, install site furnishings after landscaping and paving have been completed.
3. Install site furnishings level, plumb, true, and securely anchored **OR** positioned, **as directed**, at locations indicated on Drawings.
4. Post Setting: Set cast-in support posts in concrete footing with smooth top, shaped to shed water. Protect portion of posts above footing from concrete splatter. Verify that posts are set plumb or at correct angle and are aligned and at correct height and spacing. Hold posts in position during placement and finishing operations until concrete is sufficiently cured.
5. Posts Set into Voids in Concrete: Form or core-drill holes for installing posts in concrete to depth recommended in writing by manufacturer of site furnishings and 3/4 inch (19 mm) larger than OD of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions, with top smoothed and shaped to shed water.
6. Pipe Sleeves: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions, with top smoothed and shaped to shed water.

B. Cleaning

1. After completing site furnishing installation, inspect components. Remove spots, dirt, and debris. Repair damaged finishes to match original finish or replace component.

END OF SECTION 02764



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
02764	02720	Miscellaneous Site and Street Furnishings
02765	01204	No Specification Required
02765	02764	Site Furnishings
02765	02720	Miscellaneous Site and Street Furnishings
02770	01204	No Specification Required
02770	02764	Site Furnishings
02770	02720	Miscellaneous Site and Street Furnishings
02771	02764	Site Furnishings

SECTION 16525

LIGHTING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
  - 1. Requirements for general and emergency egress lighting equipment, components, and related installation.
  
- B. Related Sections:
  - 1. Section 16060 Grounding and Bonding for Electrical Systems
  - 2. Section 16070 Hangers and Supports for Electrical Systems
  - 3. Section 16082 Acceptance of Electrical Systems
  - 4. Section 16112 Conduits for Electrical Systems
  - 5. Section 16119 Low Voltage Electrical Power Conductors and Cables
  - 6. Section 16130 Boxes for Electrical Systems
  - 7. Section 26 27 26 Wiring Devices

1.2 REFERENCES

- A. Reference Standards:
  - 1. U. S. Government:
    - a. Federal Transit Administration (FTA):
      - 1) 49 CFR 661 Buy America Requirements
    - b. WMATA Manual of Design Criteria for Maintaining and Continued Operation of Facilities
  
- B. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
  - 1. ANSI/IEEE C62.41; Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits.
  
- C. Illuminating Society of North America (IESNA)
  - 1. IESNA LM-79, Electrical and Photometric Measurements of Solid-State Lighting Products
  - 2. IESNA LM-80, Approved Method for Measuring Lumen Maintenance of LED Lighting Sources
  - 3. IESNA TM-15, Luminaire Classification System for Outdoor Luminaires.
  
- D. National Electrical Manufacturers Association (NEMA):
  - 1. NEMA 250, Enclosures for Electrical Equipment.
  - 2. NEMA SSL 3, High Power White LED Binning for General Illumination
  - 3. NEMA ST 1 - Standard for Specialty Transformers (Except General Purpose Type)
  
- E. National Fire Protection Association (NFPA):
  - 1. NFPA 70, National Electrical Code (NEC).
  
- F. Underwriter's Laboratories, Inc. (UL):
  - 1. UL 1029, Standard for High-Intensity-Discharge Lamp Ballasts.
  - 2. UL 1598, Luminaires.

- G. U. S. Government:
  - 1. Occupational Safety and Health Administration (OSHA):
    - a. 29 CFR 1910 Occupational Health and Safety Standards.
    - b. 29 CFR 1926 Safety and Health Regulations for Construction.
  - 2. Federal Communications Commission (FCC):
    - c. 47 CFR 18 Industrial, Scientific, and Medical Equipment.

### 1.3 DESIGN REQUIREMENTS

- A. Design Criteria:
  - 1. The Lighting Fixtures described below and indicated on the Contract Drawings constitutes the basis of the lighting design for this Contract, but may not indicate the special design details required.
    - a. The lighting fixtures as described meet the requirements of the lighting design for this Contract with respect to the visible style, light source, and lenses desired.
  - 2. Provide lighting fixtures meeting the requirements of the basis of the lighting design for this Contract, and which have the special details specified in this Section.
    - a. Submit Shop Drawings and manufacturer's installation instructions to show details of assemblies and sub-assemblies, and specially-fabricated supporting and fastening devices.
    - b. Submit bills of material for the fixtures and their appurtenances.
      - 1) Reference the bills of material to the Shop Drawings.
      - 2) Provide bills of material consisting of itemized lists of the parts required (i.e. ballast capacitor igniter, and other similar item descriptions).
      - 3) Identify each part with a part number and/or manufacturer number.
    - c. Provide fixtures for exterior installation that are designed to be completely waterproof.
    - d. Provide luminaire brackets designed to be compatible with configuration of the luminaire.

### 1.4 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
  - 1. Buy America Act :
    - a. Except for those products which are exempt under the specific statutory waivers stipulated in 49 CFR 661, all other products supplied under this Section must comply with the requirements of the Buy America Act.
- B. Regulatory Requirements:
  - a. The execution of work of this Section must satisfy the applicable requirements of the latest edition of NFPA 70 (NEC), the National Occupational Safety and Health Act as embodied in 29 CFR 1910 and 29 CFR 1926, and regulations of local jurisdictional authorities.
- C. Certifications:
  - 1. All products must be Underwriters' Laboratories (UL) listed; and each fixture, Emergency Battery Unit, and exit sign must bear the UL label.
    - a. The UL standards appropriate for the products specified are listed in Paragraph 1.02.E.
    - b. Alternatively, Listing by an OSHA Nationally Recognized Testing Laboratory (NRTL) to the relevant UL standards is permitted.



## 1.5 SUBMITTALS

- A. Submit the following information for approval in accordance with the requirements of the Procurement Document:
1. Submit the following information to obtain the Engineer's approval:
    - a. The manufacturer's catalog cuts indicating the type, design, dimensions, mounting arrangement, and other industry standard lighting fixture information.
      - 1) Describe the lighting fixtures and appurtenances.
    - b. Manufacturer's photometric data and electronic ies files.
    - c. Complete photometric data for the fixture, including optical performance, completed by an independent testing laboratory developed according to the standards of the Illuminating Engineering Society of North America as follows:
      - 1) For direct, direct/indirect and indirect lights used for general illumination:
        - a) Coefficients of utilization.
        - b) Candlepower data, presented graphically and numerically, in 5 degree increments (5 degree, 10 degree, 15 degree, etc.). Data developed for up and down quadrants of normal, parallel, and at 22-1/2 degree, 45 degree, 67-1/2 degree planes to lamp(s). If light output is asymmetric, provide additional planes as required to complete report.
        - c) Zonal lumens stated numerically in 10 degree increments (5 degree, 15 degree, etc.) as above.
        - d) Average luminaire luminance calculated in the lengthwise, crosswise, and 45 degree vertical planes.
    - d. Point-by-point lighting calculations showing the uniformity of light and compliance with WMATA design requirements.
  2. Submit a complete light source inventory for approval, including specific lamp type, manufacturer, and all appropriate lamp criteria including but not limited to: life, initial and mean lumens, beam spread, candlepower, lamp envelope, base type, color temperature, and color rendering index.
  3. Quality Assurance/Quality Control Submittals:
    - a. Certificates:
      - 1) Proof that equipment furnished has the required Underwriters' Laboratories (UL) listing.
      - 2) Ballast certifications.
      - 3) Compliance with the requirements of the Buy America Act
    - b. Manufacturer's Instructions:
      - 1) Manufacturer's installation instructions.

## 1.6 EXTRA MATERIALS

- A. Maintenance Tools:
1. Provide two each of the special maintenance tools as may be necessary for re-lamping fixtures and for fixture maintenance.

## PART 2 PRODUCTS

### 2.1 MATERIALS

- A. Conduit and Raceway:

1. Provide electrical conduit and raceway in accordance with the requirements of Sections 16112, Conduits for Electrical Systems as indicated and as appropriate for the application per NFPA 70.
- B. Fixture Support Devices and Fasteners:
  1. In addition to the supporting devices and fasteners specified in Section 16070, Hangers and Supports for Electrical Systems, provide suspension accessories, canopies, casing, sockets, holders, reflectors, plaster frames, recessing boxes, and similar items required to support the lighting equipment and luminaries as specified or indicated.
- C. Wire and Cable:
  1. Provide electrical wire and cable in accordance with the requirements of Section 16119, Low Voltage Electrical Power Conductors and Cables.

## 2.2 MANUFACTURED UNITS

- A. Light Fixtures:
  1. Fixture Grounding Device and Conductor:
    - a. Provide the housing of each fixture with a separate, factory-installed grounding device and ground conductor.
- B. Lamps:
  1. Provide the proper type of lamps for the lighting fixtures scheduled on the Contract Drawings or indicated on the approved Shop Drawings.
    - a. Match the voltages of lamps to installed fixtures.
    - b. Provide lamps having the proper type of sockets to suit the fixtures provided.
  2. If fluorescent lamps are required, provide the energy saving type unless otherwise indicated on the Contract Drawings.
    - a. Fluorescent T5HO Lamps: low mercury content, T5HO lamps having a minimum CRI of 85, color temperature of 3500K, and suitable for operation with electronic ballasts or as otherwise specified. Minimum expected life (w/ 12 hour start) shall be 24,000 hours.
- C. LED Lighting Fixtures
  1. Color temperature of any submitted fixture shall be within 10% of the specified value, 3100 degrees K.
  2. Provide fixture housing with internal driver, LED board and Spot (18-degree) optical focus lens. Clear tempered, shock resistant glass lens shall be adhered to fixture cap to provide a hermetically sealed optical compartment. Provide an additional eight narrow spot optical focus lens (14 degree) for site focusing.
  3. Lens cap of fixture shall be 90 degree cut off type and provided with lens holder for use of directional linear lens accessory. The lens holder shall be 'fixed' to the correct position (relative to axis of fixture) to ensure that the fixture is aimed properly as directed by the Architect. See Architectural Drawing for specified lens orientation. Directional lens will not be used in every fixture and shall not be 'permanently' attached to holder.
  4. Lighting fixtures shall be constructed of copper-free aluminum, finish and color as specified by the Architect. Fixture housing, lens cap, LED board, optic module and lens accessory to be provided with natural physical 'stop'/locking devices to obtain and ensure optimum light output/focus.
  5. Fixture shall have integral dimming ballast.

6. Provide 360 degree rotating knuckle, with locking device and canopy mounting faceplate option of color and finish matching fixture.
  7. Mounting hardware and fixture screws shall be stainless steel.
  8. Power consumption of any submitted fixture shall not exceed the specified value of 8.2 Watts by more than 10%. If a fixture is submitted and approved at an increased wattage within 10% of the specified wattage), any power system modifications necessary to accommodate the fixtures will be the responsibility of the contractor (i.e. increased wire sizes, increased circuit breaker size, additional circuits/breakers, etc.)
  9. LED Lumen Efficacy (Lumens/Watt) of a submitted fixture shall not be less than the specified fixture (30 lumens/watt) by more than 10%. Fixture lumen output shall provide at sidewalk surface an average illumination level of 3FC maintained, 4.3 FC initial as required by WMATA Manual of Design Criteria for Station Entrance Within 30-ft. of the Entrance or Parapet Wall.
  10. Characteristics of submitted fixtures shall have the same features as the specified LED fixtures (i.e. redundant drivers, driver protection, etc.) whether specifically noted on the lighting fixture schedule or not.
  11. LED Light fixtures shall have a minimum expected life of 50,000 hours. The aforementioned life rating must be conducted with a 40 degrees calcium ambient temperature.
  12. Operational Performance: the LED circuitry shall prevent visible flicker.
  13. Thermal Management: The thermal management (of the heat generated by the LED's) shall be of sufficient capacity to assure the proper operation of the luminaire over the expected useful life. Thermal management shall be by passive design – the use of fans or other mechanical devised is not allowed.
- D. Control Power Transformers
1. Transformer: NEMA ST 1; machine tool transformer with isolated secondary winding.
  2. Enclosure: Open Type (mounted in junction box)
  3. Power Rating: 100 VA.
  4. Voltage Rating: 120VAC primary; 12VAC secondary.
- E. Boxes, Gaskets, Hardware, and Support Devices:
1. Provide plastic outlet boxes, neoprene gaskets, and stainless steel hardware to render the installation of the lighting waterproof.
  2. Supply special mounting supports and hardware, and miscellaneous materials and incidentals required to install the lighting products in place.
- F. Mounting poles:
1. Steel or aluminum, straight or tapered as shown. Complete assembly of anchor bolts, pole, arms and luminaire designed to withstand wind pressure (P) developed by wind speed (V) of 80 MPH in accordance with AASHTO LTS-3. Pole assembly to fully comply with AASHTO requirements for permissible stresses, deflection, vibration and fatigue. Ratio of deflection to pole height under action of applicable static loading not to exceed 1/60.
  2. Steel, straight or tapered. Complete assembly of anchor bolts, pole, arms and luminaire designed to withstand wind pressure (P) developed by wind speed (V) of 80 MPH in accordance with AASHTO LTS-3. Pole assembly to fully comply with AASHTO requirements for permissible stresses, deflection, vibration and fatigue. Ratio of deflection to pole height under action of applicable static loading not to exceed 1/60.
  3. Size and shape: As shown.
  4. Base assembly: Steel base plate, designed to withstand full-bending movement of shaft and welded to shaft; anchor bolts; and base cover.

5. Handhole size: As shown, with 12-gauge steel sheet coverplate.
  6. Polygonal-shaped poles fabricated with sharp bends.
  7. Longitudinally welded with welds continuous and ground smooth.
- G. Lighting controls:
1. All light fixtures shall be controlled by WMATA through existing Remote Telemetry Unit (RTU).
- H. Luminaire Pole Foundations
1. Pole/Support Structure Bases: Anchor type with hold-down or anchor bolts, leveling nuts, and bolt covers.
  2. Embedded type with underground conduit/cable entry.
  3. Comply with Specification Section 03300 Cast-in-Place Structural Concrete.
  4. Design Strength: 4000-psi (20.7-MPa), 28-day compressive strength.
- I. Luminaire Brackets
1. Provide luminaire brackets of the type and style as indicated or scheduled on the Contract Drawings and color matched to light fixture.
  2. Provide luminaire brackets fabricated to be compatible with the configuration of the luminaire.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Prior to beginning installation of the lighting fixtures and accessories, verify that all other work affecting the installation of the lighting fixtures and accessories is complete to the extent that the light fixtures may be installed over substrates or incorporated into integrated systems without adversely affecting the lighting or other construction.

### 3.2 INSTALLATION

- A. Assemble lighting fixtures if required; and install and wire the lighting fixtures, supports, brackets, and accessories at the locations and mounting heights indicated on the Contract Drawings.
1. Wire the lighting fixtures and accessories as specified in Section 16119, Low Voltage Electrical Power Conductors and Cables.
  2. Ground the lighting fixtures in accordance with the requirements of Article 410 of NFPA 70 (NEC) and Section 16060, Grounding and Bonding of Electrical Systems.
    - a. Use the fixture grounding device to connect a separate grounding conductor in compliance with requirements specified in Section 16060, Grounding and Bonding of Electrical Systems.
- B. Exposed Fixture Installation:
1. Install surface mounted and exposed fixtures as indicated on the Contract Drawings.
    - a. Install surface mounted fixtures tight up against the substrate to eliminate gaps except where NFPA 70 (NEC) or local code restrictions require a separation between the fixtures and substrate.

### 3.3 INTERFACE WITH OTHER WORK

- A. Verify the locations and clearances of other installed or proposed work, and coordinate lighting fixture installations accordingly.

- B. Coordinate the installation of lighting fixtures with all building systems and components to avoid any installation conflicts.

3.4 FIELD QUALITY CONTROL

- A. Inspect, test, and certify lighting and the associated electrical distribution system and equipment in accordance with the requirements of Section 16082, Acceptance of Electrical Systems.

3.5 CLEANING

- A. Clean new lighting fixtures by following the cleaning procedures as recommended by the fixture manufacturer:
  - 1. Use only those products for cleaning as recommended in the fixture manufacturer's literature.

3.6 AIMING AND FOCUSING

- A. Contractor shall notify the Architect and Authority one week in advance and establish schedule for a night when final aiming will be done. Final aiming shall be as directed by the Architect. Aiming shall include adjustment of fixture angle, use of and orientation of linear lens accessory and lens SP selection.
- B. Lock the aiming adjustments, set during final aiming, in position. Position must hold during relamping and normal maintenance.

END OF SECTION

## SECTION 02830

## MECHANICALLY STABILIZED EARTH (MSE) RETAINING WALLS

## PART 1 GENERAL

## 1.01 DESCRIPTION:

- A. This section specifies furnishing materials and placement for mechanically stabilized earth walls conforming to the lines, grade and dimensions shown on the contract drawings. The mechanically stabilized earth wall will consist of a non-structural levelling pad, concrete facing panels and soil reinforcement elements mechanically connected to each facing panel. The soil reinforcement elements, some of which are proprietary, employ either strip or grid type metallic or geosynthetic reinforcements in the soil mass. Soil reinforcement will have sufficient length, strength and frictional resistance as required by the specifications and **WMATA Design Criteria**. All appurtenances behind, in front of, under, mounted upon, or passing through the wall such as drainage structures, utilities, or other appurtenances shown on the plans, shall be accounted for in the stability design of the wall. All designs must conform to WMATA Design Guidelines. A geotechnical report has been prepared for the project (Geotechnical Report for WMATA Springfield-Franconia Bus Canopy Project, Springfield, VA, by HSA, Inc., Project No. 11-103W, Dated: October 2014).
- B. Related Work Specified Elsewhere:
1. Grading, Excavating, and Backfilling: Section 02320.
  2. Cast-in-Place Structural Concrete: Section 03300.

## 1.02 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards, and Specifications:
1. Comply with codes and regulations of the jurisdictional authorities.
  2. American Association of State Highway and Transportation Officials (AASHTO):
    - a. AASHTO Standard Specifications for Highway Bridges.
  3. ASTM International (ASTM):
    - a. ASTM A82, Standard Specification for Wire, Plain, for Concrete Reinforcement.
    - b. ASTM A123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
    - c. ASTM A153, Standard Specification for Zinc (Hot-Dip) on Iron and Steel Hardware.
    - d. ASTM A325, Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
    - e. ASTM A572, Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
    - f. ASTM A615, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
    - g. ASTM A706, Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement.
    - h. ASTM A775, Standard Specification for Epoxy-Coated Steel Reinforcing Bars.
    - i. ASTM A1064, Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
    - j. ASTM A1011, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
  4. **Comply with WMATA Design Criteria**
- B. Allowable Tolerances:

1. Cut and bend reinforcing steel to conform to dimensions shown within the following tolerances:
  - a. Sheared length: Plus-or-minus one inch.
  - b. Depth of truss bars: Plus zero or minus 1/2 inch.
  - c. Stirrups, ties and spirals: Plus-or-minus 1/2 inch.
  - d. All other bends: Plus-or-minus one inch.

### 1.03 DESIGN REQUIREMENTS

- A. The mechanically stabilized earth wall design shall follow the dimensions of the wall envelope shown in the contract plans. The top of leveling pad shall be located a minimum of 30" below grade. Where coping or barrier is utilized, the wall face panels shall extend up into the coping or barrier a minimum of 2 inches. The top of the face panels may be level or sloped to follow the top of wall line noted.
- B. Where walls or wall sections intersect with an angle of 130 degrees or less, a special vertical corner element panel shall be used. The corner element panel shall cover the joint of the panels that abut the corner, and allow for independent movement of the abutting panels. Corner elements shall have at least two levels of earth reinforcements.
- C. Standard facing panels shall have at least two levels of earth reinforcements to stabilize the panels against rotation and are to be constructed of reinforced concrete. Top and bottom half panels shall have at least one level of earth reinforcements. The wall facing shall be designed to accommodate differential settlement of 1 foot in 100 feet (0.5 feet in 100 feet for large rectangular panels). The spacing between adjacent panels shall be designed to be 3/4 inch  $\pm$  1/4 inch. Joints between panels shall have a shiplap configuration to protect the joint materials from vandalism. There shall be no openings through the wall facing except for utilities to pass through the wall.
- D. A geotechnical report has been developed for the project. This report is to be used as the basis of design (Geotechnical Report for WMATA Springfield-Franconia Bus Canopy Project, Springfield, VA, HSA Project No. 11-103W Dated October 2014). Any additional information required for design, detailing and installation of the MSE wall and its appurtenances is the responsibility of the contractor and his engineer.
- E. The design by the wall system supplier shall consider the external and internal stability of the wall mass as outlined below. The external stability of the structure, including slope stability, bearing capacity, and total and differential settlement, is to be included in the design calculations for the overall submittal package.
  1. Failure Plane: The reinforced soil mass shall be analyzed so that the soil stabilizing components extend sufficiently beyond the failure plane to stabilize the material. External loads which affect the internal stability, such as those applied through piling, footings, traffic (both temporary construction and permanent loads), slope surcharge, and hydrostatic and seismic loading shall be accounted for in the design.
  2. Hydrostatic Forces: Unless specified otherwise, when a design high-water surface is shown on the plans at the face of wall, the design stresses calculated from that elevation to the bottom of wall must include a 3 foot minimum differential head of saturated backfill. In addition, the buoyant weight of saturated soil shall be used in the calculation of pullout resistance.
  3. Backfill: For internal stability design of the wall, the friction angle of the select backfill used in the reinforced fill zone shall be assumed to be 34° unless shown otherwise on the Plans. The friction angle shall be determined by the standard direct shear test, AASHTO T-236, utilizing a sample of the material compacted to 95 percent of AASHTO T-99, Methods C or D at optimum moisture content. Before construction begins, the selected backfill material shall be subject to approval to show conformance with this frictional requirement. The

- friction angle of the foundation soils and the random backfill shall be assumed to be 30 unless otherwise shown on the Plans.
4. Factors of Safety: The minimum factors of safety shall be as follows:
    - a. 1.5 against pullout of the reinforcements based on pullout resistance at 1/2 inch deformation for a representative backfill (i.e., the resulting deformation should not exceed 1/2 inch at 1.5 times the design load).
    - b. 1.5 against sliding of the reinforced soil mass
    - c. 2.0 against overturning of the reinforced soil mass
    - d. 2.0 against panel connection pullout or rupture, and
    - e. 1.5 against panel connection deformation of 1/2 inch under the maximum allowable reinforcement tension (i.e., the resulting deformation should not exceed 1/2 inch at 1.5 times the design load).
    - f. **Design Factors of Safety per WMATA Design Criteria as specified in WMATA Manual of Design Criteria Facilities, Section 15**
  5. Connections: All connections shall be positive, structural connections subject to the same metal loss rates and allowable tension requirements as outlined Allowable Reinforcement Tension Section of this specification. Adequacy and capacity of panel connections is to be demonstrated by providing connection test data.
  6. Reinforcement Length: The soil reinforcement length shall be the same from top to bottom of each wall section. The reinforcement length defines the width of the entire reinforced soil mass and may vary with wall height along the length of wall. For walls with level or sloped surcharge, the minimum length embedded in the soil shall be 70 percent of the facing height, H, or 8 feet, whichever is greater. **Minimum reinforcement length shall meet Design Factors of Safety per WMATA Design Criteria which are specified in WMATA Manual of Design Criteria Facilities, Section 15.**
  7. State of Stress and Pullout Resistance : The lateral earth pressure to be resisted by the reinforcements shall be calculated using the appropriate coefficient of earth pressure, K, based on the type of reinforcement used, multiplied by vertical soil stress at each reinforcement layer. Vertical soil stress shall be calculated. The soil reinforcement length shall be sufficient to satisfy the above requirements, to meet the sliding, overturning and pullout factors of safety, and to meet any minimum reinforcement lengths required for external stability.
  8. The actual applied bearing pressures under the stabilized mass for each reinforcement length shall be clearly indicated on the design drawings. Passive pressure in front of the wall mass shall be assumed to be zero for design purposes.
  9. Calculations for stresses and factors of safety shall be based on assumed conditions at the end of the design life. The design life shall be 100 years.
  10. Allowable Reinforcement Tension: For determination of the allowable reinforcement tension, the following metal loss rates shall be assumed:
    - a. Zinc (first 2 years): 15 microns/year/side
    - b. Zinc (subsequent years to depletion): 4 microns/year/side
    - c. Carbon Steel (after depletion of zinc): 12 microns/year/side
    - d. Carbon Steel (75 to 100 years): 7 microns/year/side
  11. For ladder strips, bar mats and welded wire mesh reinforcements, the gauge of the wires or bars shall be the same in both the longitudinal and transverse directions. Fy used for design shall not exceed 65 ksi. The maximum allowable tension in the reinforcements shall consider any reduction in cross sectional area of reinforcements due to punching and corrosion losses and shall not exceed 50% of the pullout capacity of the connection devices embedded in the facing panels.
  12. A guardrail (stainless steel railing) is to be placed at the top of the wall. The top of the wall is to be designed for forces from the guardrail (railing) described in the WMATA Design criteria and current applicable building code (whichever is stricter). The guardrail and its attachment to the wall are WMATA standard.



#### 1.04 SUBMITTALS:

- A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
1. Shop Drawings: The Contractor shall submit design calculations and design drawings signed and sealed by a Professional Engineer in the Commonwealth of Virginia knowledgeable in the work for approval by the Owner prior to beginning construction. The proposed design shall satisfy the design parameters and requirements in the plans and specifications. Complete design calculations shall include the most critical geometry and loading combination for each design section that exists during construction and 'in-place'. The design drawings shall include all details, dimensions, quantities and cross-sections necessary to construct the wall. Information presented shall include, at a minimum, the following:
    - a. An elevation view for each wall, including the top of wall elevation at all horizontal and vertical break points and at least every 50 feet along the face of wall, the elevation of all steps in the leveling pads, the designation as to the type of panel, the length of soil reinforcing elements, the distance along the face of the wall to where changes in length of the soil reinforcing elements occur, the final ground line, and maximum calculated bearing pressures.
    - b. A typical cross section or cross sections showing the elevation relationship between ground conditions and proposed grades.
    - c. General notes pertaining to design criteria and wall construction. A listing summarizing the quantities for each wall.
    - d. All panel details shall show all dimensions necessary to construct the panel, all reinforcing steel in the panel, and the location of soil reinforcing
    - e. connection devices embedded in the panel. Clearly indicated details for wall construction around drainage facilities. Details of the architectural treatment. Details for diverting soil reinforcements around obstructions such as piles, catch basins and other utilities.
    - f. Details for connections between concrete panels and soil reinforcements.
  2. Product Data: Manufacturers materials specifications, installation instructions, and recommendations:
    - a. Manufacturer's certificates.
    - b. Concrete certifications and mix design with test breaks per ACI 318. Slump, Air content and admixtures are to be provided.
    - c. Mill tests on each heat showing chemical and physical analyses performed in accordance with ASTM A615, as modified by ACI 318.
    - d. Record of mill tests traceable to individual reinforcement bars supplied to the project.

#### 1.05 QUALITY ASSURANCE

- A. Construction – Contractor performing work in this section shall have a minimum of 5 years' experience and have constructed at least 50,000 square feet of segmental concrete retaining walls on projects of like scope. When requested, evidence of experience, noting project, owner, and design professional shall be furnished to the Owner.
- B. Testing – An independent testing lab shall be required to test the select fill material to determine suitability of material for the project and shall conduct compaction tests for each layer of fill material at the rate of at least 1 test per 1000 square feet per lift. The contractor is required to have full time construction observation. The observation will include daily reporting of the work progress and final certification of the MSE construction conforms to the approved shop drawings. A letter is to be issued to the owner stating the MSE wall and its appurtenances are in conformance with the approved shop drawings. The letter is required to be signed and sealed by a professional engineer.

#### 1.06 PRODUCT DELIVERY, STORAGE, AND HANDLING:

- A. The Contractor shall inspect the materials upon delivery to assure that proper type and grade of material has been received.
- B. The Contractor will ship, store and handle materials in accordance with manufacturer's recommendations and in a manner to prevent deterioration or damage due to moisture, temperature changes, contaminants, corrosion, breaking, chipping or other causes. Panels are to be shipped in stacks, front face down. Blocking is to be installed to prevent the attachment devices from contacting the panel above and is to be located immediately adjacent to the attachment lifting devices. Lifting inserts are to be cast into the top edges of the panels to permit lifting at the project site. Reinforcement connection inserts (tie strip or loop inserts) are not to be used for lifting or handling the panels.
- C. The Contractor shall protect the materials from damage. Damaged material shall not be incorporated into the MSE wall.
- D. The date of manufacture, the production lot number and piece mark are to be clearly marked on the side of each panel.

#### PART 2 PRODUCTS

##### 2.01 MANUFACTURERS

- A. Proprietary Mechanically Stabilized Earth retaining wall suppliers.
  - 1. Reinforced Earth; The Reinforced Earth Company, 12001 Sunrise Valley Drive Suite 400, Reston VA, 20191, Tel (703) 547-8797 Email: [Info@reinforcedearth.com](mailto:Info@reinforcedearth.com).
  - 2. EarthTec, Inc.; 413 Browning Court, Purcellville, VA, 20132, Tel (703) 771-7305.
  - 3. Or Approved Equal.

##### 2.02 MATERIALS:

- A. Concrete Facing Panels: Facing panels are to have a minimum thickness of 5 1/2 inches and minimum concrete cover of the reinforcing steel of 1 1/2 inches. Concrete shall follow specification 03 30 00. Panels will have a minimum concrete compressive strength of 4000 psi at 28 days. Prior to casting, attachment devices shall be set in place to the dimensions and tolerances shown on the shop drawings.
  - 1. Unless otherwise noted, the concrete surface for the front (exposed) face will have an ordinary steel form finish and for the rear (unexposed) an unformed finish. The rear face shall be free of open pockets of aggregate and surface distortions in excess of 1/4 inch.
  - 2. All units shall be manufactured within the following tolerances with respect to the dimensions shown on the shop drawings:
    - a. Attachment Device Locations and Alignment – The lateral position of reinforcing strip attachment devices shall be within 1 inch and embedment measured from the back face of the panel shall be within +1/4 inch, -1/2 inch. For attachment devices having multiple bearing surfaces for a single reinforcement, the bearing surfaces shall align within 1/16 inch.
    - b. Panel Dimensions -- All panel dimensions shall be within 1/4 inch. All hardware embedded in the panel with the exception of attachment devices shall be within 1/4 inch.
    - c. Panel Squareness --, as determined by the difference between the two diagonals, shall not exceed 1/2 inch.

- d. Panel Surface Finish -- Surface defects on smooth-formed surfaces, measured on a length of 5 feet, shall not exceed 1/4 inch. Surface defects on textured-finished surfaces, measured on a length of 5 feet, shall not exceed 5/16 inch.
3. Reinforcing Steel Bars:
  - a. ASTM A615, Grade 60, modified in accordance with ACI 318.
  - b. Wire Reinforcement: ASTM A82 or ASTM A615, Grade 60.
  - c. Welded Steel-Wire Fabric: ASTM A1064.
  - d. Metal Accessories: As recommended by CRSI Manual of Standard Practice. Where concrete surfaces will be exposed to public view in finish structure, use supports with plastic-protected legs or stainless steel legs.
- B. Soil Reinforcing and Attachment Devices: All reinforcing and attachment devices shall be carefully inspected to insure they are true to size and free from defects that may impair their strength and durability.
  1. Ribbed Reinforcing Strips. Ribbed Reinforcing Strips shall be hot rolled from bars to the required shape and dimensions. ASTM A-572 grade 65 (AASHTO M-223) or equivalent. Galvanizing shall conform to the requirements of ASTM-A123 (AASHTO M-111). The minimum galvanizing coating thickness shall be 2 ounces/square feet.
  2. Ladder Reinforcing Strips. ASTM A-82 and welded into the finished ladderstrip configuration in accordance with ASTM A-185. The longitudinal and transverse wires shall be of the same size. Galvanizing shall be applied after the ladder strips are fabricated and shall conform to the minimum requirements of ASTM A-123 (AASHTO M-111). The minimum galvanizing coating thickness shall be 2 ounces/square foot.
  3. Reinforcing Mesh and Bar Mats. Reinforcing Mesh and Bar Mats fabricated of cold drawn steel wire conforming to ASTM A-82 and ASTM A-185. The longitudinal and transverse wires shall be of the same size. Galvanizing shall be applied after the mesh is fabricated and shall conform to the minimum requirements of ASTM A-123 (AASHTO M-111). The minimum galvanizing coating thickness shall be 2 ounces/square foot.
  4. Tie Strips. hot rolled steel conforming to the minimum requirements of ASTM A-1011, Grade 50 or equivalent. Galvanizing shall conform to the minimum requirements of ASTM A-123 (AASHTO M-111) or ASTM A-153 (AASHTO M-232). The minimum galvanizing coating thickness shall be 2 ounces/square foot.
  5. Wire Tie Strips and Loop Inserts: Cold drawn steel wire conforming to the minimum requirements of ASTM A-82. Galvanizing shall conform to the minimum requirements of ASTM A-123 (AASHTO M-111). The minimum galvanizing coating thickness shall be 2 ounces/square foot.
  6. Fasteners: Hexagonal cap screw bolts and nuts conforming to the minimum requirements of ASTM A-449 (AASHTO M-164) or equivalent. Galvanizing shall conform to the minimum requirements of ASTM A-153 (AASHTO M-232).
  7. Connector Bars and Pins: cold drawn steel wire conforming to the minimum requirements of ASTM A-82 and shall be galvanized in accordance with the requirements of ASTM A-123 (AASHTO M-111). The minimum galvanizing coating thickness shall be 2 ounces/square foot.
  8. Structural Plate Connectors and Fasteners. Structural Plate Connectors used for yokes to connect reinforcements to wall panels around pile or utility conflicts shall conform to the minimum requirements of A36 structural steel and shall be galvanized. Galvanizing of Structural Plate Connectors shall conform to the minimum requirements of ASTM A-123 (AASHTO M-111). The minimum galvanizing coating thickness shall be 2 ounces/square foot. Fasteners for Plate Connectors shall consist of hexagonal cap screw bolts and nuts conforming to the minimum requirements of ASTM A-325 (AASHTO M-164) or equivalent. Galvanizing of Fasteners for Structural Plate Connectors shall conform to the minimum requirements of ASTM A-153 (AASHTO M-232).
- C. Geosynthetic Soil Reinforcing and Connection Devices
  1. Geogrids shall be structural geogrids formed by uniaxially drawing a continuous sheet of high density polyethylene material. Geogrids shall be a regular network of integrally

connected polymer tensile elements with aperture geometry sufficient to permit significant mechanical interlock with the surrounding rock or soil. Structure of the geogrid reinforcement shall be dimensionally stable and able to retain its geometry under manufacture, transport and installation.

- a. Tensar Geogrid BX1100
  - b. Or approved equal.
2. Connection devices, such as bars, pins, plates etc, shall consist of non-degrading polymer and be made for the express use with the geogrids supplied.

D. Joint Materials

1. Joint materials shall be installed to the dimensions and thicknesses in accordance with the plans or approved shop drawings.
2. Bearing Pads: Bearing pads for panels with shiplap joints shall be EPDM rubber conforming to ASTM D-2000 M2AA 807, having a durometer hardness of  $80 \pm 5$ . Bearing pads for panels with tongue and groove shall be preformed high density polyethylene (HDPE) conforming to ASTM D1505 and having a minimum density of 0.946 g/cm<sup>3</sup>.
3. Joint Cover: Where required, as shown on the plans, horizontal and vertical joints between panels shall be covered by a geotextile. The geotextile may be either a non-woven needle punched polyester geotextile or a woven monofilament polypropylene geotextile as approved by the wall supplier. Adhesive used to hold the geotextile filter fabric material to the rear face of the panels prior to backfill placement shall be approved by the wall supplier.

E. Select Granular Backfill Material

1. Provide crushed or natural sand, crushed or uncrushed gravel, blasted limestone, blasted sandstone or a standard size coarse aggregate meeting the following gradation
  - a. Sieve Size Percent Passing

3 INCHES	100
1 ½ inch	100
¾ inch	20-100
½ inch	25-60
No. 40	15-30
No. 200	0-5

2. Furnish material exhibiting an angle of internal friction of not less than 34 degrees as determined, in accordance with AASHTO-T236, on the portion finer than the No. 10 sieve compacted to 95% of PTM No. 106, Method B, at optimum moisture content. Direct shear testing may be performed on samples containing material larger than the No. 10 sieve, if the shear device conforms with AASHTO-T236, Sections 5.4 and 5.5.
3. Plasticity Index -- The Plasticity Index (P.I.), as determined by AASHTO T90, shall not exceed 6.
4. The select granular backfill material used in MSE structure will be reasonably free from organic and deleterious materials. In addition, the backfill shall conform to all of the following requirements.
  - a. Soundness -- The material shall be substantially free of shale or other soft, poor durability particles. The material shall have a magnesium sulfate soundness loss of less than 30 percent after four (4) cycles, as determined by AASHTO T-104.

Electrochemical Requirements -- The backfill material shall conform to the following electrochemical requirements:

Property	Requirement	Test Methods
Resistivity(1)	>5000 ohm-cm – no chloride Or sulfate testing is required. 2000-5000 ohm-cm perform Chloride and sulfate test at 100% saturation	AASHTO T-288-91(1) ASTM G-57-78
pH	6-10	AASHTO T-288-91(1)

Soluble Chlorides(2)	≤ 100 ppm	ASTM G-51-77 ASTM D-512-88 AASHTO T-291-91(1)
Soluble Sulfates(2)	≤ 200 ppm	ASTM D-516-88 AASHTO T-290-91(1)

1) Resistivity testing shall be performed up to and including, but not exceeding, 100 % soil saturation. Note 6 of AASHTO T-288 (Note 5 in older editions) shall not be used.

2) If the minimum resistivity exceeds 5000 ohm-cm, at 100% saturation, the need for testing of chlorides and sulfates is waived.

5. The Contractor shall furnish to the Engineer a Certificate of Compliance certifying that the select granular backfill material complies with this section of the specifications. A copy of all test results performed by the Contractor, which are necessary to assure compliance with the specifications, shall also be furnished to the Engineer.
6. If the material sampled fails to meet the specified requirements, immediately discontinue its use, and remove and replace all material placed since the last passing acceptance or verification sample was obtained. Do not continue backfilling until new backfill material has been sampled and approved.
7. Backfill not conforming to this specification shall not be used without the written consent of both the Engineer and the wall supplier.

### PART 3 EXECUTION

#### 3.01 QUALIFICATION

- A. Contractor and site supervisor must have proven qualified experience to complete the installation of the MSE wall system.

#### 3.02 WALL EXCAVATION

- A. Unclassified excavation shall be in accordance with the requirements of the general specification and the limits shown on the construction documents.

#### 3.03 FOUNDATION PREPARATION

- A. The foundation for the MSE wall structure is to be graded level for a width equal to or exceeding the length of the reinforcement as shown on the shop drawings. The subgrade material is to be compacted as directed by the project Geotechnical Engineer. Any unsuitable soils found to be unsuitable shall be replaced as directed by the project Geotechnical Engineer.
- B. At each panel foundation level a concrete levelling pad is to be cast as shown on the shop drawings. Allowable elevation tolerances are +1/8 inch and -1/4 inch from the design elevation.

#### 3.04 WALL ERECTION

- A. Concrete panels shall be placed vertically with the aid of a light crane.
- B. For erection, panels shall be handled by means of lifting devices set into the upper edge of the panels. Panels shall be placed in successive horizontal lifts in the sequence shown on the plans as backfill placement proceeds.

- C. As backfill material is placed behind the panels, the panels shall be maintained in a vertical position by means of shoulder clamps to adjacent panels and temporary wooden wedges placed in the joint at the junction of the two adjacent panels on the external side of the wall. External bracing is required for the initial lift.
- D. Vertical and horizontal alignment tolerances shall not exceed 3/4 inch in 10 feet. The overall vertical tolerance of the wall (plumbness from top to bottom) shall not exceed 3/4 inch per 10 feet of wall height.

### 3.05 REINFORCEMENT PLACEMENT

- A. Prior to placing the first layer of reinforcements (strips, mats or grids), backfill shall be placed and compacted in accordance with this specification.
- B. Bending of reinforcements in the horizontal plane which results in a kink in the alignment of the reinforcements shall not be allowed. Gradual bending in the vertical direction that does not kink the reinforcements is permitted.
- C. Connection of reinforcements to piles, or bending of reinforcements around piles, shall not be allowed. Cutting of reinforcement longitudinal bars to avoid conflicts with piles or utility obstructions shall not be allowed. A structural connection (yoke) from the wall panel to the reinforcement shall be used whenever it is necessary to avoid cutting or to avoid excessive skewing of reinforcements due to pier, pile or utility conflicts.
- D. Soil reinforcements shall be placed normal to the face of the wall, unless otherwise shown on the shop drawings or directed in writing by the MSE wall engineer. If skewing of the soil reinforcements is required due to obstructions in the reinforced fill, rotatable connections shall be used and the maximum skew angle shall not exceed 15 degrees from the normal position unless specifically addressed in design calculations justifying skewed connections are adequate.

### 3.06 CUTTING AND BENDING:

- A. Perform cutting and bending in the shop. Bend steel cold. Do not bend or straighten bars so as to damage material.
- B. Do not bend bars in the field except to correct minor errors and damage occurring during shipping and handling.

### 3.07 BACKFILLING

- A. Backfill placement shall closely follow erection of each course of panels. Backfill shall be placed in such a manner as to avoid any damage or disturbance to the wall materials or misalignment of the facing panels. Any wall materials which become damaged or disturbed during backfill placement shall be either removed and replaced at the Contractor's expense or corrected, as directed by the Engineer.
- B. Any backfill material placed within the reinforced soil mass which does not meet the requirements of this specification shall be corrected or removed and replaced at the Contractor's expense, as directed by the Engineer.
- C. Backfill shall be compacted to 95 percent of the maximum density as determined by AASHTO T-99, Method C or D.

- D. The moisture content of the backfill material prior to and during compaction shall be uniform throughout each layer. Backfill material shall have a placement moisture content less than or equal to the optimum moisture content. Backfill material with a placement moisture content in excess of the optimum moisture content shall be removed and reworked until the moisture content is uniform and acceptable throughout the entire lift. The optimum moisture content shall be determined in accordance with AASHTO T-99, Method C or D.
- E. The frequency of sampling of select granular backfill material, necessary to assure gradation control throughout construction, shall be as directed by the Engineer. If 30 percent or more of the select granular backfill material is greater than 3/4 inch in size, AASHTO T-99 is not applicable. For such a material, the acceptance criterion for control of compaction shall be either a minimum of 70 percent of the relative density of the material as determined by ASTM D-4253 and D-4254, or a method specification, based on a test compaction section which defines the type of equipment, lift thickness, number of passes of the specified equipment, and placement moisture content.
- F. The maximum lift thickness after compaction shall not exceed 8 inches, regardless of the vertical spacing between layers of soil reinforcements. The Contractor shall decrease this lift thickness, if necessary, to obtain the specified density. Prior to placement of the soil reinforcements, the backfill elevation, after compaction, shall be 2 inches above the attachment device elevation from a point approximately 12 inches behind the back face of the panels to the free end of the soil reinforcements, unless otherwise shown on the plans.
- G. Compaction within 3 feet of the back face of the panels shall be achieved by at least three (3) passes of a lightweight mechanical tamper, roller or vibratory system. The specified lift thickness shall be adjusted as warranted by the type of compaction equipment actually used, but no soil density tests need be taken within this area. Care shall be exercised in the compaction process to avoid misalignment of the panels or damage to the attachment devices. Heavy compaction equipment shall not be used to compact backfill within 3 feet. of the wall panels.
- H. At the end of each day's operation, the Contractor shall slope the last level of backfill away from the back of the panels to direct runoff of rainwater away from the wall face. In addition, the Contractor shall not allow surface runoff from adjacent areas to enter the wall construction site.

END OF SECTION

SECTION 16112

CONDUITS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Requirements for furnishing, installing, energizing, and testing conduit, tubing, and fittings for communication lines and electrical transmission, distribution, and service lines.
  
- B. Related Section:
  - 1. Refer to Procurement Documents
  - 2. Section 02585 Electrical Underground Ducts and Manholes
  - 3. Section 16050 Common Work Results for Electrical
  - 4. Section 16060 Grounding and Bonding for Electrical Systems
  - 5. Section 16070 Hangars and Supports for Electrical Systems
  - 6. Section 16082 Acceptance of Electrical Systems
  - 7. Section 16271 Low-Voltage Transformers
  - 8. Section 16446 Panelboards

1.02 REFERENCES

- A. Reference Standards:
  - 1. U. S. Government:
    - a. Federal Transit Administration (FTA):
      - 1) 49 CFR 661 Buy America Requirements.
    - b. WMATA Manual of Design Criteria for Maintaining and Continued Operation of Facilities
  
- B. American National Standards Institute (ANSI):
  - 1. ANSI/ASME B1.20.1 - Pipe Threads, General Purpose (Inch).
  - 2. ANSI C80.1 - Rigid Steel Conduit - Zinc-Coated (GCR).
  
- C. ASTM International (ASTM):
  - 1. ASTM A 568/A 568M - Standard Specification for Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold Rolled, General Requirements (Refer to Procurement Documents).
  
- D. National Fire Protection Association (NFPA):
  - 1. NFPA 70 - National Electrical Code® (NEC).
  
- E. Underwriters Laboratory, Inc. (UL):
  - 1. ANSI/UL 6 - Standard for Rigid Metal Conduit.
  - 2. ANSI/UL 360 - Standard for Liquid-Tight Flexible Steel Conduit.
  - 3. ANSI/UL 514A - Metallic Outlet Boxes.
  
- F. Institute of Electrical and Electronics Engineers (IEEE):
  - 1. IEEE C2 - National Electrical Safety Code.



1.03 DEFINITIONS

- A. Definitions for all items are as stated in NFPA 70, IEEE C2, and in other reference documents unless otherwise stated, specified, or noted.

1.04 DESIGN REQUIREMENTS

- A. Conduit Systems:
1. Provide conduit of the type and material shown in Tables 16112 - 1 below for the application indicated, or as indicated on the Contract Drawings.
    - a. In a given location, provide only the type of conduit indicated or scheduled for that location.
  1. Provide conduit fittings made of material identical to that of the conduit system with which they are used.

<b>Table 16112 - 1 Conduit System Selection</b>				
<b>Location</b>	<b>Condition 1</b>	<b>Condition 2</b>	<b>Conduit Type</b>	<b>Size (Minimum) <sup>1</sup></b>
Under-Ground	Encased	Bends, over 10 degrees in length	Rigid Galvanized Steel	1 Inch
		Conduit Risers	Rigid Galvanized Steel	1 Inch
		Exposed conduit within 6-inches of exit from encasement	Coated Rigid Galvanized Steel	1 Inch
		Straight Runs	Schedule 40	1 Inch
1 No conduit smaller than 1-inch trade size is permitted unless indicated otherwise on the Contract Drawings.				
Under-ground	Direct Burial	Classified (Hazardous Areas)	Rigid Galvanized Steel	1 Inch
		Other		1 Inch
1 No conduit smaller than 1-inch trade size is permitted unless indicated otherwise on the Contract Drawings.				

<b>Table 16112 - 1 Conduit System Selection</b>				
<b>Location</b>	<b>Condition 1</b>	<b>Condition 2</b>	<b>Conduit Type</b>	<b>Size (Minimum) <sup>1</sup></b>
Above-Ground	Outside	Exposed to weather NEMA 3R/4 Locations	Coated Rigid Galvanized Steel or Rigid Galvanized Steel	3/4 Inch
		NEMA 4X Locations	Coated Rigid Galvanized Steel	3/4 Inch
		Covered or Protected from weather NEMA 3R/4 Locations	Rigid Galvanized Steel	3/4 Inch
	Inside NEMA 1/12	Within 6-inches of floor when exposed	Coated Rigid Galvanized Steel	3/4 Inch
		Within 6-inches of floor when within footprint of floor mounted equipment		3/4 Inch
		Above suspended ceilings	Rigid Galvanized Steel	3/4 Inch
		Concealed in Open-Cell Masonry Block Wall		3/4 Inch
		Concealed in Cast-in-Place Concrete Wall or Floor	Rigid Galvanized Steel	3/4 Inch
		Concealed behind Gypsum Board Wall or Ceiling	Rigid Galvanized Steel	3/4 Inch
		Recess Mounted Lighting Fixtures and Rotating or Vibrating Equipment	Flexible Metal Conduit or Liquid-Tight Flexible Metal Conduit	3/4 Inch
		Exposed within 10'-0" AFF	Rigid Galvanized Steel	3/4 Inch
Exposed above 10'-0" AFF	Rigid Galvanized Steel	3/4 Inch		

<b>Table 16112 - 1 Conduit System Selection</b>				
<b>Location</b>	<b>Condition 1</b>	<b>Condition 2</b>	<b>Conduit Type</b>	<b>Size (Minimum) <sup>1</sup></b>
Above-Ground	Inside NEMA 3R/4/4X	Within 6-inches of floor	Coated Rigid Galvanized Steel	3/4 Inch
		Concealed in Masonry Block Wall	Rigid Galvanized Steel	
		Concealed in Cast-in-Place Concrete Wall or Floor	Rigid Galvanized Steel	3/4 Inch
		Recess Mounted Lighting Fixtures and Rotating or Vibrating Equipment	Liquid-Tight Flexible Metal Conduit	3/4 Inch
		Exposed	Coated Rigid Galvanized Steel	3/4 Inch
		Recess Mounted Lighting Fixtures and Rotating or Vibrating Equipment	Liquid-Tight Flexible Metal Conduit	3/4 Inch
1 No conduit smaller than 3/4-inch trade size is permitted unless indicated otherwise on the Contract Drawings.				

1.05 SUBMITTALS

- A. Submit the following information to the Engineer for approval in accordance with the requirements of the Procurement Document:
  - 1. Product Data:
    - a. Rigid Conduit.
    - b. Non-metallic conduit solvent.
    - e. Plastic coated rigid galvanized steel conduit.
    - f. Liquidtight flexible metal conduit.
    - g. Rigid galvanized steel conduit (RGS).
    - h. Hazardous location flexible coupling
    - i. Fittings for non-metallic conduit systems.
    - j. Fittings for metallic conduit systems.
    - k. Conduit spacers.
    - l. Heat shrink tubing.
    - m. Wall and floor penetration seals.
    - n. Cold galvanize coating.
  - 2. Shop Drawings:
    - a. Proposed departures from the original design.
  - 3. Quality Assurance/Control Submittals:
    - a. Certificates:
      - 1) Testing agency/quality verification, listing, and labeling.

1.06 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
  - 1. Buy America Act :

- a. Except for those products which are exempt under the specific statutory waivers stipulated in 49 CFR 661, all other products supplied under this Section must comply with the requirements of the Buy America Act.
- B. Regulatory Requirements:
  - 1. Perform the Work of this Section in accordance with the requirements specified in NFPA 70 (NEC), and to other applicable state, local, and national governing codes and regulatory requirements.
- C. Certifications:
  - 1. Provide products that are listed and labeled by Underwriters Laboratory, approved by Factory Mutual, or certified as meeting the standards of UL by the Electrical Testing Laboratory (ETL) for the location the product is installed in, and the application intended, unless products meeting the requirements of these nationally recognized testing laboratories are not available or unless standards do not exist for the products.
    - a. Submit evidence with the Product Data that the products represented meet testing agency quality verification requirements, including agency listing and labeling requirements.
      - 1) Such evidence may consist of either a printed mark on the data or a separate listing card.
    - b. Submit a written statement from those product manufacturers that do not provide evidence of the quality of their products that indicates why an item does not have a quality assurance verification.
      - 1) Such statements provided in lieu of quality assurance verification are subject to the acceptance of the Authority and the Engineer.

#### 1.07 DELIVERY, STORAGE AND HANDLING

- A. Packing, Shipping, Handling, and Unloading:
  - 1. Pack, ship, handle, and unload products in accordance with the requirements of Section 16050, Common Work Results for Electrical, and as detailed herein.
- B. Acceptance at Site:
  - 1. Acceptance products at the Site in accordance with the requirements of Section 16050, Common Work Results for Electrical, and as detailed herein.
- C. Storage and Protection:
  - 1. Store products in accordance with the requirements of Section 16050, Common Work Results for Electrical, and as detailed herein.
    - a. Store all products indoors on blocking or pallets.

### PART 2 PRODUCTS

#### 2.01 NON-METALLIC CONDUIT

- A. Electrical Plastic Tubing and Conduit:
  - 1. Rigid Conduit:
    - a. Provide high impact conduit conforming to the requirements of NEMA TC 2 at 90 degrees Celsius, and made from compounds conforming to the requirements of ASTM D 1784.
      - 1) Use material that at 78 degrees Fahrenheit has a tensile strength exceeding 5500 psi, a flexural strength exceeding 11,000 psi, and a compressive strength exceeding 800 psi,

- b. Provide conduits that are UL listed, labeled, or approved for both underground and above ground use.
  2. Manufacturers:
    - a. JM Eagle, [www.jmeagle.com](http://www.jmeagle.com)
    - b. Queen City Plastics, Inc., [www.queencityplastics.com](http://www.queencityplastics.com).
    - c. Approved equal.
- B. Non-Metallic Conduit Solvent:
  1. Provide solvent for non-metallic conduit joints from the same manufacturer as the conduit and conforming to the requirements of ASTM D 2564.

## 2.02 METALLIC CONDUIT

- A.
  1. Provide tubing conforming to the requirements of Article 358 in NFPA 70 (NEC) for materials and uses, ANSI C80.3 and UL 797.
  2. Provide galvanized steel tubing conduit lengths bearing the manufacturer's trademark.
  3. Manufacturers:
    - a. Tyco/Allied Tube and Conduit, [www.alliedtube.com](http://www.alliedtube.com)
    - b. Wheatland Tube Company, Division of John Maneely Company, [www.wheatland.com](http://www.wheatland.com).
    - c. Or Approved equal.
- B. Coated Rigid Galvanized Steel Conduit:
  1. Provide coated rigid galvanized steel conduit bearing the UL label.
  2. Provide base conduit of rigid hot-dip galvanized steel conduit as specified in Paragraph 2.02D, and of the type indicated, specified, or scheduled to be coated.
  3. Apply coating in accordance with the following:
    - a. Apply a 40-mil thick coating on the outside and a 2-mil thick fusion-bonded urethane coating on the inside, exterior coatings conforming to the requirements of NEMA RN 1.
    - b. Provide coating of one uniform color on all coated rigid galvanized steel conduit provided for the Contract.
  4. Provide 40-mil thick sleeves to protect internally threaded conduit openings.
    - a. Provide sleeves with an inside diameter equal to the outside diameter of the conduit/pipe protected by it; and extending either one pipe diameter or 2-inches, whichever is less, beyond the opening.
  5. Manufacturers:
    - a. OCAL, <http://www.tnb.com/contractor/docs/ocal.pdf>.
    - b. Plasti-Bond [www.plastibond.com](http://www.plastibond.com)
    - c. Perma-Cote [www.permacote.com](http://www.permacote.com)
    - d. KorKap [www.korkap.com](http://www.korkap.com)
- C. Liquidite Flexible Metal Conduit:
  1. Provide coated flexible metal conduit conforming to the requirements of Article 350 of NFPA 70 (NEC) for materials and uses and ANSI/UL 360.
  2. Provide conduit with interlocking spiral strip construction capable of bending to a minimum radius of five times its diameter without deforming the spiral strips both inside and outside of the conduit.
    - a. Provide conduit with a flexible, galvanized, interlocking spiral strip steel core jacketed with smooth, liquid-tight polyvinyl chloride designed to withstand temperatures from minus 40 degrees Celsius to plus 60 degrees Celsius.

3. Finish the interior and exterior of flexible conduit smooth and free from burrs, sharp edges, and other defects that may injure wires; and place the manufacturer's trademark on each length.
  4. Furnish an integral continuous copper ground in 1/2-inch through 1-1/4-inch coated flexible metal conduit.
  5. Acceptable Manufacturers
    - a. Electri-Flex Company, Liqueflex®, Type LA, [www.electriflex.com](http://www.electriflex.com).
    - b. ANAMET Electrical, Inc., Anaconda Sealtite®, [www.anacondasealtite.com](http://www.anacondasealtite.com).
    - c. Approved equal.
- D. Rigid Galvanized Steel Conduit (RGS):
1. Provide rigid galvanized steel conduit (RGS) conforming to the requirements of Article 344 of NFPA 70 (NEC) for materials and uses, ANSI C80.1, and UL 6.
  2. Fabricate the RGS from mild steel piping, galvanized or sherardized inside and outside, and protected against corrosion by a dichromate rinse or a zinc chromate coating.
  3. Provide defect free conduit bearing the UL label, and furnished in 10-foot minimum lengths with both ends threaded and one end fitted with a coupling.
    - a. Provide tapered NTP 3/4 inch per foot threads complying with ANSI/ASME B1.20.1.
  4. Acceptable Manufacturers:
    - a. Tyco/Allied Tube and Conduit, [www.alliedtube.com](http://www.alliedtube.com).
    - b. Wheatland Tube Company, Division of John Maneely Company, [www.wheatland.com](http://www.wheatland.com).
    - c. Approved equal.

## 2.03 CONDUIT FITTINGS

- A. Fittings for Non-Metallic Conduit Systems:
1. Electrical Plastic Tubing and Conduit:
    - a. Provide high impact non-metallic fittings conforming to same requirements as for the plastic tubing and conduit as specified in Article 2.01.
    - b. Non-Metallic Conduit Expansion Fittings:
      - 1) Provide a two-piece nonmetallic, noncorrosive, nonconductive, UL listed expansion fitting.
    - c. Acceptable Manufacturers:
      - 1) Lamson & Sessions, Carlon®, [www.carlon.com](http://www.carlon.com).
      - 2) Queen City Plastics, Inc., [www.queencityplastics.com](http://www.queencityplastics.com).
      - 3) Approved equal.
- B. Fittings for Threaded Metallic Conduit Systems:
1. Construct conduit bodies/fittings from cast malleable iron or cast steel.
  2. For coated raceway systems, provide coated fittings of cast malleable iron or cast steel from the same manufacturer that provides the uncoated conduit bodies/fittings.
  3. Conduit Outlet Bodies:
    - a. Provide malleable iron threaded entry type conduit outlet bodies with neoprene gaskets and cast steel cover.
    - b. Acceptable Manufacturers:
      - 1) EGS/Appleton Electric, [www.appletonelec.com](http://www.appletonelec.com).
      - 2) EGS/O-Z/Gedney, [www.o-zgedney.com](http://www.o-zgedney.com).
      - 3) Approved equal.
  4. Conduit Expansion Joints:

- a. Provide telescoping sleeve type galvanized, weatherproof, and vapor tight conduit expansion joints designed for 4-inch maximum expansion with an insulated bushing and lead-wool packing.
  - b. Acceptable Manufacturers:
    - 1) EGS/Appleton Electric, [www.appletonelec.com](http://www.appletonelec.com).
    - 2) EGS/O-Z/Gedney, [www.o-zgedney.com](http://www.o-zgedney.com).
    - 3) Approved equal.
5. Conduit Unions:
- a. Provide conduit unions capable of completing a conduit run when neither conduit end can be turned.
  - b. Acceptable Manufacturers:
    - 1) EGS/Appleton Electric, UNF and UNY Unions, [www.appletonelec.com](http://www.appletonelec.com).
    - 2) Thomas and Betts Company, Erickson® Coupling., [www.tnb.com/contractor/docs/tbhazardous.pdf](http://www.tnb.com/contractor/docs/tbhazardous.pdf)
    - 3) Approved equal.
6. Conduit Outlet Boxes:
- a. Provide malleable or cast iron conduit outlet boxes conforming to the requirements of UL 886, and having a cover with O-rings to keep out moisture.
  - b. Acceptable Manufacturers:
    - 1) EGS/Appleton Electric, GRF outlets and covers, [www.appletonelec.com](http://www.appletonelec.com).
    - 2) EGS/O-Z Gedney, [www.o-zgedney.com](http://www.o-zgedney.com).
    - 3) Approved equal.
7. Conduit Device Boxes:
- a. Provide malleable iron conduit device boxes with internal grounding screws and conforming to the requirements of UL 498 and UL 514A.
  - b. Acceptable Manufacturers:
    - 1) EGS/Appleton Electric, FD device boxes, [www.appletonelec.com](http://www.appletonelec.com).
    - 2) EGS/O-Z Gedney, [www.o-zgedney.com](http://www.o-zgedney.com).
    - 3) Approved equal.
8. Conduit Sealing Fittings:
- a. Provide, triple coated, malleable iron conduit sealing fittings.
    - 1) Coat the conduit sealing fittings with zinc electroplate, dichromate, and an epoxy powder coat.
  - b. Provide drain fittings in conduit sealing fittings where required.
  - c. Provide sealing covers for junction boxes where required.
  - d. Acceptable Manufacturers:
    - 1) EGS/Appleton Electric, [www.appletonelec.com](http://www.appletonelec.com).
      - a) Sealing hubs: ES.
      - b) Sealing fittings: EY, EYS, EYSF, EYSM, EUS, EYD, EYDM
    - 2) EGS/O-Z Gedney, [www.o-zgedney.com](http://www.o-zgedney.com).
    - 3) Approved equal.

#### 2.04 CONDUIT SPACERS

- A. Provide non-metallic, interlocking type conduit spacers which snap together to join any combination of intermediate and base units together, both vertically and horizontally.
- B. Manufacturers:
  1. Underground Devices Inc., [www.udevices.com](http://www.udevices.com).
  2. The George-Ingraham Corp.
  3. Approved equal.

## 2.05 HEAT SHRINK TUBING

- A. Provide all-weather corrosion resistant vinyl plastic heat shrink tubing designed for application on the exterior of metallic conduit to protect against galvanic action, moisture or other deteriorating contaminants.
- B. Manufacturers:
  - 1. Tyco Electronics, Raychem, [www.raychem.com](http://www.raychem.com).
  - 2. Thomas & Betts
  - 3. Approved equal.

## 2.06 WALL AND FLOOR PENETRATION SEALS

- A. Provide watertight mechanical seals capable of holding up to 20 psig, and sealing against water, soil, and backfill material.
- B. Acceptable Manufacturers:
  - 1. Pipeline Seal & Insulator, Inc., Thunderline/Link-Seal, [www.linkseal.com](http://www.linkseal.com).
  - 2. Flexicraft Industries, PipeSeal, <http://flexicraft.com>.
  - 3. Approved equal.

## 2.07 FINISHES

- A. Cold Galvanize Coating:
  - 1. Provide a cold galvanize coating to provide protection against corrosion by forming an insoluble zinc salt barrier from a cathodic reaction when the coating is damaged by abrasion and exposed to weather.
    - a. Provide a single component pre-mixed liquid organic zinc compound producing 95 percent zinc in the dry film.
    - b. Provide a coating that bonds to clean iron, steel, or aluminum through electrochemical action.
  - 2. Acceptable Manufacturers:
    - a. ZRC. Worldwide, [www.zrcworldwide.com](http://www.zrcworldwide.com).
    - b. Clearco
    - c. Krylon
    - d. Rustoleum
    - e. Or approved equal

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A. Although the Contract Drawings are generally indicative of the Work, take field measurements to verify actual conditions.
  - 1. Due to the small scale of the Contract Drawings it is not possible to indicate all offsets, fittings, and apparatus required or the minor structural obstructions that may be encountered during the Work.
- B. Inspect the condition of existing conduit that is required for the Work of this Section.



### 3.02 PREPARATION

- A. After carefully investigating structural and finish conditions and other in-place construction work, prepare and submit detailed Shop Drawings showing proposed departures from the original design due to field conditions or other causes.
  - 1. Layout the electrical work according to accepted standard electrical trade practice to suit actual field measurements.
  - 2. Arrange the electrical work to consider existing conditions and to preserve access to other equipment, rooms, areas, and similar features of the construction.
- B. Submit Product Data and catalog cuts for all products provided under this Section.
  - 1. Clearly indicate the usage of each product on the submittal.
- C. Obtain roughing-in dimensions of electrically operated equipment, including equipment being installed by both electrical and other construction trades.
  - 1. Set conduit and boxes only after receiving approved dimensions and checking such equipment locations.
- D. Remove dirt, debris, and other obstructions from existing conduit required for the Work of this Section by blowing out and mandreling the conduits as applicable.

### 3.03 INSTALLATION

- A. Perform the Work of this Section as specified in Section 16050, Common Work Results for Electrical.
- B. Fabricate and install conduit and wireway systems in accordance with accepted electrical trade standard practice.
  - 1. Layout the electrical work of this Section to suit actual field measurements.
    - a. Record the actual installed elevations and locations of duct banks and the as-found locations of conflicting utility lines on the record drawings specified in Section 01775, Closeout, and submit the record drawings.
  - 2. Install the electrical Work of this Section in conformance to the wiring methods general requirements of Article 300 in NFPA 70 (NEC), and to all other applicable Articles of NFPA 70 governing wiring methods.
  - 3. Cut conduit and wireway square, and ream the cut ends according to the requirements of NFPA 70 (NEC) to deburr the openings so that they are not restricted more than cuts made by the material manufacturer.
  - 4. Avoid bending conduits as much as possible and practical; but if bends are made, use an approved conduit bending tool or machine to make the bends.
  - 5. Do not install crushed or deformed conduit, and remove crushed or deformed conduit from the Site.
  - 6. On conduit that is installed outside, provide a second equipment ground conductor and use fittings with a built-in ground lug for bonding.
  - 7. Provide flexible conduit only to the extent permitted by NFPA 70 (NEC).
    - a. In flexible conduits that do not have an integral ground wire, install a green insulated wire in addition to the neutral wire for grounding purposes.
      - 1) Form a 'J' or 'S' hook with a drip loop to allow flexibility.
      - 2) Provide a second equipment grounding conductor on outside conduit and provide fittings with built-in ground lug for bonding.
    - b. In exposed areas, use coated flexible metal conduit and fittings.
    - c. Use flexible metal conduit or liquid tight flexible metal conduit for final connection to recessed lighting fixtures and rotating and vibrating equipment.

- 1) Flexible Metal Conduit is only permitted for final connections to lighting fixtures in dry, environmentally conditioned spaces.
  - 2) Liquid tight flexible metal conduit, as herein specified, for final connection to recess mounted lighting fixtures in unconditioned spaces and to all rotating and vibrating equipment including transformers, motors, solenoid valves, pressure switches, limit switches, generators, engine-mounted devices and pipe-mounted devices.
  - 3) Flexible conduit not to exceed 18 inches in length for motor connections, 36 inches in length for equipment connections or 72-inches for lighting fixture connections.
8. Provide fittings and apparatus as required to construct the approved electrical design.
- a. Running threads on conduit are not permitted.
    - 1) Where couplings and connectors are required for metal conduits, use approved threaded couplings and connectors.
  - b. Provide conduit unions where necessary to complete a conduit run when neither conduit end can be turned.
  - c. Where conduit and raceway runs cross building expansion joints, make provision for expansion in the conduit and raceway runs.
  - d. Provide sealing fittings with drain fittings in all lower runs and vertical runs.
  - e. Provide sealing covers for junction boxes where required.
  - f. Provide weatherproof conduit hubs on all conduit connections exterior to the building, and on instruments, process equipment, and pump motors.
9. Installing RGS and Coated Conduit:
- a. Installation of the RGS and Coated Conduit System shall be performed in accordance with the Manufacturer's recommendations.
  - b. To assure correct installation of Coated Conduit System, the installer shall have a current and unexpired certification provided by the Manufacturer to install coated conduit.
  - c. Threading Conduit:
    - 1) Field thread the conduits per the manufacturers instructions.
      - a) For coated conduit, first use a cylindrical guide, oversized to fit over the plastic coating, to neatly cut the coating off at the proposed end of the threads.
      - b) Do not damage or remove the coating beyond the proposed end of the threads.
    - 2) Once the threading operation is complete, protect the newly cut threads against corrosion by applying a "sealing" compound as recommended by the manufacturer.
  - d. Assembling RGS and Coated Conduit Fittings:
    - 1) Use coated conduit bodies, clamps, supports, accessories, and fittings with coated conduit systems.
    - 2) Just prior to assembling each conduit joint, apply the conduit manufacturer's touch-up compound to the end of the conduit in the area normally covered by the fitting sleeve.
    - 3) Use cloth or other material over strap type wrenches to protect the coating while tightening conduits.
10. Breathers and drains shall be provided at the low point(s) of all conduit runs in NEMA 3R, 4, 4X and 7 areas, and where otherwise subject to the accumulation of condensation. Conduits shall be arranged to drain away from dry areas toward damp or wet areas, and away from equipment and enclosures.

C. Exposed Work:

1. In exposed work, run conduit and raceway parallel to centerlines and structure surfaces; or perpendicular to centerlines where required, with right angle turns consisting of symmetrical bends or fittings.
  2. Maintain at least 6 inches clearance between conduit and raceway runs and pipes, ducts, and flues of mechanical systems.
  3. If a portion of a metallic conduit run, whether plastic-coated or not, extends above grade or is otherwise exposed to personnel, ensure that the conduit is properly bonded to an equipment grounding conductor at both ends.
    - a. Install the equipment grounding conductor either inside or outside the box.
- D. Concealed Work:
1. When performing electrical work in concealed spaces, provide the same quality workmanship as in exposed work.
  2. Conceal conduits and raceways in the structure's construction where practicable unless otherwise indicated on the Contract Drawings or required by the Engineer.
    - a. Group conduit and raceway runs in concealed work as much as practical to avoid congesting the concealed spaces.
    - b. Do not weaken the structure by excessive or unnecessary cutting.
      - 1) Only make cuts into the structure's construction in conformance to the applicable building codes.
  3. Conduits and Raceways Embedded in Concrete Slabs:
    - a. Separate multiple conduits encased together by not less than two inches of concrete.
    - b. Locate conduit installed in floor slabs within the reinforced area of the slab.
    - c. Where conduit crosses expansion joints, provide weather tight expansion and deflection fittings and bonding jumpers.
  4. Install below grade conduit in conformance with the requirements of Section 02585, Electrical Underground Ducts and Manholes.
    - a. For conduits that pass under building support walls, provide a minimum of 3 inches of concrete encasement all around.
    - b. For underground and concrete encased duct banks, provide non-metallic conduit spacers.
      - 1) Provide sufficient space to allow pouring the concrete envelope without displacing or shifting the individual conduits.
      - 2) Install conduit spacers at intervals not exceeding five feet.
- E. Hangers and Supports:
1. Install auxiliary support structures, anchors, and fasteners as specified in Section 16070, Hangers and Supports for Electrical Systems.
    - a. Mount or suspend conduit and wireway systems directly on structural members of the structures and walls.
    - b. Do not attach conduit or raceway systems to suspended ceiling members or to the suspending mediums.
    - c. Securely attach anchors into walls.
  2. At all conduit attachments, allow space between the mounting surfaces and the conduit by providing U-channel supports, clamp-backs, or spacers.
    - a. Attach wall-mounted conduit runs close to the walls following the contour of the walls, parallel to the walls and other building lines except at bends.
- F. Structure Penetrations:
1. Make penetrations in existing concrete structures by core-drilling.
    - a. Drill the penetrations true, clean, and free from spalling.
  2. At penetrations through fire rated floors, walls, and similar assemblies, provide firestopping as specified in Section 07841, Firestopping.

3. Install a wall penetration seal at all wall penetrations.
    - a. Size wall penetrations to accommodate the conduit outside diameter plus either 1/4 inch or a hole allowance to allow the installation of the wall penetration seal.
  4. For conduits that enter rooms from concrete floors or masonry, provide corrosion protection by using an RGS- or -coated conduit that extends from 12 inches inside the concrete or masonry to at least 6 inches into the room.
- G. Wiring:
1. Install wiring in conduit as indicated.
  2. Prior to the installation of any wire, verify that the conduit is clean and free of debris.
  3. Install a separate ground conductor within every conduit.

### 3.04 FIELD QUALITY CONTROL

- A. Inspection:
1. Inspect installed conduit runs for obstructions, proper support, proper grounding, and completeness.

END OF SECTION

## WMATA MANUAL OF DESIGN CRITERIA FACILITIES, SECTION 15

detail the proposed instrumentation and monitoring to ensure the permanent structure will not be over-stressed or otherwise damaged.

- 15 .4.2.1.8.1 The Contractor shall submit, , working drawings for the option selected for approval . The working drawings shall include supporting computations for all governing loading cases during construction and the order of procedure proposed. In all cases, the specifications for support of excavation must reflect any limitations inherent in the design of the permanent structure. The Designer shall show on the General Notes sheet/sketch, similar to those shown on [Figure 15.3](#), illustrating construction basis for the design.

### 15 .4.2.2 Reinforced Concrete Rigid Earth Tunnel Sections

- 15 .4.2.2.1 The method of driving these tunnels is proposed to be full shield for the circular section. Temporary tunnel support will be provided by precast concrete lining and permanent support by cast-in-place concrete lining.
- 15 .4.2.2.2 These sections shall be designed as rigid structures using working [stress design methods, per Section 15.2.2.4](#). Horizontal earth pressure shall be calculated using an earth pressure factor established in [consultation with the Designer's geotechnical consultant and approved](#) by WMATA.
- 15 .4.2.2.3 The structural design shall be checked by ultimate strength design methods using a load factor of one. The maximum concrete stress, considering rectangular stress distribution, shall not exceed 85% of the required 28-day concrete strength. Two horizontal earth pressure factors, 0.45 and 1.00, shall be used in these check analyses.

### 15 .4.2.3 Flexible Earth Tunnel Sections - See [Section 15.10.2](#) ., One Pass System Circular Earth Tunnels

### 15 .4.2.4 Permanent Retaining Walls

- 15 .4.2.4.1 Reinforced Concrete Retaining Walls - Retaining walls shall be designed on the basis of specific soils information relating to the backfill material and in accordance with the procedures outlined in the AREMA Manual, [Chapter 8, Part 5](#). [The footings of the retaining wall shall be designed using working stress design methods, per Section 15.2.2.4](#).
- 15 .4.2.4.2 External Stability of Wall System
  - 15 .4.2.4.2.1 Stability of the retention system as a whole must satisfy three conditions: The factors of safety against sliding and overturning must be adequate; the soil pressure beneath the toe of the foundation must not exceed the allowable soil pressure; and differential settlements of the foundation must not be excessive.
  - 15 .4.2.4.2.2 Safety Against Sliding
    - 15 .4.2.4.2.2.1 Sliding of a retaining wall is resisted by the friction between the soil and base and by the passive earth pressure of the soil in contact with the outer face of the foundation.

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- 15 .4.2.4.2.2** The factor of safety against sliding is equal to horizontal resisting forces divided by the horizontal component of the backfill pressures, which should be at least 1.5. The friction between the base and clean sand or silty sand is equal to the effective normal pressure on the base times the tangent of the friction angle  $\phi$  between soil and base. The value of  $\phi$  may be taken as  $30^\circ$  for a coarse-grained soil containing no silt or clay, and as  $24^\circ$  for a coarse-grained soil containing silt. The value of  $\phi$  between sand and underlying clay can be assumed as  $20^\circ$ . The passive resistance in front of the wall shall be disregarded unless approved otherwise by the Authority.
- 15 .4.2.4.2.3** Safety Against Overturning - The factor of safety against overturning is determined by dividing the sum of moments of forces tending to resist rotation of the wall about the center of rotation of the wall/footing by the sum of moments of forces tending to produce the overturning. A factor of safety of at least 1.5 is required. If walls rest on a highly compressible or cohesive soils, based on the information and the Designer's Geotechnical Design Report, a minimum factor of safety of 2 shall be provided.
- 15 .4.2.4.2.4** Allowable Soil Pressure and Settlement - The maximum base pressure at the toe of the wall will be limited by the allowable bearing capacity of the soil. The foundation/footing should be designed such that the point of application of the resultant force is within the middle third.
- 15 .4.2.4.2.5** Overall Stability -where retaining walls are underlain by weak soils ( $\Theta < 25^\circ$ ), the overall stability of the mass containing the retaining wall shall be checked with respect to the most critical surface of sliding. A minimum factor of safety of 2 is required.
- 15 .4.2.4.3** Reinforced Earth/Mechanically Stabilized Earth: This system may be used only after prior approval of the Authority.
- 15 .4.2.4.3.1** Reinforced Earth (RE) and Mechanically Stabilized Earth (MSE) walls shall be designed in accordance with the current requirements of the AASHTO Standard Specifications for Highway Bridges and as supplemented by the criteria and requirements below.
- 15 .4.2.4.3.2** Design Life of walls shall be minimum 100 years; with minimum 5-year warranty period on wall system, during which annual inspections shall be performed by the engineer of record or authorized agent.
- 15 .4.2.4.3.3** RE/MSE wall supplier shall be the engineer of record for the RE/MSE wall design, and shall be responsible for internal, external and global stability design including allowable bearing capacity. Supplier shall certify that wall installation conforms to approved design.
- 15 .4.2.4.3.4** RE/MSE wall supplier shall provide the following for WMATA approval:

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**15 .4.2.4.3.4.1** With Proposal package:

Complete specifications identifying

Design parameters (including minimum required soil bearing capacity)

Materials and design properties

Installation methods

Catalog cuts

Equipment list

Sample calculations for tallest wall section (including internal, external and global stability calculations, and settlement calculations for which design/builder will be fully responsible)

QC Plan and QC Staff

Cost Loaded Bar Chart Schedule showing planned start and finish dates of activities and associated costs

Identification of limit of work and access through site.

Method of controlling differential settlement along the wall based on the available soil boring information. (To include at least the minimum requirements in [Section 15.4.2.4.3.7](#) below.)

Monitoring program to monitor potential settlements and other wall movements.

Schematic design of drainage system to control, collect and discharge water from behind the wall.

Design for corrosion protection of steel elements.

**15 .4.2.4.3.4.2** Prior to Construction :

**15 .4.2.4.3.4.2.1** Final calculations with P.E. stamp (including internal, external and global stability calculations, and settlement calculations).

**15 .4.2.4.3.4.2.2** Shop Drawings

**15 .4.2.4.3.4.2.3** Details of drainage system to control, collect and discharge water from behind the wall.

**15 .4.2.4.3.5** RE/MSE wall design/constructor must demonstrate the groundwater and soil corrosiveity properties at the site, including pH, will not affect the performance and service life of the wall.

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**15 .4.2.4.3.6 Backfill:**

**15 .4.2.4.3.6.1** Backfill for undercut shall be Virginia DOT Stone No. 57 as specified in the latest edition of Virginia Department of Transportation Specifications, Road and Bridge Specifications, or equivalent.

**15 .4.2.4.3.6.2** Backfill for reinforced earth volume: VDOT Stone No. 57 or Select Granular Backfill Material as specified below .

**15 .4.2.4.3.6.3** Select Granular Backfill Material shall be free from organic and other deleterious material and conform to the following gradation limits:

<b>% by Weight of Material</b>	
<b>U.S. Sieve Size</b>	<b>Passing Sieve</b>
1½ in	100
½ in	25 - 60
No. 40	15 - 30
No. 200	0 - 5

**15 .4.2.4.3.6.4** Plasticity Index (PI) for Select Granular Backfill Material shall not exceed 6.

**15 .4.2.4.3.6.5** Random backfill beyond the limits of the reinforced earth volume shall meet the requirements for backfill in Standard Specification [Section 2320](#) , Section 2.01.A. The pH for Random Backfill shall be between 5.0 and 8.0 .

**15 .4.2.4.3.7** Subgrade Preparation: To control differential settlement along the length of wall, undercut within limits described below, place Tensor Geogrid BX1100 or WMATA approved equal on excavated surface, overlay geogrid with layer of geotextile fabric and fill with VDOT Stone No. 57.

**15 .4.2.4.3.8 Limits of undercut:**

**15 .4.2.4.3.8.1** Length: The entire length of the wall.

**15 .4.2.4.3.8.2** Width: Equal to or greater than the length of the reinforcing elements behind the wall, and in front of the wall to a distance from the edge of the leveling pad equal to or greater than the depth of undercut.

**15 .4.2.4.3.8.3** Depth: Minimum 3 feet, but shall be increased in areas of weak soil if shown in soil boring reports, so that differential settlement is eliminated or reduced to a negligible amount. If unstable or poor soil conditions are encountered during excavation, the engineer of record shall propose a



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solution; any resulting additional work and material, such as undercut, rip rap, fabric and, fill will be paid as a unit price item.

- 15 .4.2.4.4** RE/MSE wall supplier shall provide the following minimum factors of safety (FOS):

External Stability	Minimum FOS
Sliding	2.0
Overturning	2.7
Global Stability (Overall depth/Deep seated slope stability)	1.7
Bearing Capacity	2.5
Pullout Resistance	2.0

- 15 .4.2.4.5** Wall face:

- 15 .4.2.4.5.1** Reinforced Concrete Panels are preferred.
- 15 .4.2.4.5.2** Minimum concrete strength at installation shall be 4000 psi.
- 15 .4.2.4.5.3** Alignment of panels and construction of wall face shall provide a true vertical plane with uniform surface after deflection. Precast tolerances and erection tolerances shall be coordinated.
- 15 .4.2.4.5.4** A minimum of 2 layers of steel reinforcing per panel with maximum vertical spacing of 30" on centers shall be provided. Panels shall be adequately reinforced for flexure.
- 15 .4.2.4.5.5** All panels shall be keyed to each other (shear connection).

- 15 .4.2.4.6** Concrete Block Wall may be used as an alternate, with WMATA approval.

- 15 .4.2.4.6.1** Minimum strength of concrete block at installation shall be 4000 psi.
- 15 .4.2.4.6.2** Alignment of blocks and construction of wall face shall provide a true vertical plane with uniform surface after deflection. Precast tolerances and erection tolerances shall be coordinated.
- 15 .4.2.4.6.3** Place steel reinforcement on 16" centers vertically (every other course) for 8" block. Place steel reinforcing in the course of every other block in the horizontal direction. On the course of blocks in between, place an intermediate reinforcing layer of continuous

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geotextile or geogrid extending a minimum 8 feet length into backfill behind wall. All blocks shall be doweled to each other.

- 15 .4.2.4.6.4** The steel reinforcing shall be designed to provide the full structural support, neglecting any contribution from the geotextile or geogrid, which shall be assumed to provide the facial stability only.
- 15 .4.2.4.6.5** Inextensible Reinforcements: RE/MSE walls to be retained with inextensible reinforcement.
  - 15 .4.2.4.6.5.1** Reinforcement Material: Steel, hot-dipped Galvanized after fabrication.
  - 15 .4.2.4.6.5.2** Minimum layers and spacing in accordance with [Section 15.4.2.4.6.3](#) above.
  - 15 .4.2.4.6.5.3** Minimum length > 1.0 x H (wall height)
- 15 .4.2.4.6.6** Settlement:
  - 15 .4.2.4.6.6.1** No settlement 3 months after completion of the wall. Surcharge wall as needed to accelerate settlement.
  - 15 .4.2.4.6.6.2** Allowable during construction, as long as an approved monitoring and remediation program can be implemented without compromising the project schedule.
  - 15 .4.2.4.6.6.3** Design/Construction documents shall include provisions such as subgrade preparation to limit settlement. See Subgrade Preparation [Section 15.4.2.4.3.7](#) above.
- 15 .4.2.4.6.7** RE/MSE wall shall be designed to support a traffic barrier and moment slab withstanding AASHTO loading and deflection due to fire truck (WB-50). Traffic barrier shall be capable of accommodating future site lighting pole shown on plans.
- 15 .4.2.4.6.8** Provide effective permanent drainage including necessary drainage blankets in back of and behind the reinforced zone, and other internal drainage elements, to eliminate seepage from behind the wall. Drainage from behind the wall shall be controlled, collected and discharged from common point(s).
- 15 .4.2.4.6.9** Detailed design for corrosion protection (100 year minimum) of any steel elements in the system including consideration of stray current, aggressive elements infiltrating from surface flows and groundwater flows. All steel elements in the system must be hot-dipped galvanized.
- 15 .4.2.4.6.10** Design/Construction shall accommodate installation of planned subsurface utilities, such as ballast drains, cable trenches, ductbanks, light pole foundations and storm drain pipes; without decreasing wall performance/service

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**15 .4.2.4.6.11** RE/MSE wall supplier shall provide a full time inspector during wall construction. Inspector shall provide daily reports through the Contractor. Reports shall include, but not be limited to, pre-placement, placement, and post-placement inspection records of precast panels.

**15 .4.2.5 Linings for Structures Tunneled in Rock**

**15 .4.2.5.1** For each rock tunnel construction contract , the Designer shall prepare a Geotechnical Design Report, based on current subsurface information, describing the basis of the design, estimated loads on the lining and lining construction specifications.

**15 .4.2.5.1.1** The design shall consider pressure mobilized by the resistance of the rock mass to the outward deflection of the lining. The recommended average properties of the rock elastic modulus are 100,000 psi in compression and 50,000 psi in shear. Crown grouting will be required to fill voids between the rock and the permanent lining. For horseshoe tunnels, crossovers and station structures, satisfactory drainage shall be provided behind the lining and hydrostatic pressures shall be assumed to be relieved. However, in cases where exploratory information indicates complete drainage may be impracticable, the design loading shall include an allowance for exterior hydrostatic pressures or alternatively, grouting will be required to reduce the permeability and expected inflow, and provide drainage . For horseshoe tunnels, crossovers and stations waterproofing shall be provided in the crown and side walls. In A hydrostatic pressure relief system will not be required for circular tunnels. However, full water proofing must be designed in all cases.

**15 .4.2.5.2** Where exploratory information indicates drainage is necessary and practical to relieve hydrostatic pressure on the lining , provide drainage, spaced longitudinally as required. At each such location there should be four drains installed to a predetermined pattern. Also, specify the installation of additional drains if required by conditions encountered during construction. Generally, the drain holes shall be 3-inch diameter and be spaced 10 feet apart.

**15 .4.2.5.3** The Designer shall specify tunneling method(s) and techniques to be employed based on the WMATA Tunneling Specifications.

**15 .4.2.5.4 Tunnel Type**

**15 .4.2.5.4.1** Depending on size, two basic rock tunnel designs shall be considered:

**15 .4.2.5.4.1.1** Running tunnels, including single and double track and crossovers with track centers not exceeding 14'-0".

**15 .4.2.5.4.1.2** Station tunnels, including crossovers and transition sections when the crossovers and transition sections have more than 14'-0" distance between tracks.

**15 .4.2.5.4.2 Design of Running Tunnel Linings**

**4-29-15 Office of Parking**

This document approves staging area only. Staging area must be fenced.

Parking notice signs shall be posted 10 days in advance.

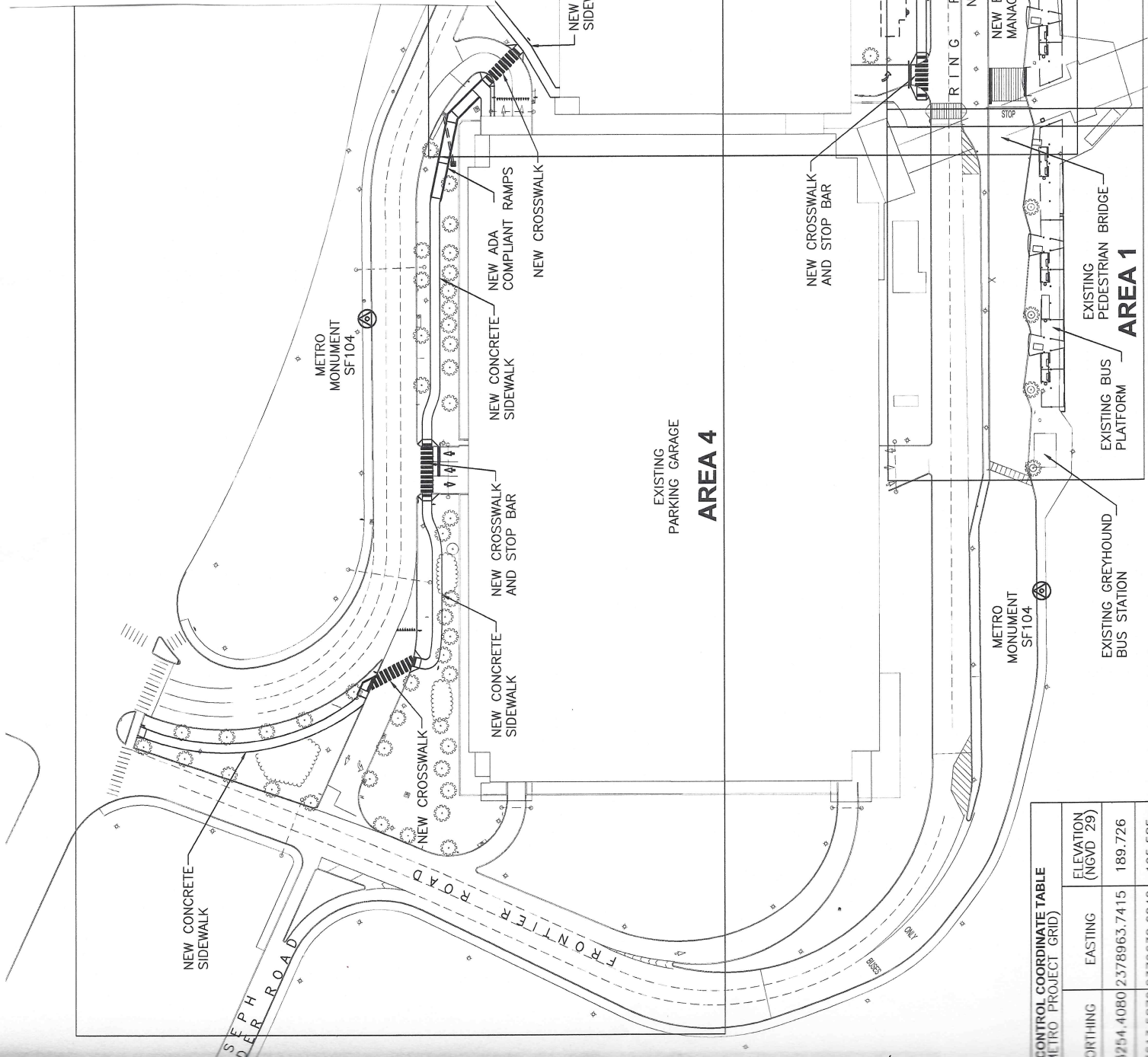
Any areas disturbed shall be restored to it's current condition or better upon completion of work.

Construction traffic must move safely through the active parking lot.

The Concept Maintenance of Traffic Plan for Overall Site is **CONCEPTUAL** only.

Fully phased MOT (Maintenance of Traffic) and detour plans must be approved by Office of Parking prior to any commencement of work.

Contact the Office of Parking at (202) 962-5179 for additional information.



**CONTROL COORDINATE TABLE**  
METRO PROJECT GRID)

ORTHING	EASTING	ELEVATION (NGVD 29)
1254.4080	2378963.7415	189.726
1313.5870	2379632.6242	195.585