

**REPORT OF**  
**SUBSURFACE EXPLORATION AND**  
**GEOTECHNICAL ENGINEERING ANALYSIS**

**ECS PROJECT NO. 01:13983-B**

**ROBINSON TERMINAL NORTH**  
**500/501 NORTH UNION STREET**  
**ALEXANDRIA, VIRGINIA**

**FOR**  
**ALEXANDRIA NORTH TERMINAL, LLC**

**NOVEMBER 14, 2014**



November 14, 2014

Alexandria North Terminal, LLC  
2900 K Street, NW  
Suite 401  
Washington, DC 20007

ECS Project No. 01:13983-B

Reference: Report of Subsurface Exploration and Geotechnical Engineering Analysis,  
Robinson Terminal North, 500/501 North Union Street, Alexandria, Virginia  
22314

Dear Mr. Blazar:

As authorized by your acceptance of our Proposal No. 01:47793-GPR4 dated May 16, 2014 and most recently revised September 12, 2014, ECS Mid-Atlantic, LLC (ECS) has completed the subsurface exploration and geotechnical engineering analysis for the proposed mixed use development at the physical addresses of 500 and 501 North Union Street, Alexandria, Virginia. Please note that ECS previously issued an addendum letter regarding uplift of the building foundation (ECS Report No. 01:13983-A).

A report including the results of our subsurface exploration, boring data, laboratory testing, engineering recommendations, as well as a Boring Location Diagram are enclosed herein. The recommendations presented are intended for use by your office and for use by other professionals involved in the design and construction stages of the project described herein.

This report has been prepared to aid in the evaluation of this site and to assist the design team with the design of the proposed development. We appreciate the opportunity to be of service to Alexandria North Terminal, LLC on this project. If you have any questions regarding the information and recommendations contained in the accompanying report, please do not hesitate to contact us.

Respectfully,

**ECS MID-ATLANTIC, LLC**

Chris M. Egan, E.I.T.  
Staff Project Manager

Manol P. Andonyadis, P.E.  
Principal Engineer



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REPORT

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PROJECT

Robinson Terminal North  
500/501 North Union Street  
Alexandria, Virginia 23314

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CLIENT

Alexandria North Terminal, LLC  
2900 K Street, NW  
Suite 401  
Washington, DC 20007

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PROJECT NO.      01:13983-B

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DATE                      November 14, 2014

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## **PROJECT OVERVIEW**

### **Introduction**

This report presents the results of our subsurface exploration performed for the proposed mixed use development located at 500/501 North Union Street, Alexandria, Virginia. This exploration was conducted in general accordance with ECS Proposal No. 01:47793-GPR4, dated May 16, 2014 and most recently revised September 12, 2014, which was authorized by your office. Please note that ECS previously issued an addendum letter regarding uplift of the building foundation (ECS Report No. 01:13983-A).

### **Site Location and Description**

The project site is located at the physical addresses of 500 and 501 North Union Street in Alexandria, Virginia. The site is currently developed with two warehouse buildings and site grades generally range from approximately EL. 0 feet along the Potomac River to approximately EL. 13 feet at the southwest side of the western building. The project site is split by North Union Street, which divides the addresses of 500 and 501 North Union Street. The overall project site is bordered to the south by Oronoco Street, to the east by the Potomac River, to the west by existing commercial structures, and to the north by the Potomac River and Oronoco Bay Park.

### **Proposed Construction**

The project will consist of the design and construction of two multi-use buildings located at 500 and 501 North Union Street in the City of Alexandria, Virginia. Based on the information provided to our office, we understand that the building located at 500 North Union Street (west building) will be six levels above-grade and one-level below grade with retail on the ground level and residential units and hotel rooms occupying the upper levels. The building located at 501 North Union Street (east building) will be four levels above grade and one parking level below grade. Retail will occupy the first level with residential units on the remaining levels.

We understand that each building will have a finished floor elevation of about EL. 12 feet and will be founded on mat slab foundations. Based on the information provided by Ehlert-Bryan, we understand that the maximum anticipated column load is 1,200 kips, the average column load is 800 kips, and the maximum column load is 5 kips per lineal foot. It is our understanding that there are environmental conditions for which there are significant costs associated with excavation haul-off and dewatering.

The description of the proposed project, as given above, is based on information provided to us and a review of the drawings provided. If any of the information is in error, either due to our misunderstanding or due to any design changes which may occur later, we recommend ECS be contacted so we may review our recommendations and provide any alternate or additional recommendations considered warranted at that time.

## **Scope of Work**

The recommendations presented in this report are based on the results of our subsurface exploration, laboratory testing, and review of available geologic and/or geotechnical information. ECS previously performed six borings (referenced as B-1 through B-6) and recently performed six additional borings (referenced as B-7 through B-12) within the proposed development limits. Each of the borings were extended to depths between 60± and 80± feet below the existing site grades.

Each of the borings were located in the field by representatives of ECS based on the provided site plan, utilizing on-site landmarks and estimated distances by standard pacing and taping techniques. The results of the borings, along with a Boring Location Diagram, are included in the Appendix of this report. The Boring Location Diagram was developed from the site plans provided by your office.

## **Purposes of Exploration**

The purpose of this exploration was to observe the subsurface conditions at the site and to develop engineering recommendations to guide the design and construction of the project. We accomplished these purposes by performing the following scope of services:

1. drilling borings to explore the subsurface soil and groundwater conditions,
2. performing laboratory tests on selected representative soil samples from the borings to evaluate pertinent engineering properties,
3. analyzing the field and laboratory data to develop appropriate engineering recommendations, and
4. preparing this geotechnical report.

## **EXPLORATION PROCEDURES**

### **Subsurface Exploration Procedures**

The soil borings were performed utilizing an ATV-mounted auger-drilling rig, which utilized mud rotary drilling. After completion of the borings, the boreholes were grouted, excess spoils drummed, and the boreholes filled and patched.

Representative soil samples are obtained by means of the split-barrel sampling procedure in accordance with ASTM Standard D-1586. In the split-barrel sampling procedure, a 2-inch O.D., split-barrel sampler is driven into the soil a distance of 18 inches by means of a 140-pound hammer falling 30 inches. The number of blows required to drive the sampler through the last 12-inch interval is termed the Standard Penetration Test (SPT) "N" value and is indicated for each sample on the boring logs. This value can be used to provide a qualitative indication of the in-place relative density of cohesionless soils.

A field log of the soils encountered in the boring was maintained by the drill crew. After recovery, each sample was removed from the sampler and visually classified. Representative portions of each sample were then sealed and brought to our laboratory in Chantilly, Virginia for further visual classification and laboratory testing.

### **Laboratory Testing Program**

Representative soil samples were selected and tested in our laboratory to check field classifications and to determine pertinent engineering properties. The laboratory testing program included visual classifications, moisture content tests, Atterberg Limits tests, and grain size distribution analysis tests. All data obtained from the laboratory tests are included in the Appendix of this report.

Each soil sample was visually classified on the basis of texture and plasticity in accordance with the Unified Soil Classification System. The group symbols for each soil type are indicated in parentheses following the soil descriptions on the boring logs. A brief explanation of the Unified System is included with this report. The soil engineer grouped the various soil types into the major zones noted on the boring logs. The stratification lines designating the interfaces between earth materials on the boring logs and profiles are approximate; in situ, the transitions may be gradual, rather than distinct.

The soil samples from the most recent exploration will be retained in our laboratory for a period of 60 days, after which they will be discarded unless other instructions are received as to their disposition.

## **EXPLORATION RESULTS**

### **Regional Geology**

The proposed site is located in the Atlantic Coastal Plains Physiographic Province. This Coastal Plain Province is characterized by a series of south-easterly dipping layers of relatively consolidated sandy clay deposits, with lesser amounts of gravel. These Coastal Plain deposits are estimated to be approximately 250 feet thick and are underlain by the eastward continuation of the crystalline rock of the Piedmont Physiographic Province.

Locally, the higher elevations of the general site area have often retained few remnants of the Quaternary Age River Terrace deposits. These river deposits are typified by bedded to inter-bedded accumulations of gravel, sand, silt and clay that often pinch and lense rapidly in both the vertical and horizontal plain. These Quaternary Age Deposits are typically underlain, by the Potomac Group sediments of the older Cretaceous Age.

The Cretaceous Age Potomac Group deposits generally consist of inter-bedded, discontinuous, sand and clay layers that generally slope to the southeast at roughly 50 to 80 feet per mile or approximately 0.5 to 0.8 degrees. The sand layers generally consist of bedded fine to medium sand with variable amounts of clay and silt making up portions of the overall soil matrix. In isolated areas, gravel can also be encountered. The clay layers of the Potomac Group are commonly referred to as "marine clay", although it is generally believed that they were deposited in a deltaic environment. These very stiff to hard clays are often moderately to highly over consolidated and have a blocky structure.

### **Soil Conditions**

The subsurface conditions encountered within the three soil borings performed at the site were consistent with the regional geology and the findings of our geotechnical reports prepared for nearby sites. Three major soil strata were encountered within the borings. These strata are described in the subsequent text and shown in the following table. For detailed information at specific locations, please refer to the Boring Logs, included in the Appendix of this report.

#### **Stratum I – Fill**

Beneath the concrete slab, fill soils were encountered in each boring, ranging from depths of 2± to 15± feet below existing ground surface. Fill depths correspond with elevations ranging from approximately EL. 8 to -6 feet. The fill soils varied greatly in type, moisture, and relative density/consistency. These materials included sand, silt, clay, bricks, asphalt, organics, and gravel in addition to other debris. These materials are anticipated to have been placed in an uncontrolled manner.

#### **Stratum II – Alluvial Soils**

Beneath the fill soils, natural alluvial soils were encountered in the borings. This stratum was generally encountered between EL. 8 to -6 feet and EL. -40 to -50 feet. Generally, these soils consisted of interbedded and alternating layers of Silty SAND (SM), GRAVEL (GP, GW), and CLAY (CL/CH). In general, the soils ranged from loose to very dense

and soft to very stiff in relative density and consistency, respectively. The Stratum II soils varied widely in relative density and/or consistency in addition to soil type over short horizontal distances, a characteristic common for sites bordering large rivers such as the Potomac. It is likely that the ancient Potomac River eroded and replaced soils of differing type and density over long periods of time, the result of which is a highly variable soil layer extending from approximately EL. -5 feet to EL. -50 feet.

### Stratum III – Potomac Soils

Marine CLAY (CH) was generally encountered below approximately EL. -40 feet to EL. -50 feet. These soils were generally recorded to be stiff to hard in consistency.

### Groundwater Conditions

Observations for groundwater were not made during the drilling operations. In mud rotary drilling operations, water is introduced into the boreholes, and the groundwater position cannot be determined by observing water in the boreholes. Groundwater levels were read from monitoring wells that were previously installed by others. The groundwater levels were read on October 10, 2014 and were measured at depths of  $3.5\pm$  feet below top of slab and  $7.27\pm$  feet below top of slab in the east and west buildings, respectively. Survey elevations were not available for the monitoring wells. Based on the elevations for our previous borings, the measured groundwater depths roughly correspond to elevations of about EL. +4.5 feet for the east building and EL. +5.7 feet for the west building.

The highest groundwater observations are normally encountered in late winter and early spring. Variations in the location of the long-term water table may occur as a result of changes in precipitation, water level in the Potomac River, surface water runoff, adjacent construction or below-grade drained buildings and other factors not immediately apparent at the time of this report's preparation for design.

## **ANALYSIS AND RECOMMENDATIONS**

The following sections present recommendations pertaining to the support of the proposed building. These include recommendations for building foundations, earthwork, and other related issues. Discussion of the factors affecting the building foundations for the proposed construction, as well as additional recommendations regarding design and construction at the project site are included below. We recommend that ECS review the final design and specifications to check that the earthwork and foundation recommendations presented in this report have been properly interpreted and implemented in the design and specifications.

### **One Below-Grade Level Construction**

We anticipate that the lowest basement levels will be at approximately EL. +1 feet, with corresponding foundation bearing elevations at approximately EL. -2 feet. At about EL. -2 feet, the soils transition from the overlying fill materials into the variably dense underlying alluvial Stratum II soils. Some over excavation to go through existing fills should be anticipated at the foundation level for this option. The natural soils below EL. -2 feet appear suitable for support of a mat foundation. The predominant soil characteristic identified below EL. -2 feet was medium dense granular soils, which are suitable for mat foundation support, as indicated above.

Considering a bearing elevation of approximately EL. -2 feet, ECS anticipates that the bearing soils are capable of supporting overlying pressures of approximately 3,000 psf for a mat foundation. Since stabilized groundwater levels as high as approximately EL. +5 feet were encountered, effective temporary construction dewatering will be required to construct a mat foundation below EL. -2 feet. The borings reveal the presence of highly permeable granular soils from Stratum II below EL. -2 feet, and the contractor would be required to develop a coherent dewatering scheme to address these permeable granular soils that will transmit significant volumes of groundwater into the excavation. The basement walls will require full waterproofing up to the finished exterior grade at about EL. +10 feet, and the base of the mat will also require waterproofing.

### **Mat Foundation Design**

Based on our assumed lowest floor elevation, it is our anticipation that most of the overlying Stratum I fill soils will be removed in the process of establishing the design subgrade elevations. As such, the anticipated soils at the slab foundation bearing elevation would consist of slight remnant fill materials, or predominantly granular Stratum II soils.

We recommend that the proposed structures be supported on a mat foundation system bearing in the competent natural alluvial soils of Stratum II. With some potential selective undercutting to achieve a natural soil subgrade, mat slabs can be supported on grade. The slab shall be underlain by typical capillary drainage layers 4 to 6 inches thick and a suitable waterproofing barrier shall be used.

A mat foundation system bearing in the competent natural alluvial soils of Stratum II can be designed utilizing a modulus of subgrade reaction,  $k$ , of 70 kcf and a net contact stress of 3,000 psf. "Spot" contact stresses of 3,500 psf can be utilized in isolated areas with radii less than 30

feet. This allowable bearing pressure assumes that the bottom of the proposed mat will bear at or below approximately EL. -2 feet. The net allowable soil bearing pressure refers to that pressure which may be transmitted to the foundation bearing soils in excess of the final minimum surrounding overburden pressure.

Competent natural alluvial soils suitable for support of the proposed structure can be identified on the boring logs as those natural soils having an SPT N-Value of 6 blows per foot (bpf) or greater. Based on the subsurface exploration performed within the limits of the proposed structure, we anticipate that most of the soils at the foundation bearing elevation will be suitable for support of the proposed structure on a mat foundation system with allowable contact pressures of 3,000 psf. It should be noted that unsuitable soft / loose natural soils and existing fills were encountered near the bearing elevation at some of the boring locations. If soft / loose natural or unsuitable soils such as existing fill are observed at the foundation bearing elevation, the unsuitable soils should be undercut and removed. At these locations, the foundation element could be backfilled with lean concrete or compacted engineered fill up to the original design bottom of foundation elevation, with the footing constructed on top of the hardened lean concrete or new engineered fill. During construction, the bearing capacity at the final mat subgrade should be tested in the field by the geotechnical engineer or their authorized representative to document that the in situ bearing capacity at the mat subgrade is adequate for the design loads. Depending upon encountered conditions, it may be beneficial to over-excavate and prepare a stone blanket as a construction surface.

Settlement of a structure is a function of the compressibility of the natural soils, the design bearing pressure, column loads, fill depths, and the elevation of the footing with respect to the original ground surface. For a mat foundation designed for the recommended bearing pressures, we estimate that total foundation settlements and differential settlements will be less than an inch with differential settlements on the order of half the total settlement amount. These settlement estimates have been based upon the assumed structural information, bottom of foundation elevation, and the data obtained by the subsurface explorations performed by ECS.

### **General Mat Foundation Recommendations**

The bearing capacity of the subgrade soils should be confirmed immediately prior to placement of a concrete working mat. The soils should be observed by an experienced soil technician working under the direct supervision of a registered professional geotechnical engineer. Any soils which are soft or which become loosened by construction activities or water intrusion should be removed and replaced with a lean concrete or compacted stone. In addition, some undercutting may be required in isolated locations across the site, as discussed in previous sections, due to unsuitable or loose natural soils near the foundation subgrade elevations. Proper construction dewatering of the subgrade soils will be necessary during construction to minimize difficulties during foundation installation. Construction dewatering is discussed in a subsequent section of this report.

The mat may be placed in one continuous concrete pour or in sections. If the mat is placed in one continuous pour, we recommend that super plasticizers (high range water reducers) be used in the concrete mix designed to decrease the water to cement ratio, which will in turn, reduce the potential for shrinkage cracks in the mat. Cold joints should not be permitted during placement of the mat concrete.

If the mat is placed in sections, we recommend that the construction joints be designed so as to ensure that the joints are watertight. We recommend that the mat be placed in a checkerboard fashion so that every other square is placed to minimize shrinkage effects. If internal braces (rakers) are utilized for the support of the earth retention system, box outs within the mat will be required due to penetration of the rakers for the mats. The joints in the mat around the rakers should also be constructed using a watertight seal.

Since the soils at the subgrade elevation are moisture and disturbance sensitive, we recommend that an attempt be made to minimize disturbance of the subgrade. The first step of construction should be to install the construction dewatering system as discussed in greater detail in the following sections. Upon completion of the excavation, a 2 to 3-inch lean concrete mud mat should be used as a working mat, to prevent disturbance of the subgrade soils during reinforcing steel placement and framing.

A properly installed mat, with proper crack control, permits only limited water to migrate to the surface of the mat. However, it is virtually impossible to eliminate all water intrusion in an undrained condition. Therefore, we recommend that the mat be constructed considering a fully waterproofed condition. The waterproofing should be placed in accordance with the manufacturer's recommendations. Some post installation leakage is common and should be repaired using injection grouting or as determined by the waterproofing installation contractor's and/or product manufacturer's warranty.

It may be feasible to further reduce the potential for water to penetrate the waterproofing/mat by underlaying the mat with a minimum of 10 inches of compacted crushed gravel (type No. 57 stone) and to facilitating the drainage by installing trenches installed in a grid pattern below the mat. The trenches should extend on the order of up to two (2) feet below the mat subgrade, or deeper if required, and be designed to flow to a suitable connection/drainage path (to be determined). Further details pertaining to this design could be generated at a later date if requested.

### **Mat Foundation - Uplift Resistance**

If sufficient dead load is not available to overcome potential buoyant uplift forces, tie down anchors will be required. Based upon the subsurface conditions encountered at the site and our experience, we anticipate that post-grouted tie down anchors could achieve working capacities in the range of 50 to 70 tons each. We would anticipate unbonded lengths on the order of 20 feet and bonded lengths on the order of 30 feet. Final tie down anchor design should be performed by an experienced specialty design-build contractor. The anchors should be 100% proof tested to 1.33 times the design load. We anticipate that the anchors would be initially installed prior to the mud mat placement and then incorporated into the mat structure. Other tie down anchors systems (such as micropiles and helical anchors) could be feasible alternatives. The capacity and configuration of the chosen anchor system should be determined by a specialty design-build contractor experienced with design and installation.

### **Below Grade Waterproofing**

Based on recent readings at the ground water monitoring wells previously installed in both buildings, the static groundwater level is anticipated to vary between approximately EL. +6 feet

and EL. -15 feet. We anticipate that the bottom of the mat foundation will bear at an elevation of approximately EL. -2. The bottom of foundation elevation will be below the currently existing groundwater level. As such, we recommend that the below grade walls be waterproofed up to the ground surface. As an alternative, waterproofing could be installed up to 10 feet above the highest anticipated static ground water level, with damp proofing to the ground surface; however, this will not provide as much protection as fully waterproofing the below-grade structure, and some minor leakage should be anticipated.

Waterproofing should consist either of bentonite wall panels or continuous waterproofing membranes. Care must be exercised during installation and backfilling to minimize damage to the waterproofing system. Any areas which have become damaged, should be repaired or replaced. It is important that the waterproofing be continuous around the entire perimeter of the structure to be effective. Perimeter waterproofing should extend down the sides of the mat to the bottom and extending along the bottom.

Water stops should be provided at construction joints at the interface of the perimeter walls with the mat foundation, at adjacent pours of the perimeter walls, and within construction joints within the mat. The design of these water stops and waterproofing is especially critical to providing effective waterproofing. Such joints provide a conduit for water infiltration if not properly waterproofed.

All penetrations through the mat such as floor drains, tiedown anchors, or other penetrations should incorporate bentonite strips or other water stops to prevent the migration of water along the interface of the penetration with the mat concrete.

### **Below Grade Walls**

The below grade walls should be designed to withstand lateral earth pressures, hydrostatic water pressure (where applicable), and surcharge loads. Based on the groundwater levels observed during the recent subsurface exploration and the understanding that flood levels to El. +12 should be planned for, we recommend that the below-grade walls be designed for a lateral soil and water pressure of 90 psf per foot of wall depth for the full wall embedment. The wall design should also account for any surcharge loads within a 45° degree slope from the base of the wall.

We anticipate that a “lot line” earth retention system consisting of steel sheet pile walls will be used to stabilize the excavation and construct the lowest basement levels and walls. If a space exists between the formed basement walls and the sheeting, then it should be filled with a granular soil material.

To help reduce pressures against the below grade walls, and to reduce the settlement of the wall backfill, it is recommended that the wall backfill be compacted to 92% to 95% of the maximum dry density determined in accordance with ASTM Specification D-698, Standard Proctor Method. Where the fill will be supporting pavement or other structures, the fill should also be compacted to 95% of this specification, except that the upper 1 foot should be compacted to 100% of the maximum dry density referenced above. Backfill materials which are placed behind below-grade walls should be free of organic materials and debris, free-draining, non-frost susceptible, and should not include existing unsuitable fill materials or any highly plastic CH or MH materials. It is imperative that no CH/MH soils be used as backfill, due to the shrink-swell potential of these materials.

### **Site Seismic Classification (IBC)**

The International Building Code (IBC) 2009 requires site classification for seismic design based on the upper 100 feet of a soil profile. Where site specific data are not available to a depth of 100 feet, appropriate soil properties are permitted to be estimated by the registered design professional preparing the soils report based on known geologic conditions. The seismic site class definitions for the weighted average of either the SPT N-values or the shear wave velocities in the upper 100 feet of the soil profile are presented in Table 9.4.1.2 of ASCE 7 as referenced in IBC 2012 Building Code (Section 1613.3.2) and in the table below.

<b>Site Class</b>	<b>Soil Profile Name</b>	<b>Shear Wave Velocity, Vs, (feet/s)</b>	<b>Standard Penetration Test (SPT) N-value</b>
A	Hard Rock	$V_s > 5,000$ fps	N/A
B	Rock	$2,500 < V_s \leq 5,000$ fps	N/A
C	Very dense soil and soft rock	$1,200 < V_s \leq 2,500$ fps	$N_{AVG} > 50$ bpf
D	Stiff Soil Profile	$600 \leq V_s \leq 1,200$ fps	$15 \leq N_{AVG} \leq 50$ bpf
E	Soft Soil Profile	$V_s < 600$ fps	$N_{AVG} < 15$ bpf

In the absence of actual shear wave ( $V_s$ ) data, we utilized the Standard Penetration Test (SPT) N-values recorded from the borings. Considering the subsurface profile encountered at this site, we recommend that the design for the buildings be based on a seismic site classification of Site Class D.

### **Utility Installation**

Existing fill material was encountered in the borings performed during this exploration. Existing fill material may be suitable for support of utilities; however, the proposed utility subgrade should be checked by the GER or their representative prior to utility placement. If areas of soft or unsuitable soils are encountered, the material will need to be removed and replaced or suitably reinforced with the use of geotextiles.

Any existing utilities on-site that are not planned to be reused should be removed, along with any unsuitable backfill materials, and capped at the property lines, or rerouted around the property and reconnected. The suitability of any existing utilities and utility trench backfill that will remain in place should be evaluated for structural support in the field by the GER. Care should be exercised during site grading operations so as not to damage any utilities that are to remain.

Beneath the existing fill material (where encountered), each of the borings encountered natural soils, which are generally firm and are expected to be suitable for support of the utility pipes. All loose or organic materials encountered at the utility pipe subgrade should be removed. The pipe subgrade should be observed and probed for density by the GER or their authorized representative to evaluate the suitability of materials encountered. Any relatively isolated, thin soft or yielding areas should be undercut or replaced with suitable compacted fill or pipe bedding material.

It is recommended that fill placed for support of the utilities meet the requirements for compacted backfill given in this report. The utility pipes should be provided with granular bedding material. The granular bedding material should consist of at least 6-inches of coarse, open-graded gravel or crushed stone. Compacted backfill should be free of topsoil, root, ice or any other deleterious material designated by the GER as unsuitable. The backfill should be placed in shallow horizontal layers of maximum 8-inch loose thickness and compacted with necessary type of compaction equipment to obtain at least 95% and 90% of the maximum dry density per ASTM D 698 in structural/paved and nonstructural (landscaped) areas, respectively. All backfill should be placed and compacted at a moisture content to facilitate adequate compaction without significant yielding of the surface, and should generally be within  $\pm 2$  percentage points of the optimum moisture content per Standard Proctor tests.

The backfill below pavements and structures should consist of materials meeting the requirements for compacted fill given in this report. The backfill in nonstructural (landscaped) areas can consist of the material removed from the trench excavation.

Our engineering analysis and recommendations are based upon the subsurface information as developed by our field exploration and the general information provided to ECS by your office or other design team members.

## **ANALYSIS AND RECOMMENDATIONS: PROJECT CONSTRUCTION**

### **Subgrade Preparation and Earthwork Operations**

The subgrade preparation should consist of stripping all surface cover materials, undocumented fill material, topsoil, and any other soft, wet, or otherwise unsuitable material from the proposed building and pavement areas. Care must be exercised to identify additional unsuitable materials, and affect their removal. Procedures such as proofrolling, observation, or test pitting operations may be utilized to assist in identifying the presence of unsuitable materials, as required. We recommend the earthwork clearing be extended a minimum of 10 feet beyond the building and pavement limits. Stripping limits should be extended an additional 1 foot for each foot of fill required at the building's exterior edge. The limits discussed in this paragraph define the expanded building and pavement limits.

After stripping to the desired grade, and prior to fill placement, the stripped surface should be observed by the Geotechnical Engineer of Record (GER) or their authorized representative. Proofrolling using a loaded dump truck, having an axle weight of at least 10 tons, may be used at this time to aid in identifying localized soft or unsuitable material which should be removed. Any soft or unsuitable materials encountered during this proofrolling should be removed and replaced with an approved backfill compacted to the criteria presented in the section entitled Fill Placement.

The preparation of fill subgrades, as well as proposed building or roadway subgrades should be observed on a full-time basis. These observations should be performed by an experienced geotechnical engineer, or their representative, to document unsuitable materials that have been removed, and that the subgrade is suitable for support of the proposed construction and/or fills.

### **Fill Placement**

New engineered fill materials underneath the proposed structures, for use as backfill, or for support of pavements should consist of an approved material, free of organic matter and debris, cobbles or rock fragments greater than 4 inches. New fill materials should also have a Liquid Limit and Plasticity Index less than or equal to 40 and 15, respectively, unless they are shown to have "very low" expansion potential. Unacceptable fill materials include topsoil and organic materials (OH, OL, and PT), and high plasticity SILT (MH) or CLAY (CH) that cannot be shown to have "very low" expansion potential. Under no circumstances should high plasticity soils be used as fill material in proposed structural areas.

The on-site materials may be reused, as appropriate, provided that they do not contain organic or foreign debris, are not highly plastic, are not environmentally impacted, and conform to the criteria outlined above. The suitability of any materials for use as engineered fill should be further evaluated at the time of construction.

Any suitable on-site soils may require moisture content adjustments, such as the application of discing or other drying techniques or spraying of water to the soils prior to their use as controlled fill materials. The planning of earthwork operations should recognize and account for these efforts and increased costs.

Should borrow materials from an off-site source be required, a sample should be submitted to the GER at least five days prior to importing the material to the site for the appropriate lab testing to determine if the material meets the criteria outlined above.

Fill materials should be placed in lifts not exceeding 8-inches in loose thickness and moisture conditioned to within  $\pm 2$  percentage points of the optimum moisture content. Soil bridging lifts within the expanded building and pavement limits should not be used. Excessive settlement of the structures can occur when bridging lifts are utilized in structural areas. Structural fill soils in the building and roadway areas should be compacted to a minimum of 95% of the maximum dry density obtained in accordance with ASTM D 698.

The expanded footprint of the proposed structures or pavement and fill areas should be well defined, including the limits of the fill zones at the time of fill placement. Grade control should be maintained throughout the fill placement operations. All fill operations should be observed on a full-time basis by a qualified soil technician to document that the specified compaction requirements are being met. A minimum of one compaction test per 2,500 square feet of area should be tested in each lift placed. The elevation and location of the tests should be clearly identified at the time of fill placement.

Compaction equipment suitable to the soil type used as fill should be used to compact the fill material. Theoretically, any equipment type can be used as long as the required density is achieved. Ideally, a steel drum roller would be most efficient for compacting and sealing the surface soils. All areas receiving fill should be graded to facilitate positive drainage from building pad and pavement areas of any free water associated with precipitation and surface runoff.

Fill materials should not be placed on frozen soils. All frozen soils should be removed prior to continuation of fill operations. Borrow fill materials should not contain frozen materials at the time of placement. All frost-heaved soils should be removed prior to placement of fill, stone, concrete, or asphalt.

### **Construction Groundwater Control**

Excavations will extend below the permanent groundwater elevation, and significant recharge of groundwater is anticipated based on the proximity to the Potomac River. The variability of interbedded layers of granular and cohesive soils will likely present variable pump yield rates across the site. The construction dewatering scheme is critical, and an experienced dewatering contractor should be selected to plan and execute the dewatering effort. The dewatering mechanisms chosen by the contractor shall be capable of lowering and maintaining the groundwater at least 3 feet below planned foundation bearing elevation subgrades during construction. For preliminary planning purposes, we estimate a flow rate of approximately 200 to 300 gallons per minute for temporary groundwater control. The rate assumes that the size of the excavation does not exceed 400 feet by 500 feet in plan view and groundwater will be lowered to an elevation of EL. -5 feet. Deeper excavations will require more aggressive forms of dewatering. The estimated rates are for preliminary planning purposes only. An experienced dewatering contractor should review the subsurface conditions encountered to evaluate anticipated rates. Because of the importance of dewatering, we recommend that pump tests be performed to better estimate rates and plan the dewatering system.

It is our anticipation that a perimeter system of downhole submersible wells extending well below planned excavation limits would be the most suitable form of dewatering for the subject development, supplemented with interior deep wells as the excavation progresses. Please note that should the sheet pile walls be embedded within the underlying Potomac Clay layer, the amount of water that the dewatering system will need to account for will be greatly reduced. However, the amount of water that will need to be accounted for during dewatering will depend on the water-tightness of the final sheeting and shoring system design. Although additional cost and effort would be required to extend into the Potomac Formation that was typically encountered between EL. -40 to El. -50, the volume of water requiring treatment for environmental conditions would be expected to decrease significantly.

To avoid encountering a "quick" condition within the excavation, the hydrostatic pressure must be maintained at a lower level than the effective weight of the soil. Maintaining the water level at least 3 feet below the level of excavation (as previously recommended) should avoid the potential for a quick condition. Redundancy in the dewatering system should be employed to ensure that the system runs continuously and effectively to maintain this separation. The dewatering efforts should not be terminated until sufficient dead load and anchor resistances exceed the highest anticipated hydrostatic levels.

Based on a dewatering elevation of EL. -5 feet, ECS anticipates that this elevation corresponds with typical tidal fluctuations and effective stress variations previously experienced. Therefore, we do not anticipate that dewatering will cause significant settlement of the adjacent structures. However, as a precaution, we recommend that the Owner implement a monitoring system as outlined in the section entitled Adjacent Monitoring.

### **Support of Excavation (SOE) and Underpinning**

Based on our conversations with you, we understand that a system of sheet piles will likely be used. However, we also understand that other methods of SOE are under consideration. At the time of this report preparation, other systems such as a slurry wall, deep soil mixing, and soldier piles and lagging are being considered by the project team, but are not expected to be more advantageous than sheet piles based upon our understanding of project constraints. If the method of SOE changes at any time, ECS should be notified to provide additional recommendations based on the selected system.

Evaluation of the SOE system was not part of our current scope of services. We would be happy to provide these services if requested. Sheet piles should be driven a sufficient distance so that the earth retention system will not become undermined if it becomes necessary to step down perimeter footings up to 2 feet. Sheet piles should be designed for lateral earth pressures equivalent to not less than 30 times the height of the excavation in pounds per square foot. The design should also account for any surcharge loads that are within a 45° slope from the base of the wall.

The contractor should avoid stockpiling excavated materials or equipment immediately adjacent to the excavation walls. We recommend that stockpiled materials be kept back from the excavation a minimum distance equal to 1/2 the excavation depth to limit surcharging the excavation walls. If this is impractical due to space constraints, the excavation walls should be retained with bracing designed for the anticipated surcharge load. In addition, the earth retention system design should consider surcharge loads from cranes and other construction equipment during construction as well as buildings and vehicle traffic.

Temporary slopes should be constructed no steeper than 3H:1V and maintained for no more than 30 days. The slopes should be protected from erosion since the soils are highly erodible. Permanent slopes should be constructed no steeper than 4H:1V.

Adjacent buildings may need to be underpinned prior to commencement of excavation operations. We recommend that the adjacent building be underpinned using either a bracket pile and grade beam system or excavated underpinning pits. We recommend that the bracket piles be installed prior to commencement of excavation operations and that the load from the building be transmitted to the bracket piles via a post tensioned grade beam. If excavated underpinning pits are used, we recommend that the installation of a dewatering system be completed prior to excavation of underpinning pits. Because of perched groundwater conditions, some sump pit and pumping may be required in individual pits.

### **Earth Retention System/Support of Excavation (SOE) Performance Requirements**

We recommend the following specification for use in the construction documents associated with the earth retention system.

#### **Part 1 – General**

1. Contractor/Designer shall design and construct a temporary Support of Excavation (SOE) system sufficient to support the project's below grade construction.

#### **Part 2 – Submittals**

1. SOE design plans sealed by a licensed Professional Engineer for the jurisdiction the work is performed in.
2. All supporting calculations for the SOE design, including global stability calculations.
3. Subsurface data utilized for the SOE design.
4. The braced excavation contractor shall submit the anticipated movement amounts (vertically and laterally) of each portion of the excavation support system to the owner's engineering consultant. These anticipated movements will also serve as the basis for evaluating the performance of the excavation support system. If creep movements are anticipated, the contractor shall state the total expected magnitude and rate during the time frame the SOE system is required to support the excavation. The contractor's estimated excavation support movements shall be subject to review and acceptance by the owner's engineering consultant before they are used as the performance standard.
5. If not stated on the plans, the method of sheet pile installation.

#### **Part 3 – Performance Requirements**

1. The performance of the braced excavation system will be monitored (measured) by the owner's engineering consultants. These measurements will serve as the basis for determining the performance and adequacy of the excavation support system. The initial baseline measurements and periodic movement data will be

provided to all parties involved in construction. The initial baseline measurements shall be obtained before significant portions of the below grade excavation work occur, and preferably before any excavation work begins. The contractor may make his own independent measurements; however, the owner's engineering consultant's measurements will serve as the basis for performance evaluation.

2. If the movements of the excavation support system exceed the contractor's estimate, additional support for the excavation support system shall be provided by the contractor on an urgent basis, at no additional cost to the owner. If the excavation support system is creeping (inward or downward), and the owner's engineers projected estimate of total movement (within the performance time period of the excavation support system) exceeds the total movement estimates provided by the contractor, then additional support shall be added to the braced excavation system to halt the creeping, also on an urgent basis, at no additional cost to the owner.

#### **Part 4 – Monitoring by Owner's Engineering Consultant**

The earth retention system shall be monitored for lateral deformations. A series of three-dimensional reflectors around the excavation to monitor the earth retention system shall be installed. These reflectors shall be installed on the soldier piles and installed on every third pile, at a minimum.

1. The earth retention system shall be monitored for lateral deformations. A series of three-dimensional reflectors around the excavations to monitor the earth retention system shall be installed. These reflectors shall be installed at a minimum of on every third soldier pile. Prior to or very near the commencement of below grade excavation work, baseline data of the position of the SOE system will be obtained. Baseline measurements and subsequent movement evaluation will be performed with either total station, laser technology or optical surveying equipment. Total station technology is capable of making precise measurements of movement ( $\pm 0.125$  inches). Reflector "targets" will be attached to the SOE system by the Owner's Engineering Consultant, with the full cooperation and assistance of the SOE contractor. The Owner's Engineering Consultant, with the assistance of the SOE contractor, shall replace any previously established targets if they are damaged during construction.
2. Monitoring Frequency. The SOE monitoring frequency is as follows:
  - Twice weekly during excavation of lowest below grade level
  - Twice weekly during construction of all below grade levels
  - Monitoring frequency will remain at twice per week until the structural engineer (SE) indicates that all below grade level walls and floors are constructed and capable of resisting the below grade soil and water pressures.
  - Monitoring ceases after below grade construction ends and SE indicates that all below grade level walls and floors are constructed and capable of resisting the below grade soil and water pressures.
3. Reporting.
  - The results of the monitoring readings will be transmitted verbally to either the general contractor's representative or the SOE contractor's

representative during the field work. Any significant movements since the prior readings will be identified.

- Written reports containing the monitoring data and corresponding graphical presentation of said data will be provided by the Engineer to all interested parties, electronically and in hardcopy form, on a weekly or twice monthly basis.

## **Adjacent Monitoring**

### **Settlement Monitoring**

During construction, we recommend that a monitoring program, possibly including the installation of three-dimensional reflectors, tilt plates, and settlement points be implemented to monitor any settlement of selected nearby structures, utilities and roadways within the 150 foot influence zone. Typically, the settlement monitoring points are created by scribing the face of an existing building or installing three-dimensional reflectors and taking ongoing survey shots, periodically during the excavation, to see if there is any building impact. With respect to settlement monitoring points on the street, these are usually installed about 1 point per 50 to 100 feet of exposed site perimeter face. The most critical points of the settlement generally occur near the midpoint of the excavation. On relatively short walls, on the order of about 100 feet, it is the usual practice to install at least two settlement points.

### **Vibration Monitoring**

During sheet pile installation, a vibration monitoring program may need to be implemented during construction operations. We recommend monitoring of the vibrations that are generated during the installation of the earth retention system. The purpose of this monitoring is to document vibrations that may be generated. We recommend that vibration monitoring be performed adjacent to structures within a 50 foot radius of pile driving operations. We recommend monitoring vibrations using digitally recorded seismographs, installed and observed by a qualified seismic technician, for each day of demolition and pile driving to record vibration levels.

While it is unlikely that significant settlement of adjacent structures and streets will occur if proper workmanship is employed during construction, it is prudent to perform such monitoring to defend against unfounded claims of structural damage by adjacent property owners. By having data available, such claims can be appropriately addressed.

## **Closing**

This report has been prepared to aid in the evaluation of this site and to assist the project team with the feasibility and preliminary design of the proposed development. The report scope is limited to this specific project and the location described. The project description represents our current understanding of the significant aspects of the proposed development relevant to the geotechnical considerations.

Once final design information has been established, we recommend that we be given the opportunity to review the final design and provide additional recommendations as necessary. Depending on the final building design, additional borings may be required.

## **APPENDIX**

Unified Soil Classification System

Reference Notes for Borings Logs

Boring Logs (Borings B-1 through B-12)

Laboratory Testing Summary

Liquid and Plastic Limits Test Report

Particle Size Distribution Report

Boring Location Diagram

# UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D 2487)

Major Divisions		Group Symbols	Typical Names	Laboratory Classification Criteria			
<b>Coarse-grained soils</b> (More than half of material is larger than No. 200 Sieve size)		<b>Gravels</b> (More than half of coarse fraction is larger than No. 4 sieve size)		GW	Well-graded gravels, gravel-sand mixtures, little or no fines	$C_u = D_{60}/D_{10}$ greater than 4 $C_c = (D_{30})^2 / (D_{10} \times D_{60})$ between 1 and 3	
		GP	Poorly graded gravels, gravel-sand mixtures, little or no fines	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: GW, GP, SW, SP Less than 5 percent GM, GC, SM, SC More than 12 percent Borderline cases requiring dual symbols <sup>b</sup>	Not meeting all gradation requirements for GW		
<b>Sands</b> (More than half of coarse fraction is smaller than No. 4 sieve size)		<b>Gravels with fines</b> (Appreciable amount of fines)			GM <sup>a</sup>	Silty gravels, gravel-sand mixtures	Atterberg limits below "A" line or P.I. less than 4  Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
		GC	Clayey gravels, gravel-sand-clay mixtures	SW	Well-graded sands, gravelly sands, little or no fines		
<b>Sands with fines</b> (Appreciable amount of fines)		<b>Clean sands</b> (Little or no fines)		SP	Poorly graded sands, gravelly sands, little or no fines	Not meeting all gradation requirements for SW	
		SM <sup>a</sup>	Silty sands, sand-silt mixtures	SC	Clayey sands, sand-clay mixtures	SP	Atterberg limits above "A" line or P.I. less than 4  Limits plotting in CL-ML zone with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
<b>Fine-grained soils</b> (More than half material is smaller than No. 200 Sieve)		<b>Silts and clays</b> (Liquid limit less than 50)		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity	<div style="text-align: center;"> <b>Plasticity Chart</b> </div>	
<b>Silts and clays</b> (Liquid limit greater than 50)		Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays		Atterberg limits above "A" line with P.I. greater than 7  Limits plotting in CL-ML zone with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
		Organic silts and organic silty clays of low plasticity		OL	Organic silts and organic silty clays of low plasticity		
		Inorganic clays of high plasticity, fat clays		MH	Inorganic clays of high plasticity, fat clays		
<b>Highly Organic soils</b>		Organic clays of medium to high plasticity, organic silts		CH	Organic clays of medium to high plasticity, organic silts		Atterberg limits above "A" line with P.I. greater than 7
		Peat and other highly organic soils		OH	Peat and other highly organic soils		
Pt		Pt		Pt	Peat and other highly organic soils		

<sup>a</sup> Division of GM and SM groups into subdivisions of d and u are for roads and airfields only. Subdivision is based on Atterberg limits; suffix d used when L.L. is 28 or less and the P.I. is 6 or less; the suffix u used when L.L. is greater than 28.

<sup>b</sup> Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. For example: GW-GC, well-graded gravel-sand mixture with clay binder. (From Table 2.16 - Winterkorn and Fang, 1975)

## REFERENCE NOTES FOR BORING LOGS

### I. Drilling Sampling Symbols

SS	Split Spoon Sampler	ST	Shelby Tube Sampler
RC	Rock Core, NX, BX, AX	PM	Pressuremeter
DC	Dutch Cone Penetrometer	RD	Rock Bit Drilling
BS	Bulk Sample of Cuttings	PA	Power Auger (no sample)
HSA	Hollow Stem Auger	WS	Wash sample
REC	Rock Sample Recovery %	RQD	Rock Quality Designation %

### II. Correlation of Penetration Resistances to Soil Properties

Standard Penetration (blows/ft) refers to the blows per foot of a 140-lb. hammer falling 30 inches on a 2-inch OD split-spoon sampler, as specified in ASTM D 1586. The blow count is commonly referred to as the N-value.

#### A. Non-Cohesive Soils (Silt, Sand, Gravel and Combinations)

<i>Density</i>		<i>Relative Properties (Sands &amp; Gravels)</i>	
Under 4 blows/ft	Very Loose	With Clay or Silt	5% to 12%
5 to 10 blows/ft	Loose	Clayey or Silty	>12%
11 to 30 blows/ft	Medium Dense		
31 to 50 blows/ft	Dense	<i>Relative Properties (Silts &amp; Clays)</i>	
Over 51 blows/ft	Very Dense	With Sand or Gravel	<30%
Over 80 blows/ft	Extremely Dense	Sandy or Gravelly	≥30%

<i>Particle Size Identification</i>		
Boulders		12 inches or larger
Cobbles		3 to 12 inches
Gravel	Coarse	¾ to 3 inches
	Fine	¼ to ¾ inch
Sand	Coarse	2.00 mm to ¼ inch (dia. of lead pencil)
	Medium	0.42 to 2.00 mm (dia. of broom straw)
	Fine	0.074 to 0.42 mm (dia. of human hair)
Silt and Clay		0.0 to 0.074 mm (particles cannot be seen)

#### B. Cohesive Soils (Clay, Silt, and Combinations)

<i>Blows/ft</i>	<i>Consistency</i>	<i>Unconfined Comp. Strength Q<sub>p</sub> (tsf)</i>	<i>Degree of Plasticity</i>	<i>Plasticity Index</i>
Under 2	Very Soft	Under 0.25	None to slight	0 – 4
3 to 4	Soft	0.25-0.49	Slight	5 – 7
5 to 8	Medium Stiff	0.50-0.99	Medium	8 – 22
9 to 15	Stiff	1.00-1.99	High to Very High	Over 22
16 to 30	Very Stiff	2.00-3.00		
31 to 50	Hard	4.00–8.00		
Over 51	Very Hard	Over 8.00		

### III. Water Level Measurement Symbols

WL	Water Level	BCR	Before Casing Removal	DCI	Dry Cave-In
WS	While Sampling	ACR	After Casing Removal	WCI	Wet Cave-In
WD	While Drilling	▽	Est. Groundwater Level	▽	Est. Seasonal High GWT

The water levels are those levels actually measured in the borehole at the times indicated by the symbol. The measurements are relatively reliable when augering, without adding fluids, in a granular soil. In clay and plastic silts, the accurate determination of water levels may require several days for the water level to stabilize. In such cases, additional methods of measurement are generally applied.

CLIENT <b>Alexandria North Terminal, LLC</b>	JOB # <b>13983-B</b>	BORING # <b>B-7</b>	SHEET <b>1 OF 2</b>	
PROJECT NAME <b>Robinson Terminal North - Final Geotechnical Study</b>	ARCHITECT-ENGINEER <b>Ehlert-Bryan</b>			

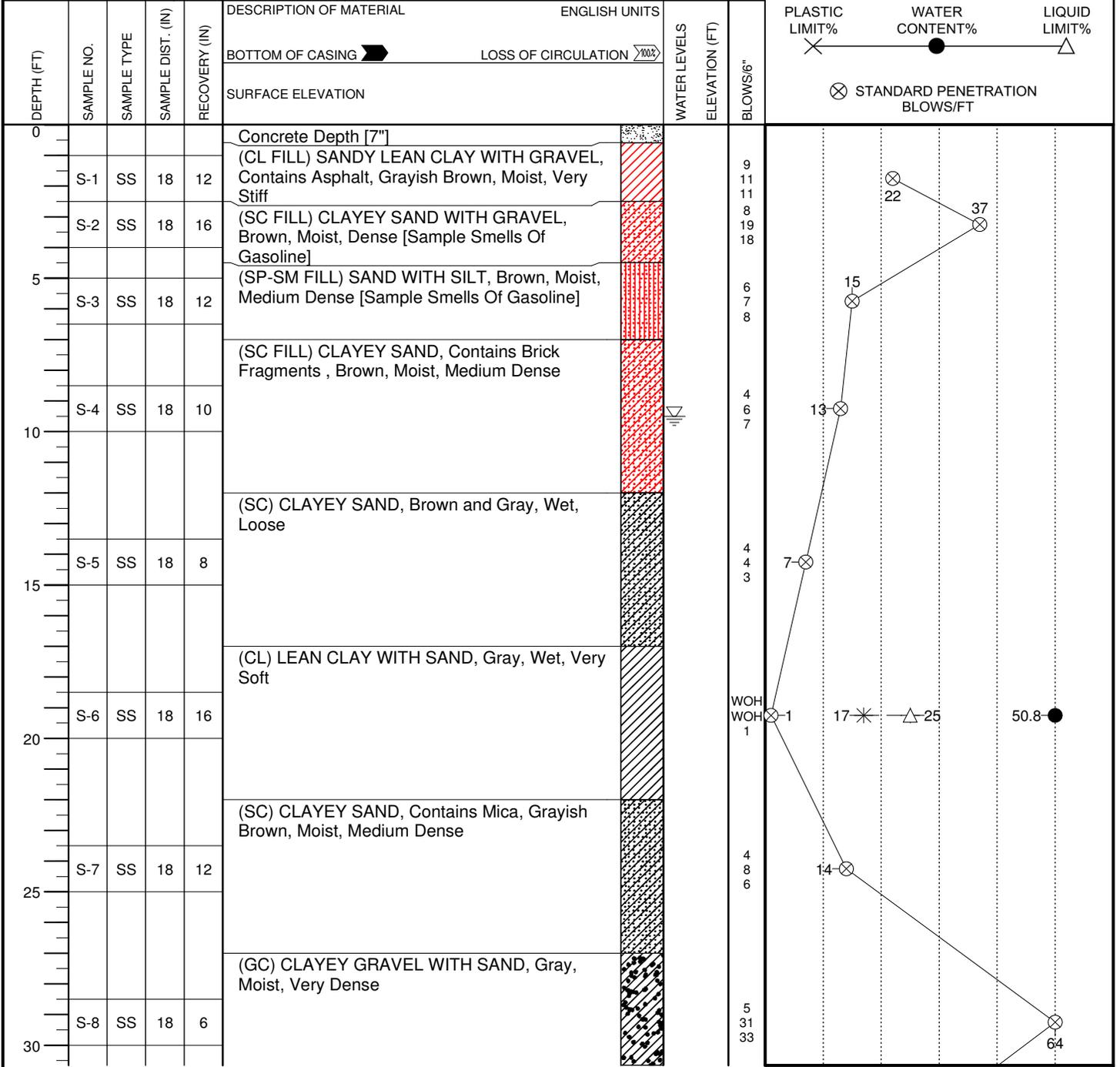
SITE LOCATION <b>500 N. Union Street, Alexandria, City of Alexandria</b>		
NORTHING	EASTING	STATION

○ CALIBRATED PENETROMETER TONS/FT<sup>2</sup>

ROCK QUALITY DESIGNATION & RECOVERY  
RQD% - - - REC% ———

PLASTIC LIMIT%      WATER CONTENT%      LIQUID LIMIT%

⊗ STANDARD PENETRATION BLOWS/FT



CONTINUED ON NEXT PAGE.

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.					
WL 9.50	WS □	WD □	BORING STARTED	10/07/14	
WL(BCR)	WL(ACR)		BORING COMPLETED	10/07/14	CAVE IN DEPTH
WL			RIG 55 LC ATV	FOREMAN Nadal	DRILLING METHOD 3.25 HSA/MUD ROTARY

CLIENT <b>Alexandria North Terminal, LLC</b>	JOB # <b>13983-B</b>	BORING # <b>B-7</b>	SHEET <b>2 OF 2</b>	
PROJECT NAME <b>Robinson Terminal North - Final Geotechnical Study</b>	ARCHITECT-ENGINEER <b>Ehlert-Bryan</b>			

SITE LOCATION  
**500 N. Union Street, Alexandria, City of Alexandria**

NORTHING \_\_\_\_\_ EASTING \_\_\_\_\_ STATION \_\_\_\_\_

○ CALIBRATED PENETROMETER TONS/FT<sup>2</sup>

ROCK QUALITY DESIGNATION & RECOVERY  
RQD% - - - REC% \_\_\_\_\_

PLASTIC LIMIT%      WATER CONTENT%      LIQUID LIMIT%

⊗ STANDARD PENETRATION BLOWS/FT

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	ENGLISH UNITS	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
					BOTTOM OF CASING	LOSS OF CIRCULATION			
					SURFACE ELEVATION				
35	S-9	SS	18	12	(GC) CLAYEY GRAVEL WITH SAND, Gray, Moist, Very Dense			10 6 9	15
					(CL) SANDY LEAN CLAY, Brownish Gray, Wet, Stiff				
40	S-10	SS	18	14	(CH) FAT CLAY, Gray to Brown, Moist, Stiff to Very Stiff			4 7 16	23
45	S-11	SS	18	16				3 5 9	14
50	S-12	SS	18	14				4 6 11	17
55	S-13	SS	18	10				4 10 9	19
60	S-14	SS	18	16				8 13 12	25
					END OF BORING @ 60.00'				

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL 9.50	WS <input type="checkbox"/>	WD <input type="checkbox"/>	BORING STARTED	10/07/14	
WL(BCR)	WL(ACR)		BORING COMPLETED	10/07/14	CAVE IN DEPTH
WL			RIG 55 LC ATV	FOREMAN Nadal	DRILLING METHOD 3.25 HSA/MUD ROTARY

CLIENT <b>Alexandria North Terminal, LLC</b>	JOB # <b>13983-B</b>	BORING # <b>B-8</b>	SHEET <b>1 OF 2</b>	
PROJECT NAME <b>Robinson Terminal North - Final Geotechnical Study</b>	ARCHITECT-ENGINEER <b>Ehlert-Bryan</b>			

SITE LOCATION  
**500 N. Union Street, Alexandria, City of Alexandria**

NORTHING \_\_\_\_\_ EASTING \_\_\_\_\_ STATION \_\_\_\_\_

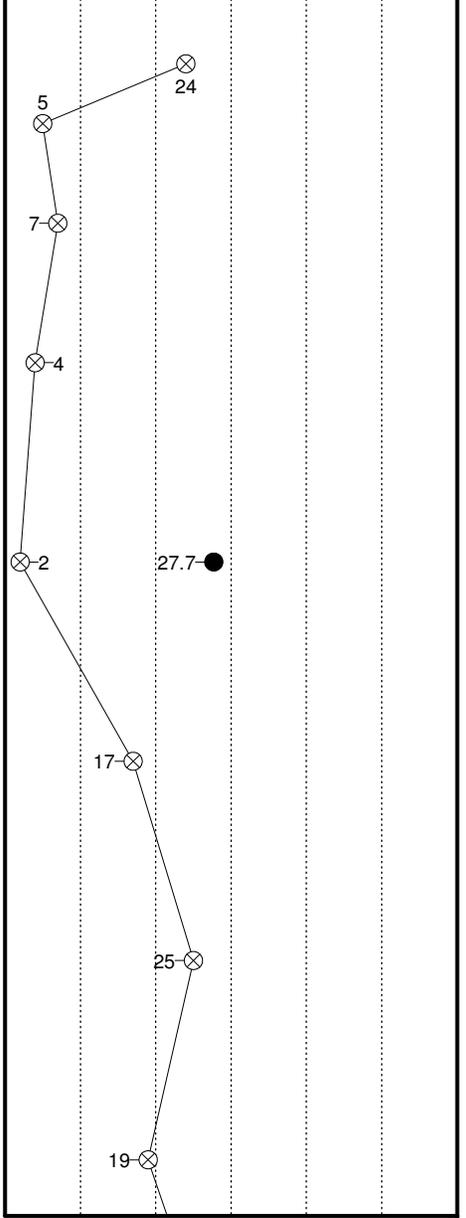
○ CALIBRATED PENETROMETER TONS/FT<sup>2</sup>

ROCK QUALITY DESIGNATION & RECOVERY  
RQD% - - - REC% \_\_\_\_\_

PLASTIC LIMIT%      WATER CONTENT%      LIQUID LIMIT%

⊗ STANDARD PENETRATION BLOWS/FT

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	ENGLISH UNITS	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0					Concrete Depth [7"]				
	S-1	SS	18	10	(CL FILL) SANDY LEAN CLAY, Contains Brick, Brown, Moist, Very Stiff				
	S-2	SS	18	10	(CL FILL) GRAVELLY LEAN CLAY, Brown, Moist, Medium Stiff				
5	S-3	SS	18	12	(CL) LEAN CLAY WITH SAND, Tan, Moist, Medium Stiff				
	S-4	SS	18	8	(CH) FAT CLAY, Gray, Moist to Wet, Very Soft to Soft				
15	S-5	SS	18	12					
	S-6	SS	18	16	(SC) CLAYEY SAND, Contains Mica, Brown, Wet, Medium Dense				
25	S-7	SS	18	18	(SC) CLAYEY SAND, Brown, Moist, Medium Dense				
30	S-8	SS	18	16					



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THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL 9.00      WS <input type="checkbox"/> WD <input type="checkbox"/>	BORING STARTED      10/06/14	
WL(BCR)      WL(ACR)	BORING COMPLETED      10/06/14	CAVE IN DEPTH
WL	RIG 55 LC ATV      FOREMAN Nadal	DRILLING METHOD 3.25 HSA/MUD ROTARY

CLIENT <b>Alexandria North Terminal, LLC</b>	JOB # <b>13983-B</b>	BORING # <b>B-8</b>	SHEET <b>2 OF 2</b>	
PROJECT NAME <b>Robinson Terminal North - Final Geotechnical Study</b>	ARCHITECT-ENGINEER <b>Ehlert-Bryan</b>			

SITE LOCATION <b>500 N. Union Street, Alexandria, City of Alexandria</b>		
NORTHING	EASTING	STATION

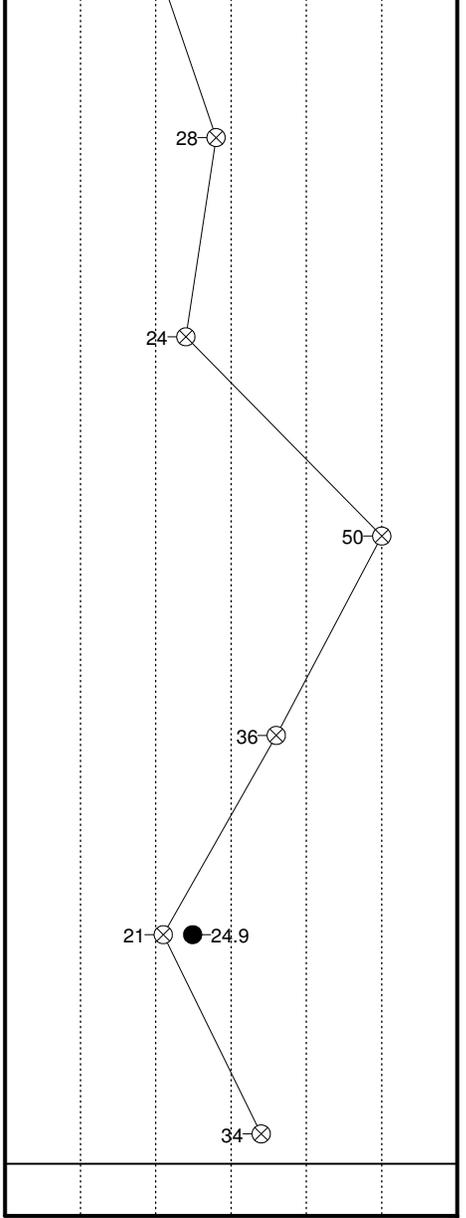
○ CALIBRATED PENETROMETER TONS/FT<sup>2</sup>

ROCK QUALITY DESIGNATION & RECOVERY  
RQD% - - - REC% - - -

PLASTIC LIMIT%      WATER CONTENT%      LIQUID LIMIT%

⊗ STANDARD PENETRATION BLOWS/FT

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	ENGLISH UNITS	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
					BOTTOM OF CASING	LOSS OF CIRCULATION			
					SURFACE ELEVATION				
35	S-9	SS	18	8	(SC) CLAYEY SAND, Brown, Moist, Medium Dense			11 13 15	28
40	S-10	SS	18	10	(SC) CLAYEY SAND WITH GRAVEL, Brown to Gray, Moist, Dense to Very Dense			13 12 12	24
45	S-11	SS	18	16				11 32 18	50
50	S-12	SS	18	14				13 16 20	36
55	S-13	SS	18	18	(CH) FAT CLAY WITH SAND, Gray to Brown, Moist, Very Stiff to Hard			10 13 8	21 ● 24.9
60	S-14	SS	18	16				9 17 17	34
END OF BORING @ 60.00'									



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.					
WL 9.00	WS	WD	BORING STARTED	10/06/14	
WL(BCR)	WL(ACR)		BORING COMPLETED	10/06/14	CAVE IN DEPTH
WL			RIG 55 LC ATV	FOREMAN Nadal	DRILLING METHOD 3.25 HSA/MUD ROTARY

CLIENT <b>Alexandria North Terminal, LLC</b>	JOB # <b>13983-B</b>	BORING # <b>B-9</b>	SHEET <b>1 OF 2</b>	
PROJECT NAME <b>Robinson Terminal North - Final Geotechnical Study</b>	ARCHITECT-ENGINEER <b>Ehlert-Bryan</b>			

SITE LOCATION  
**500 N. Union Street, Alexandria, City of Alexandria**

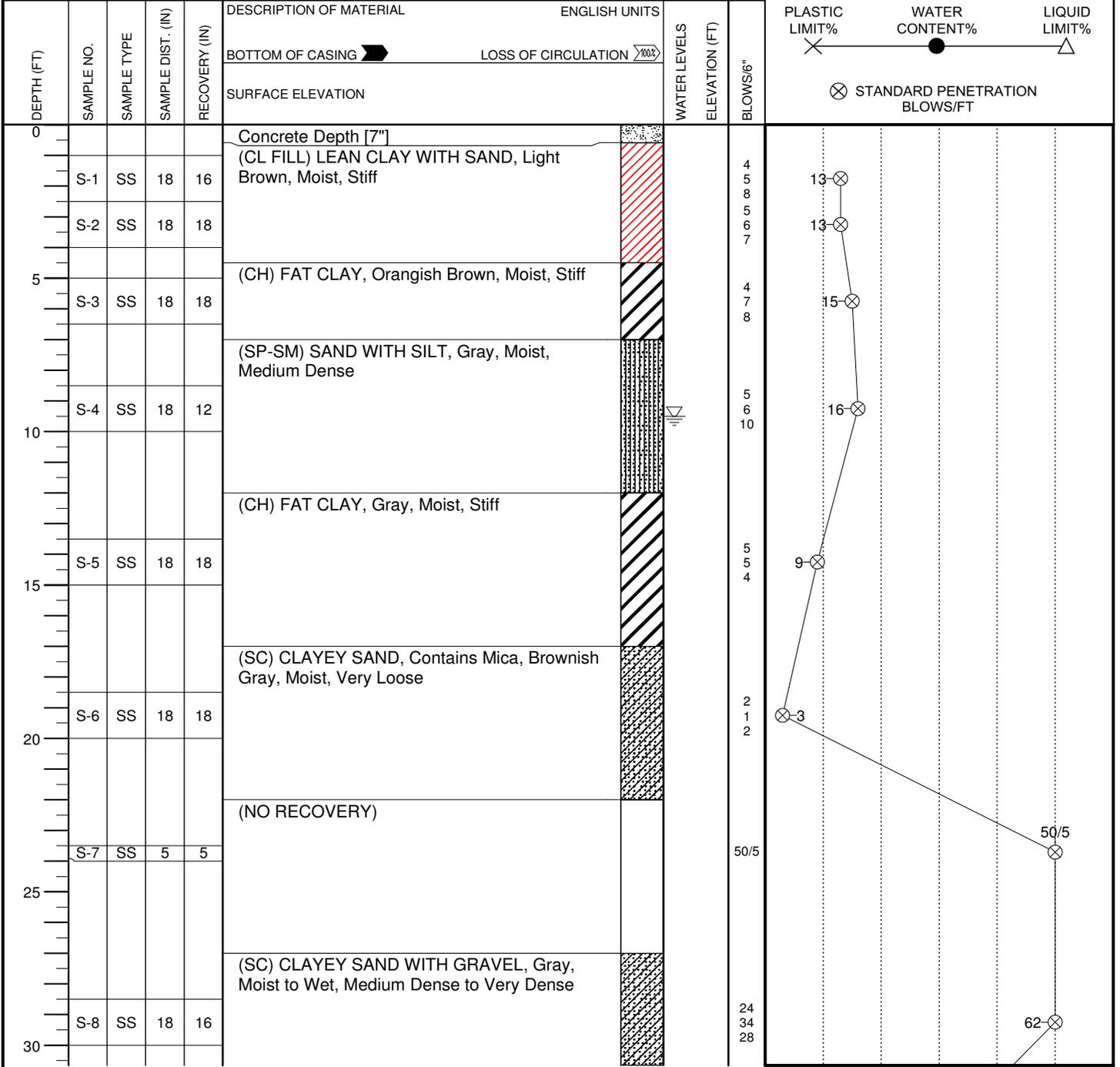
NORTHING \_\_\_\_\_ EASTING \_\_\_\_\_ STATION \_\_\_\_\_

○ CALIBRATED PENETROMETER TONS/FT<sup>2</sup>

ROCK QUALITY DESIGNATION & RECOVERY  
RQD% - - - REC% \_\_\_\_\_

PLASTIC LIMIT%      WATER CONTENT%      LIQUID LIMIT%

⊗ STANDARD PENETRATION BLOWS/FT



CONTINUED ON NEXT PAGE.

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL 9.50	WS <input type="checkbox"/>	WD <input type="checkbox"/>	BORING STARTED	10/02/14	
WL(BCR)	WL(ACR)		BORING COMPLETED	10/02/14	CAVE IN DEPTH
WL			RIG 55 LC ATV	FOREMAN Nadal	DRILLING METHOD 3.25 HSA/MUD ROTARY

CLIENT <b>Alexandria North Terminal, LLC</b>	JOB # <b>13983-B</b>	BORING # <b>B-9</b>	SHEET <b>2 OF 2</b>	
PROJECT NAME <b>Robinson Terminal North - Final Geotechnical Study</b>	ARCHITECT-ENGINEER <b>Ehlert-Bryan</b>			

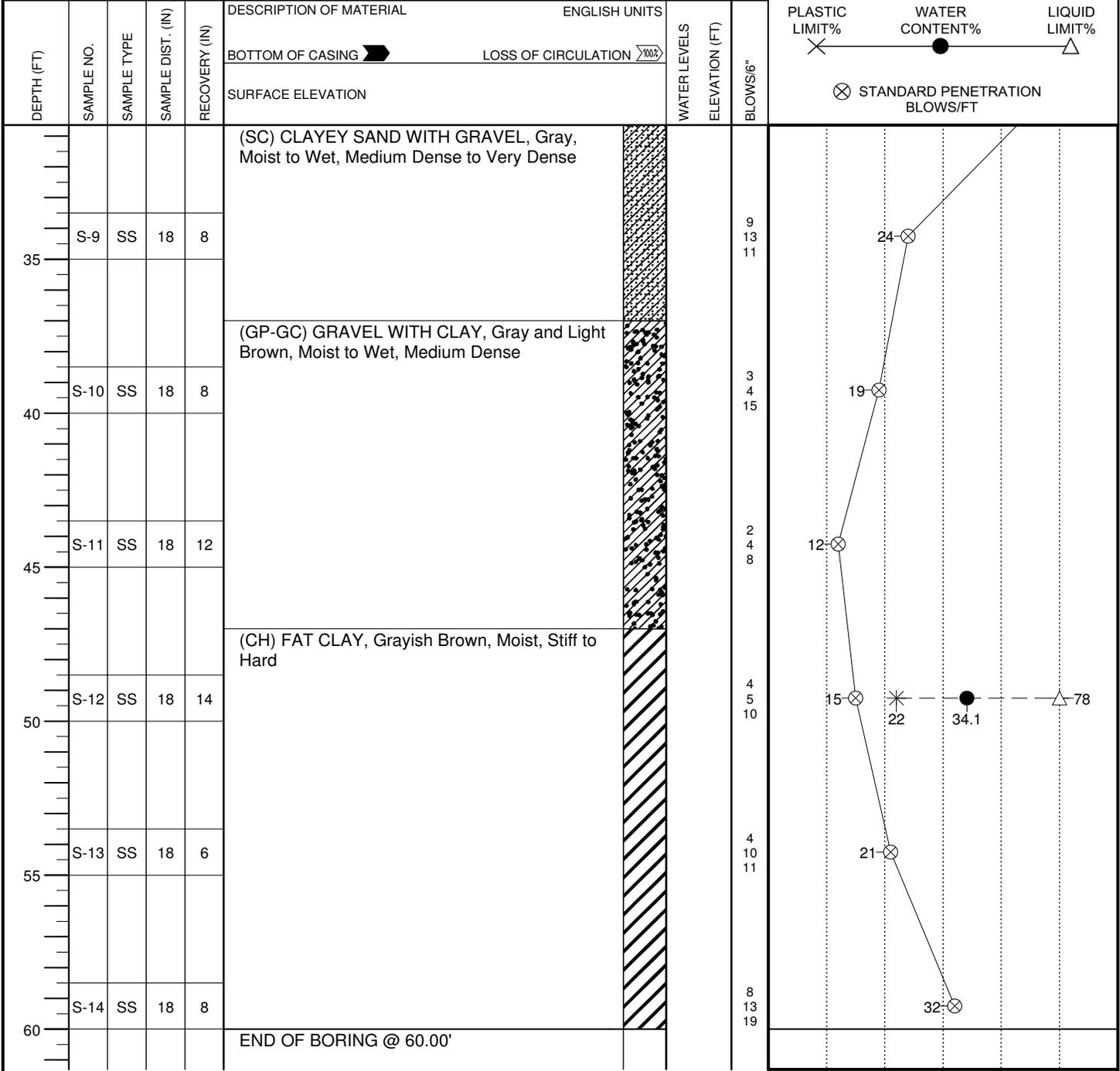
SITE LOCATION <b>500 N. Union Street, Alexandria, City of Alexandria</b>		
NORTHING	EASTING	STATION

○ CALIBRATED PENETROMETER TONS/FT<sup>2</sup>

ROCK QUALITY DESIGNATION & RECOVERY  
RQD% - - - REC% - - -

PLASTIC LIMIT%      WATER CONTENT%      LIQUID LIMIT%

⊗ STANDARD PENETRATION BLOWS/FT



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL 9.50	WS <input type="checkbox"/>	WD <input type="checkbox"/>	BORING STARTED	10/02/14	
WL(BCR)	WL(ACR)		BORING COMPLETED	10/02/14	CAVE IN DEPTH
WL			RIG 55 LC ATV	FOREMAN Nadal	DRILLING METHOD 3.25 HSA/MUD ROTARY

CLIENT <b>Alexandria North Terminal, LLC</b>	JOB # <b>13983-B</b>	BORING # <b>B-10</b>	SHEET <b>1 OF 2</b>	
PROJECT NAME <b>Robinson Terminal North - Final Geotechnical Study</b>	ARCHITECT-ENGINEER <b>Ehlert-Bryan</b>			

SITE LOCATION  
**500 N. Union Street, Alexandria, City of Alexandria**

NORTHING \_\_\_\_\_ EASTING \_\_\_\_\_ STATION \_\_\_\_\_

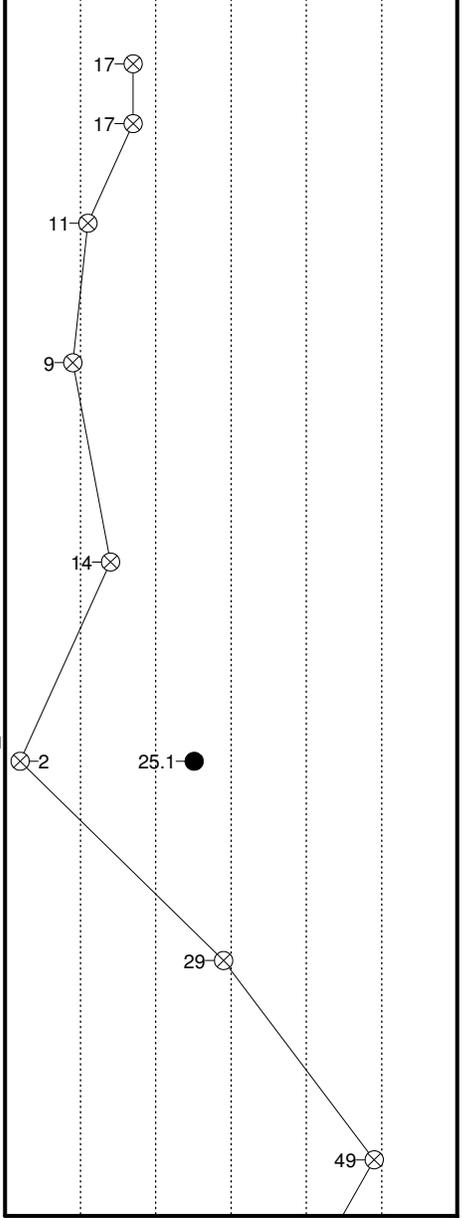
○ CALIBRATED PENETROMETER TONS/FT<sup>2</sup>

ROCK QUALITY DESIGNATION & RECOVERY  
RQD% - - - REC% \_\_\_\_\_

PLASTIC LIMIT%      WATER CONTENT%      LIQUID LIMIT%

⊗ STANDARD PENETRATION BLOWS/FT

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	ENGLISH UNITS	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0					Concrete Depth [7"]				
	S-1	SS	18	10	(SC FILL) CLAYEY SAND WITH GRAVEL, Light Gray, Moist, Medium Dense				
	S-2	SS	18	12	(SC) CLAYEY SAND, Light Brown to Red, Moist, Medium Dense				
5	S-3	SS	18	14					
					(GC) CLAYEY GRAVEL, Dark Gray, Wet, Loose				
10	S-4	SS	18	10					
					(CL) LEAN CLAY, Pinkish Gray, Moist, Stiff				
15	S-5	SS	18	12					
					(CL) LEAN CLAY, Brown, Wet, Very Soft				
20	S-6	SS	18	16					
					(SC) CLAYEY SAND WITH GRAVEL, Brown, Moist to Wet, Medium Dense to Dense				
25	S-7	SS	18	12					
30	S-8	SS	18	14					



CONTINUED ON NEXT PAGE.

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL 7.50      WS <input type="checkbox"/> WD <input type="checkbox"/>	BORING STARTED      10/07/14	
WL(BCR)      WL(ACR) <input type="checkbox"/>	BORING COMPLETED      10/07/14	CAVE IN DEPTH
WL	RIG 55 LC ATV      FOREMAN Nadal	DRILLING METHOD 3.25 HSA/MUD ROTARY

CLIENT <b>Alexandria North Terminal, LLC</b>	JOB # <b>13983-B</b>	BORING # <b>B-10</b>	SHEET <b>2 OF 2</b>	
PROJECT NAME <b>Robinson Terminal North - Final Geotechnical Study</b>	ARCHITECT-ENGINEER <b>Ehlert-Bryan</b>			

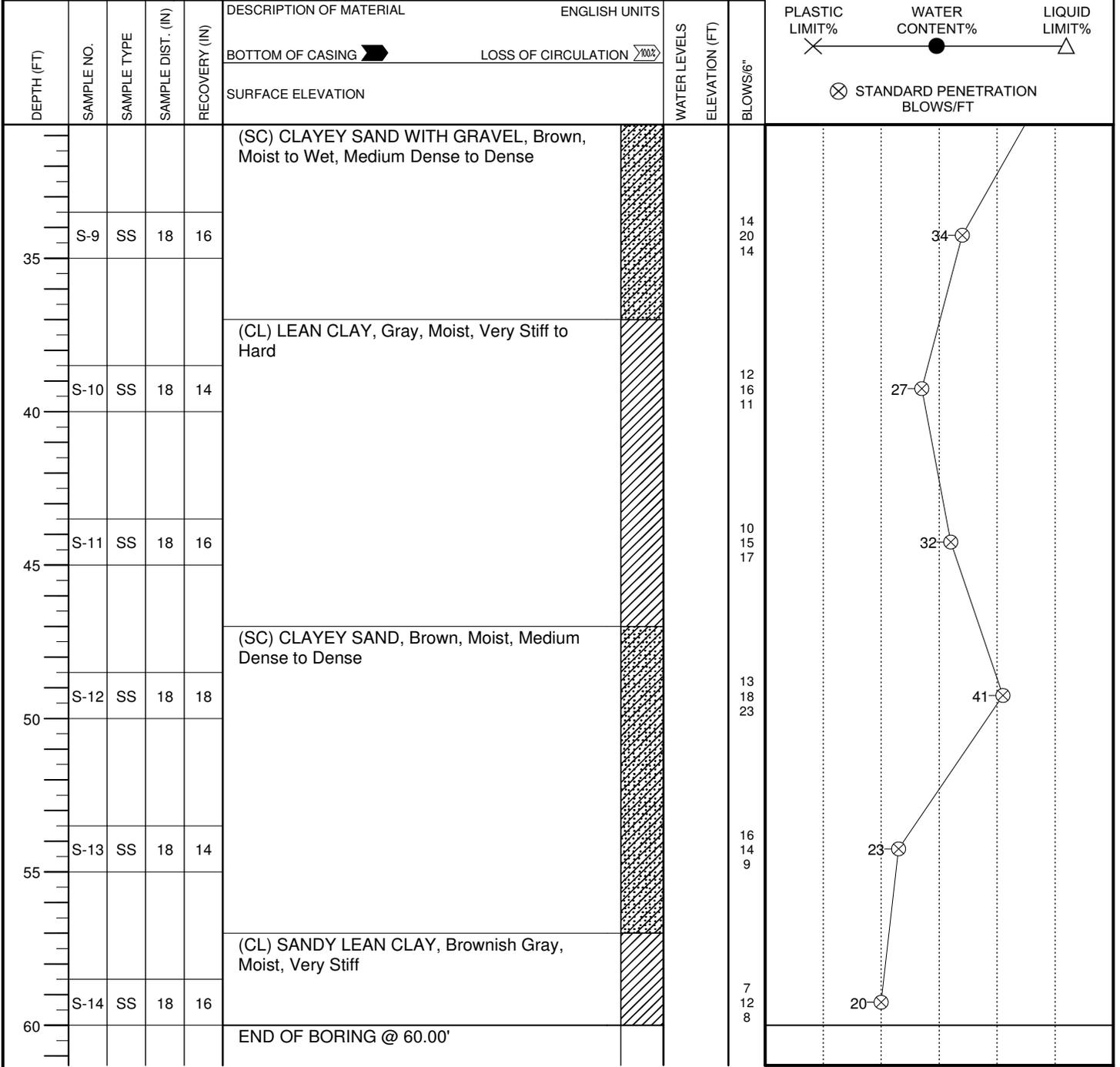
SITE LOCATION <b>500 N. Union Street, Alexandria, City of Alexandria</b>		
NORTHING	EASTING	STATION

○ CALIBRATED PENETROMETER TONS/FT<sup>2</sup>

ROCK QUALITY DESIGNATION & RECOVERY  
RQD% - - - REC% - - -

PLASTIC LIMIT%      WATER CONTENT%      LIQUID LIMIT%

⊗ STANDARD PENETRATION BLOWS/FT



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL 7.50	WS <input type="checkbox"/>	WD <input type="checkbox"/>	BORING STARTED	10/07/14	
WL(BCR)	WL(ACR)		BORING COMPLETED	10/07/14	CAVE IN DEPTH
WL			RIG 55 LC ATV	FOREMAN Nadal	DRILLING METHOD 3.25 HSA/MUD ROTARY

CLIENT <b>Alexandria North Terminal, LLC</b>	JOB # <b>13983-B</b>	BORING # <b>B-11</b>	SHEET <b>1 OF 2</b>	
PROJECT NAME <b>Robinson Terminal North - Final Geotechnical Study</b>	ARCHITECT-ENGINEER <b>Ehlert-Bryan</b>			

SITE LOCATION <b>500 N. Union Street, Alexandria, City of Alexandria</b>		
NORTHING	EASTING	STATION

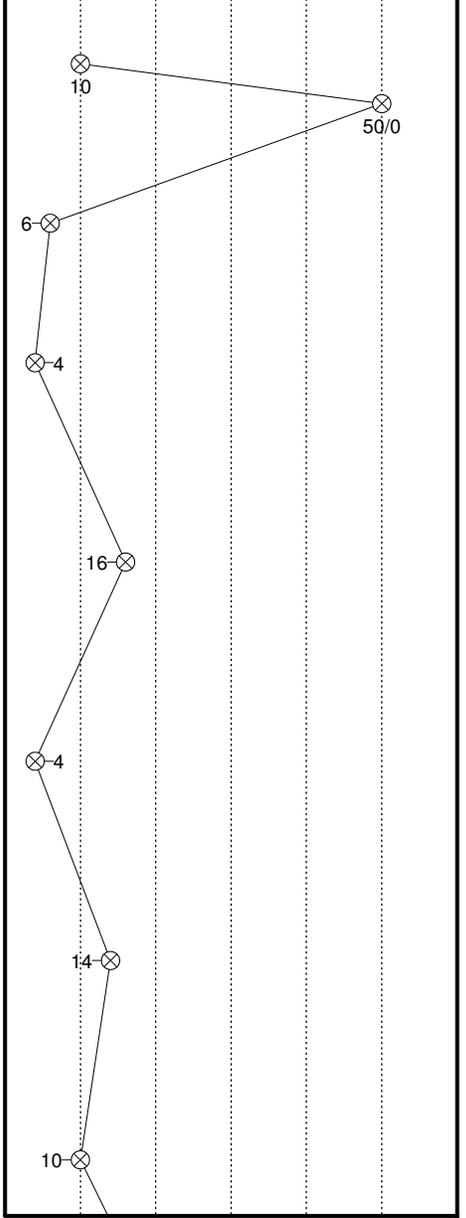
○ CALIBRATED PENETROMETER TONS/FT<sup>2</sup>

ROCK QUALITY DESIGNATION & RECOVERY  
RQD% - - - REC% - - -

PLASTIC LIMIT%      WATER CONTENT%      LIQUID LIMIT%

⊗ STANDARD PENETRATION BLOWS/FT

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	ENGLISH UNITS	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0					Concrete Depth [7"]				
	S-1	SS	18	3	(GW-GM FILL) WELL-GRADED GRAVEL WITH SILT, Gray, Moist, Loose to Extremely Dense				4
	S-2	SS	6	2			5		
					(CL) SANDY LEAN CLAY, Brownish Red to Brown, Moist, Soft to Medium Stiff				50/0
5	S-3	SS	18	12			3		
					(SP-SC) SAND WITH CLAY, Grayish Brown, Moist, Medium Dense				2
	S-4	SS	18	16			2		
10					(NO RECOVERY)				2
	S-5	SS	18	18			2		
15					(SC) CLAYEY SAND, Gray, Moist, Loose to Medium Dense				10
	S-6	SS	18	0			10		
20									6
	S-7	SS	18	16			3		
25									1
	S-8	SS	18	14			3		
30									7



CONTINUED ON NEXT PAGE.

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.					
WL 9.50	WS <input type="checkbox"/>	WD <input type="checkbox"/>	BORING STARTED	10/09/14	
WL(BCR)	WL(ACR)		BORING COMPLETED	10/09/14	CAVE IN DEPTH
WL			RIG 55 LC ATV	FOREMAN Nadal	DRILLING METHOD 3.25 HSA/MUD ROTARY

CLIENT <b>Alexandria North Terminal, LLC</b>	JOB # <b>13983-B</b>	BORING # <b>B-11</b>	SHEET <b>2 OF 2</b>	
PROJECT NAME <b>Robinson Terminal North - Final Geotechnical Study</b>	ARCHITECT-ENGINEER <b>Ehlert-Bryan</b>			

SITE LOCATION <b>500 N. Union Street, Alexandria, City of Alexandria</b>		
NORTHING	EASTING	STATION

○ CALIBRATED PENETROMETER TONS/FT<sup>2</sup>

ROCK QUALITY DESIGNATION & RECOVERY  
RQD% - - - REC% - - -

PLASTIC LIMIT%      WATER CONTENT%      LIQUID LIMIT%

⊗ STANDARD PENETRATION BLOWS/FT

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	ENGLISH UNITS	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
					BOTTOM OF CASING	LOSS OF CIRCULATION			
					SURFACE ELEVATION				
35	S-9	SS	18	18	(SC) CLAYEY SAND, Gray, Moist, Loose to Medium Dense			8 10 13	23
					(CL) GRAVELLY LEAN CLAY WITH SAND, Gray, Moist, Very Stiff				
40	S-10	SS	18	8	(CL) LEAN CLAY, Dark Gray, Wet, Stiff			7 5 6	11
					(CL) SANDY LEAN CLAY WITH GRAVEL, Brown to Gray, Moist to Wet, Soft to Stiff			4 2 1	3
45	S-11	SS	18	16					12.6
					(CL) LEAN CLAY WITH SAND, Brown, Wet, Very Stiff			4 6 9	15
50	S-12	SS	18	14					
					(CL) LEAN CLAY WITH SAND, Brown, Wet, Very Stiff			5 8 8	16
55	S-13	SS	18	14					
					(WOOD Fragments) [No Soil Recovered]				
60	S-14	SS	8	1				10 50/2	50/2
					END OF BORING @ 60.00'				

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL 9.50	WS	WD	BORING STARTED	10/09/14	
WL(BCR)	WL(ACR)		BORING COMPLETED	10/09/14	CAVE IN DEPTH
WL			RIG 55 LC ATV	FOREMAN Nadal	DRILLING METHOD 3.25 HSA/MUD ROTARY

CLIENT <b>Alexandria North Terminal, LLC</b>	JOB # <b>13983-B</b>	BORING # <b>B-12</b>	SHEET <b>1 OF 2</b>	
PROJECT NAME <b>Robinson Terminal North - Final Geotechnical Study</b>		ARCHITECT-ENGINEER <b>Ehlert-Bryan</b>		

SITE LOCATION  
**500 N. Union Street, Alexandria, City of Alexandria**

NORTHING	EASTING	STATION
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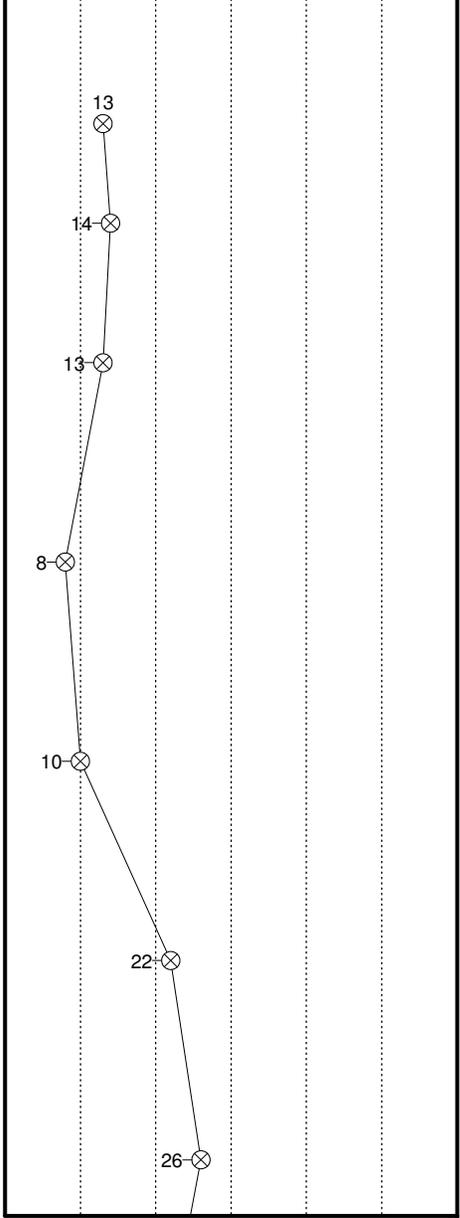
○ CALIBRATED PENETROMETER TONS/FT<sup>2</sup>

ROCK QUALITY DESIGNATION & RECOVERY  
RQD% - - - REC% \_\_\_\_\_

PLASTIC LIMIT%      WATER CONTENT%      LIQUID LIMIT%

⊗ STANDARD PENETRATION BLOWS/FT

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	ENGLISH UNITS	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
					BOTTOM OF CASING	LOSS OF CIRCULATION			
0					Concrete Depth [14"]				
	S-1	SS	18	10	(CL FILL) SANDY LEAN CLAY WITH GRAVEL, Brownish Gray, Moist, Stiff				
5	S-2	SS	18	10					
	S-3	SS	18	8	(CL) GRAVELLY LEAN CLAY, Brownish Gray, Moist to Wet, Medium Stiff to Stiff				
10									
	S-4	SS	18	18					
15									
	S-5	SS	18	14	(CL) SANDY LEAN CLAY, Contains Wood, Gray, Wet, Stiff				
20									
	S-6	SS	18	10	(SC) CLAYEY SAND WITH GRAVEL, Gray, Wet, Medium Dense				
25									
	S-7	SS	18	16	(CH) FAT CLAY, Gray to Brownish Red, Moist, Medium Stiff to Very Stiff				
30									



**CONTINUED ON NEXT PAGE.**

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL 9.50	WS <input type="checkbox"/>	WD <input type="checkbox"/>	BORING STARTED 10/08/14	
WL(BCR)	WL(ACR)		BORING COMPLETED 10/08/14	CAVE IN DEPTH
WL			RIG 55 LC ATV FOREMAN Nadal	DRILLING METHOD 3.25 HSA/MUD ROTARY

CLIENT <b>Alexandria North Terminal, LLC</b>	JOB # <b>13983-B</b>	BORING # <b>B-12</b>	SHEET <b>2 OF 2</b>	
PROJECT NAME <b>Robinson Terminal North - Final Geotechnical Study</b>	ARCHITECT-ENGINEER <b>Ehlert-Bryan</b>			

SITE LOCATION <b>500 N. Union Street, Alexandria, City of Alexandria</b>		
NORTHING	EASTING	STATION

○ CALIBRATED PENETROMETER TONS/FT<sup>2</sup>

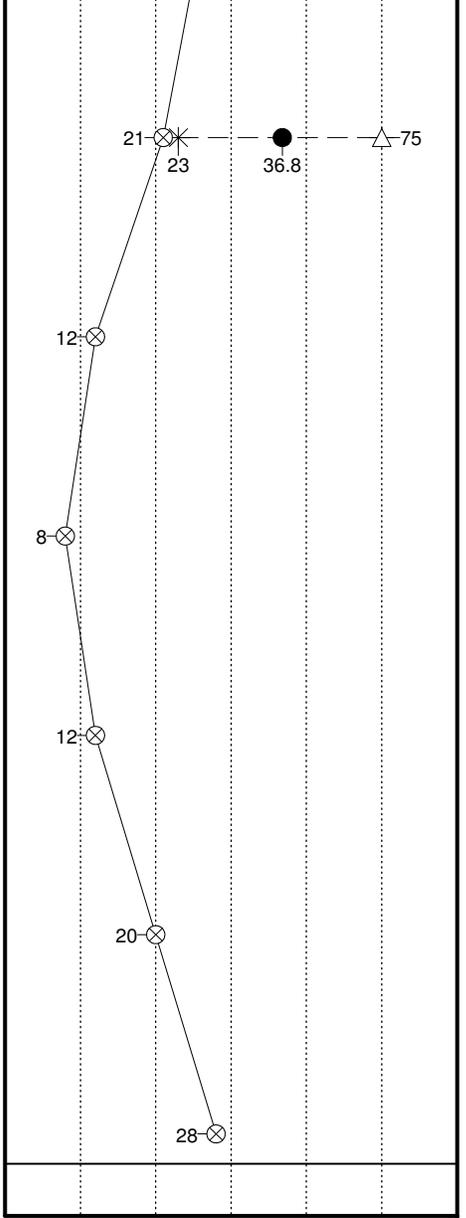
ROCK QUALITY DESIGNATION & RECOVERY  
RQD% - - - REC% - - -

PLASTIC LIMIT%      WATER CONTENT%      LIQUID LIMIT%

⊗ STANDARD PENETRATION BLOWS/FT

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	ENGLISH UNITS	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
					BOTTOM OF CASING	LOSS OF CIRCULATION			
					SURFACE ELEVATION				

					(CH) FAT CLAY, Gray to Brownish Red, Moist, Medium Stiff to Very Stiff				
35	S-8	SS	18	14					
40	S-9	SS	18	12					
45	S-10	SS	18	14					
50	S-11	SS	18	10					
55	S-12	SS	18	16					
60	S-13	SS	18	16					
END OF BORING @ 60.00'									



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.					
WL 9.50	WS <input type="checkbox"/>	WD <input type="checkbox"/>	BORING STARTED	10/08/14	
WL(BCR)	WL(ACR)		BORING COMPLETED	10/08/14	CAVE IN DEPTH
WL			RIG 55 LC ATV	FOREMAN Nadal	DRILLING METHOD 3.25 HSA/MUD ROTARY

# Laboratory Testing Summary

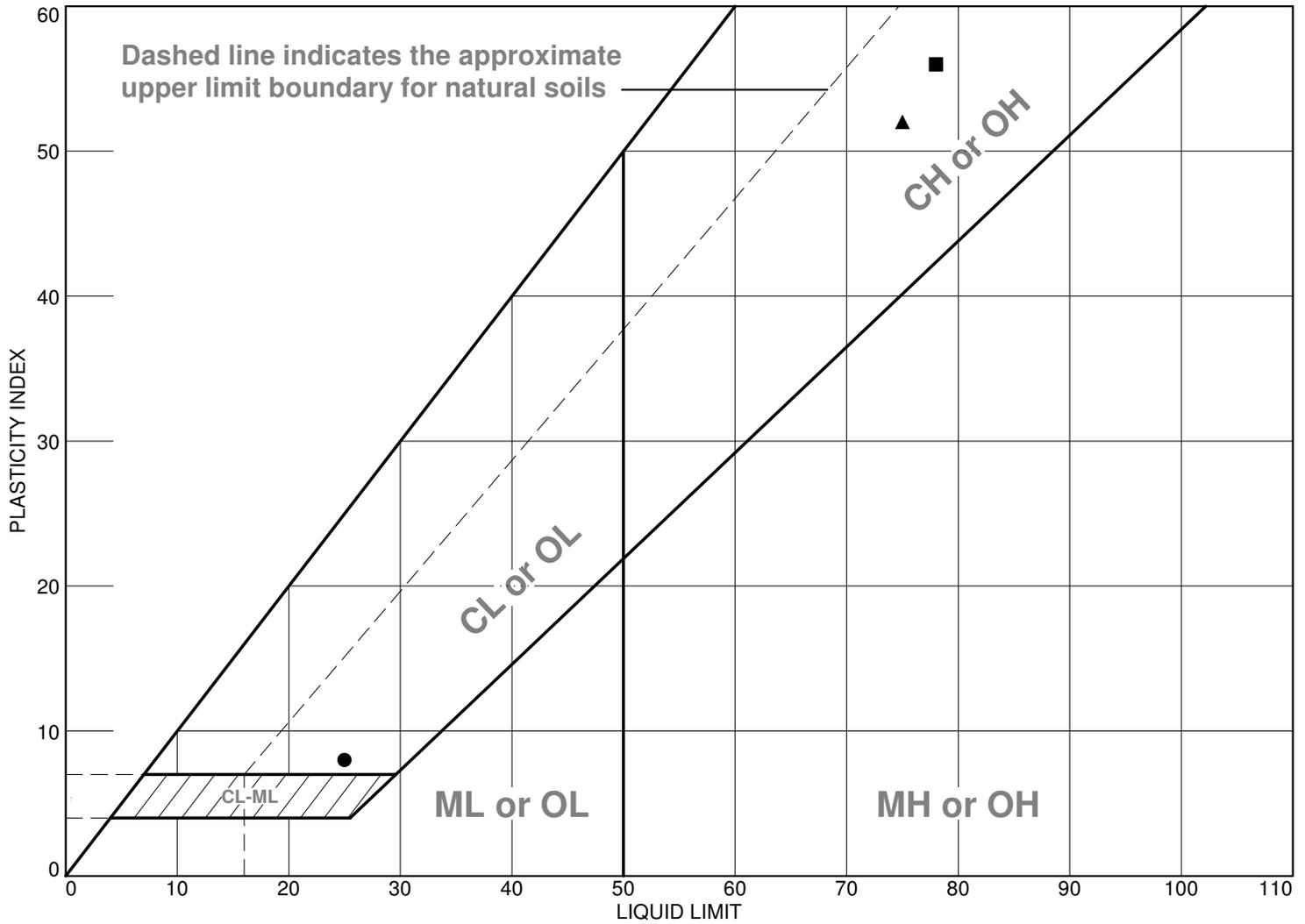
Sample Source	Sample Number	Depth (feet)	MC <sup>1</sup> (%)	Soil Type <sup>2</sup>	Atterberg Limits <sup>3</sup>			Percent Passing No. 200 Sieve <sup>4</sup>	Moisture - Density (Corr.) <sup>5</sup>		CBR Value <sup>6</sup>	Other
					LL	PL	PI		Maximum Density (pcf)	Optimum Moisture (%)		
B-7												
	S-6	18.50 - 20.00	50.8	CL	25	17	8	77.0				
B-8												
	S-5	13.50 - 15.00	27.7									
	S-13	53.50 - 55.00	24.9									
B-9												
	S-12	48.50 - 50.00	34.1	CH	78	22	56	82.3				
B-10												
	S-6	18.50 - 20.00	25.1									
B-11												
	S-11	43.50 - 45.00	12.6									
B-12												
	S-8	33.50 - 35.00	36.8	CH	75	23	52	95.7				

**Notes:** 1. ASTM D 2216, 2. ASTM D 2487, 3. ASTM D 4318, 4. ASTM D 1140, 5. See test reports for test method, 6. See test reports for test method  
**Definitions:** MC: Moisture Content, Soil Type: USCS (Unified Soil Classification System), LL: Liquid Limit, PL: Plastic Limit, PI: Plasticity Index, CBR: California Bearing Ratio, OC: Organic Content (ASTM D 2974)

**Project No.** 13983-B  
**Project Name:** Robinson Terminal North - Final Geotechnical Study  
**PM:** Chris Egan  
**PE:** Jimmy Racine  
**Printed On:** Tuesday, October 28, 2014



# LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Lean Clay with Sand Trace Mica Brown (CL)	25	17	8	94.2	77.0	CL
■	Fat Clay with Sand Light Olive Brown (CH)	78	22	56	86.2	82.3	CH
▲	Fat Clay Yellowish Brown (CH)	75	23	52	99.4	95.7	CH

**Project No.** 13983-B      **Client:** Alexandria North Terminal, LLC

**Project:** Robinson Terminal North - Final Geotechnical Study

● **Source of Sample:** B-7      **Depth:** 18.50-20.00      **Sample Number:** S-6  
 ■ **Source of Sample:** B-9      **Depth:** 48.50-50.00      **Sample Number:** S-12  
 ▲ **Source of Sample:** B-12      **Depth:** 33.50-35.00      **Sample Number:** S-8

**Remarks:**

- Data Entered: 10/16/14
- Data Entered: 10/16/14
- ▲ Data Entered: 10/16/14



**ECS MID-ATLANTIC, LLC**

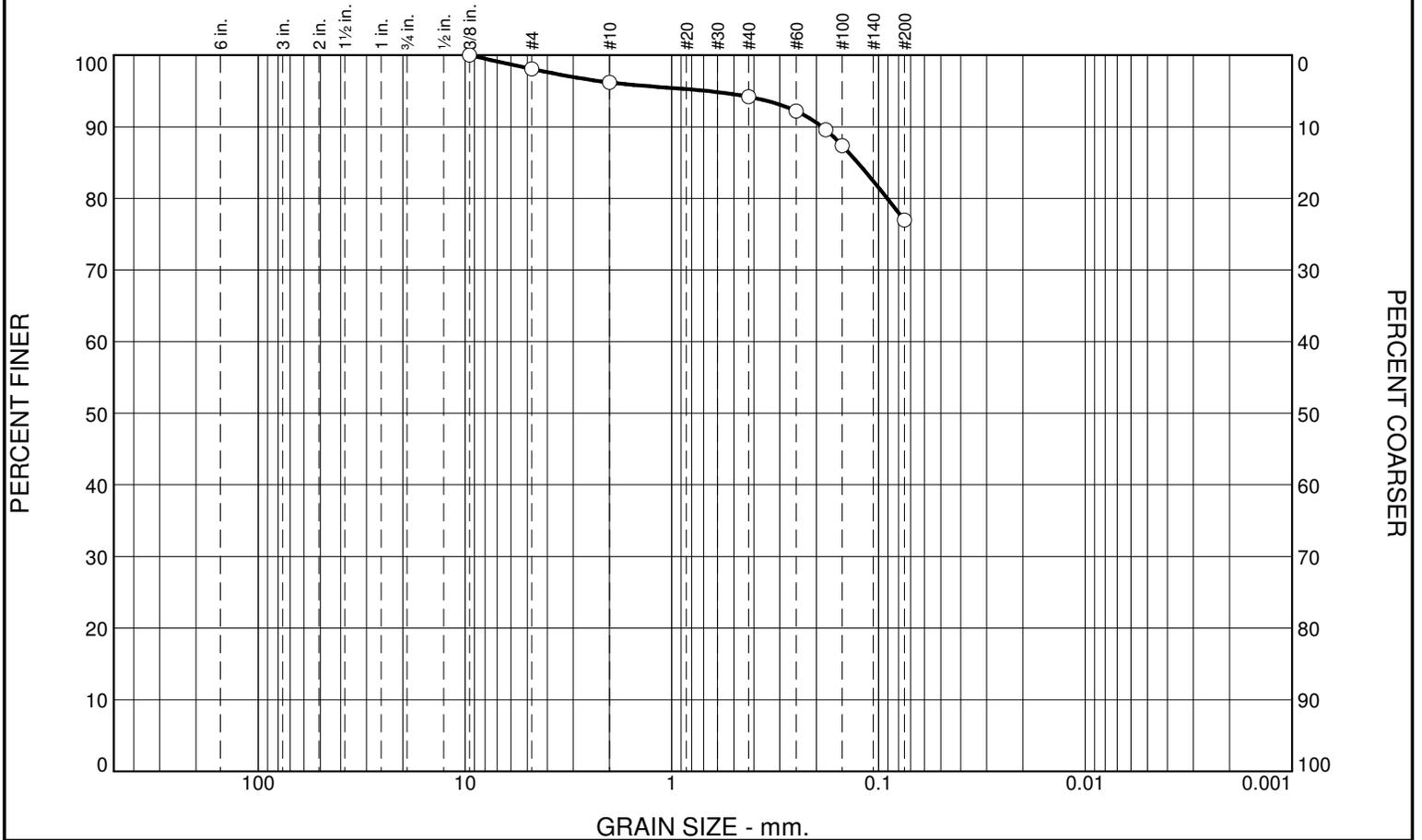
14026 Thunderbolt Place, Suite 100  
 Chantilly, VA 20151-3232

Phone: (703) 471-8400  
 Fax: (703) 834-5527

**Figure**

**Tested By:** ○ HTN1   □ HNT1   △ HNT1      **Checked By:** DVT

# Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.9	1.9	2.0	17.2	77.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.375	100.0		
#4	98.1		
#10	96.2		
#40	94.2		
#60	92.2		
#80	89.6		
#100	87.4		
#200	77.0		

**Soil Description**

Lean Clay with Sand Trace Mica Brown (CL)

**Atterberg Limits**

PL= 17      LL= 25      PI= 8

**Coefficients**

D<sub>90</sub>= 0.1876      D<sub>85</sub>= 0.1262      D<sub>60</sub>=  
D<sub>50</sub>=              D<sub>30</sub>=              D<sub>15</sub>=  
D<sub>10</sub>=              C<sub>u</sub>=              C<sub>c</sub>=

**Classification**

USCS= CL              AASHTO= A-4(4)

**Remarks**

Data Entered: 10/16/14

\* (no specification provided)

**Source of Sample:** B-7      **Depth:** 18.50-20.00  
**Sample Number:** S-6

**Date:** 10/14/14



**ECS MID-ATLANTIC, LLC**  
14026 Thunderbolt Place, Suite 100  
Chantilly, VA 20151-3232  
Phone: (703) 471-8400  
Fax: (703) 834-5527

**Client:** Alexandria North Terminal, LLC  
**Project:** Robinson Terminal North - Final Geotechnical Study

**Project No:** 13983-B

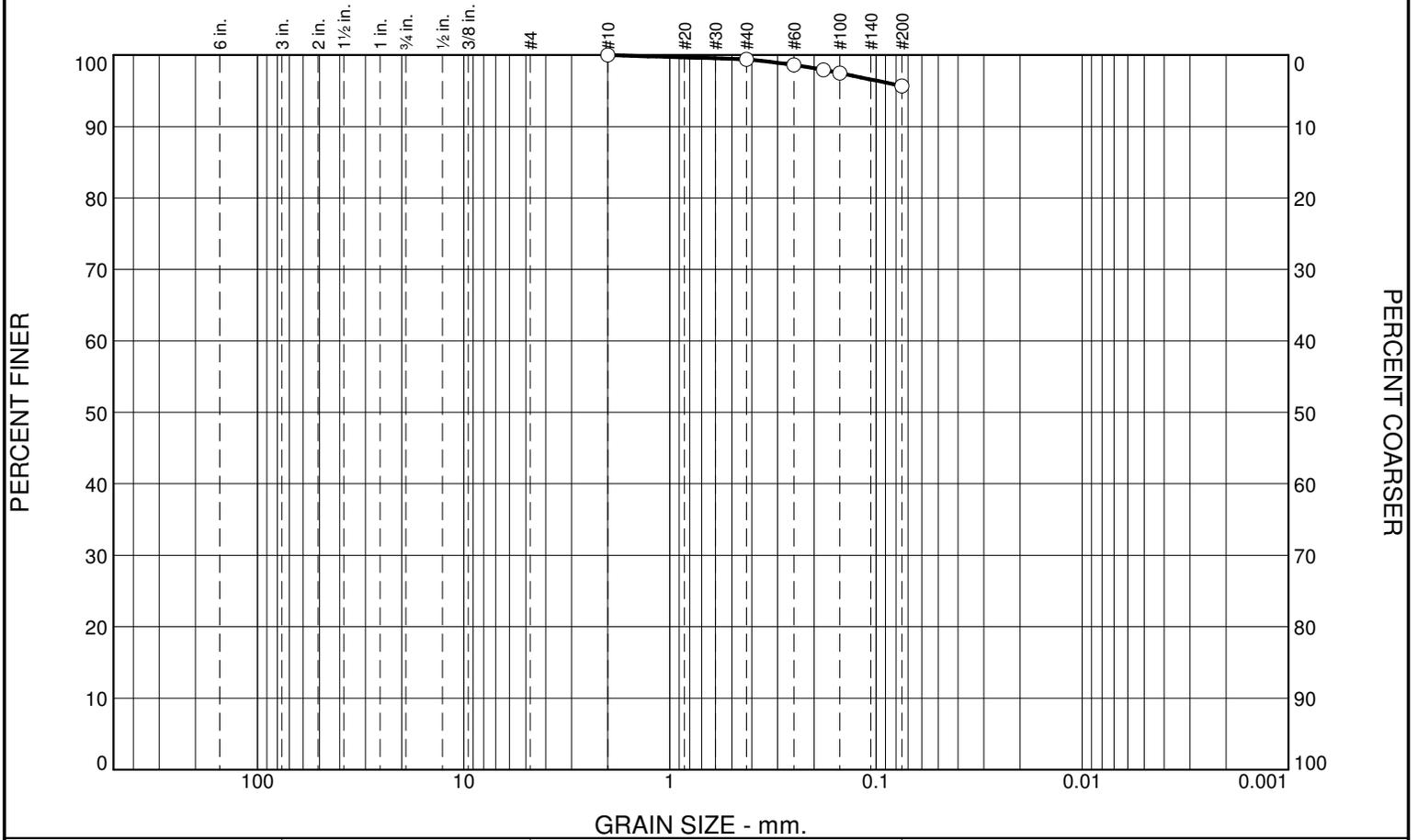
**Figure**

**Tested By:** KV

**Checked By:** DVT



# Particle Size Distribution Report



GRAIN SIZE - mm.

% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.6	3.7	95.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#40	99.4		
#60	98.6		
#80	97.9		
#100	97.5		
#200	95.7		

**Soil Description**

Fat Clay Yellowish Brown (CH)

**Atterberg Limits**

PL= 23      LL= 75      PI= 52

**Coefficients**

D<sub>90</sub>=      D<sub>85</sub>=      D<sub>60</sub>=  
D<sub>50</sub>=      D<sub>30</sub>=      D<sub>15</sub>=  
D<sub>10</sub>=      C<sub>u</sub>=      C<sub>c</sub>=

**Classification**

USCS= CH      AASHTO= A-7-6(57)

**Remarks**

Data Entered: 10/16/14

\* (no specification provided)

**Source of Sample:** B-12      **Depth:** 33.50-35.00  
**Sample Number:** S-8

**Date:** 10/14/14



**ECS MID-ATLANTIC, LLC**  
14026 Thunderbolt Place, Suite 100  
Chantilly, VA 20151-3232  
Phone: (703) 471-8400  
Fax: (703) 834-5527

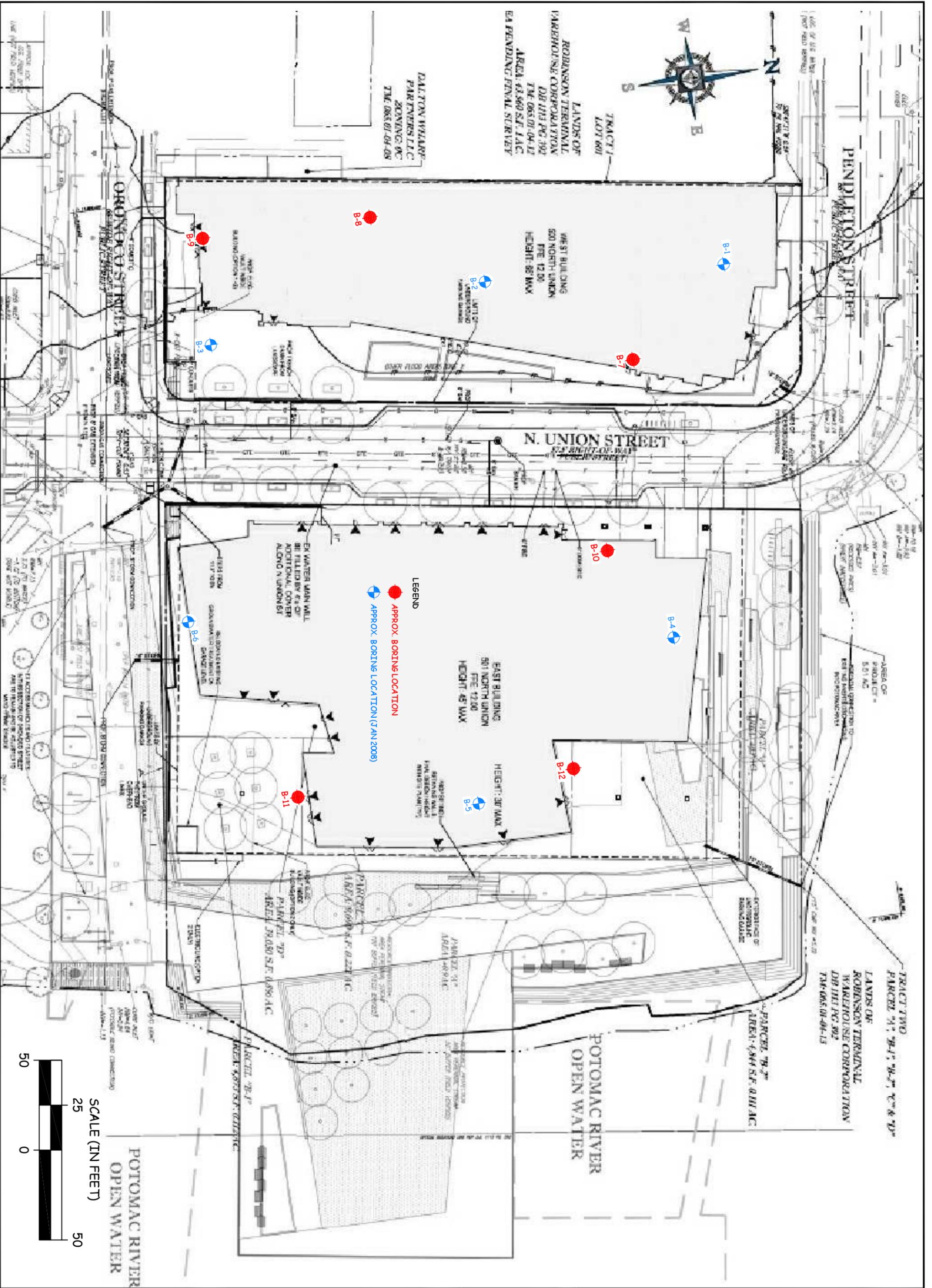
**Client:** Alexandria North Terminal, LLC  
**Project:** Robinson Terminal North - Final Geotechnical Study

**Project No:** 13983-B

**Figure**

**Tested By:** KV

**Checked By:** DVT



# ROBINSON TERMINAL NORTH ALEXANDRIA, VA



## BORING LOCATION DIAGRAM

ALEXANDRIA NORTH TERMINAL, LLC

ECS REVISIONS	
ENGINEER	DRAFTING
CME	RAC
SCALE	1"=50'
PROJECT NO.	13983B
SHEET	1 OF 1
DATE	10-27-14