ATTACHMENT A-5

REPORT OF

SUBSURFACE EXPLORATION AND GEOTECHNICAL ENGINEERING ANALYSIS

FORT DUPONT ICE ARENA
3779 ELY PLACE, SE
WASHINGTON, D.C.

ECS PROJECT NO. 37:1383

FOR

QUINN EVANS ARCHITECTS

OCTOBER 17, 2014

ECS CAPITOL SERVICES, PLLC
"Setting the Standard for Service"
Geotechnical • Construction Materials • Environmental • Facilities • Code Compliance

October 17, 2014

Mr. Daniel Curry
Quinn Evans Architects
2121 Ward Place, NW
Floor 4
Washington, DC 20037

ECS Project No. 37:1383

Reference: Report of Subsurface Exploration and Geotechnical Engineering Analysis, Fort Dupont Ice Arena, 3779 Ely Place, SE, Washington, DC

Dear Mr. Curry:

As authorized by your acceptance of our Proposal No. 37:553-GPR most recently revised August 12, 2014, ECS Capitol Services, PLLC (ECS) has completed the subsurface exploration and geotechnical engineering analysis for the proposed Fort Dupont Ice Arena in SE, Washington, DC.

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 planning stages of the project described herein. These recommendations should be considered preliminary until the final design drawings are completed and we have a chance to review and comment on our analysis, if necessary.

We appreciate the opportunity to be of service to Quinn Evans Architects on this project. If you have any questions with regard to the information and recommendations contained in this report, or if we may be of further service to you during the planning and/or construction phase of this project, please do not hesitate to contact the undersigned.

Respectfully,

ECS CAPITOL SERVICES, PLLC

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REPORT

PROJECT

Subsurface Exploration and
Geotechnical Engineering Analysis
Fort Dupont Ice Arena
3779 Ely Place, SE
Washington, DC

CLIENT

Quinn Evans Architects
2121 Ward Place, NW
Washington, DC 20037

PROJECT NO. 37:1383

DATE October 17, 2014

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PROJECT OVERVIEW

Introduction

This report presents the results of our subsurface exploration and geotechnical engineering analysis performed for the proposed Fort DuPont Ice Arena project located at the address of 3779 Ely Place, SE, Washington, DC. This report was prepared in general accordance with ECS Proposal No. 37:553-GPR most recently revised August 12, 2014 and authorized by your office. In preparing this report, we have consulted information from the original subsurface exploration on this particular site and information from nearby sites in the area. Please note this report has been prepared using only the information from the current subsurface exploration and the original subsurface exploration information has been included within this report for informational purposes.

Site Location and Existing Site Conditions

Based on the information provided to us and our site observations, the project site is located at the address of 3779 Ely Place, in Southeast Washington, DC. The subject parcel is partially occupied by the existing Dupont Ice Arena and partially occupied by a parking lot. The site is bound to the north by Ely Place, SE, to the west by the Nationals Youth Baseball Academy, and to the south and east by wooded areas. Existing site grades, obtained from the topographical survey provided to us, range from approximately EL. +119 feet on the west edge of the site to approximately EL. +158 feet on the east side of the site. The site generally slopes upward from west to east across the parking lot from elevation +119 feet to +133. Grades continue to slope upward at approximately 2H:1V to the east from the edge of the parking lot to the building elevation and beyond to elevation +158 feet at the east property line.

Proposed Construction

Based on the preliminary site plan provided to us by you, we understand the project will consist of the design and construction of a new ice arena. We understand the existing estimated 30,000 sf facility will remain in place and be renovated and a new 30,000 sf facility containing one ice rink and associated amenities will be added. The construction of the new facility will be split into phases so at least one ice rink is available for use throughout construction and demolition. The new ice-rink will be built in the existing parking lot (eastern edge) and will be elevated above the at-grade parking, allowing vehicles to park and pass under the structure. The lowest finished floor elevation will be EL. 142 feet and we anticipate existing grades under the structure will remain relatively unchanged (EL. 126 to EL. 130 feet). The proposed arena will also contain office space, locker rooms, storage space, mezzanine viewing areas, kitchen, ancillary rooms, and offices which will be constructed between the new rink and proposed rink. We understand the ice rinks will have a finish floor elevation of approximately +142 feet and west rink will be elevated to allow at grade parking below the structure. The east rink, lobby and ancillary spaces will be built into the hillside where the existing structure is located and will have finish floor elevations of EL. +142 feet with the exception of the lobby area (north side of site) and mechanical room (south side of the site) which will have lowest finished floor elevations of approximately EL. 130 feet. We have shown our current understanding of the building footprints on the Boring Location Diagram which is included in the Appendix. From the information you have provided, we understand interior column loads are on the order of 125 kips, exterior column loads are on the order of 400 kips, and wall loads are on the order of 5 kips per linear foot.

In addition to the proposed ice arena construction, site improvements will include various stormwater management facilities. Although project specifics were not available, we have assumed bio-retention areas to manage stormwater will be included as part of the project; therefore, we performed infiltration testing at 5 locations with an invert elevation of 8 feet below existing site grades.

The description of the project site is based on the information provided by the project team, and the plans provided to us at this time. If any of this information is inaccurate, either due to our misunderstanding or design changes, we recommend we be contacted in order to provide alternative recommendations that may be warranted.

Purpose and Scope of Work

The purpose of this analysis was to develop engineering recommendations to guide the design and construction budgeting of the project based on review of the exploration findings and performing an engineering analyses using the current site plan. We accomplished these purposes by performing the following scope of services:

1. Reviewing the geotechnical reports prepared for adjacent project sites by ECS,
2. Reviewing the original site drawings and soil borings previously performed on the site,
3. Performing eleven soil borings,
4. Performing five, in-situ, infiltration tests,
5. Reviewing laboratory testing performed to determine their engineering properties,
6. Analyzing the field and laboratory data from the exploration to develop appropriate engineering recommendations, and
7. Preparing this geotechnical report of summarizing our findings and recommendations.

ECS recently performed a total of 11 soil borings (referenced as B-1 through B-11) at the project site. Of the borings performed, eight (B-4 through B-11) fall within or close proximity to the proposed building footprint while the remaining three borings (B-1 through B-3) fall within the proposed stormwater management areas. Stormwater management areas may also be installed at the northeast and southeast corners of the existing building (near borings B-4 and B-5). In addition to the borings performed, five auger probes were advanced adjacent to borings B-1 through B-5 for in-situ infiltration testing.

The subsurface exploration included split spoon sampling, Standard Penetration Tests (SPT), groundwater level observations in the boreholes, and in-situ infiltration testing. Laboratory tests were then conducted on selected soils samples to determine certain engineering properties.

Borings were located in the field by ECS personnel measuring from existing site features. We consider the boring locations to be accurate to within ±5 feet of the plan location shown herein. The ground surface elevations were interpolated from the topographical survey provided to ECS. We consider the boring elevations to be accurate to within ±3 feet of actual elevation. The results of the completed soil borings along with a Boring Location Diagram are included in the appendix of this report. We have also included two cross-section profiles (labeled as A-A' and B-B') showing the subsurface conditions through different areas of the proposed development.

EXPLORATION PROCEDURES

Subsurface Exploration Procedures

Soil Borings

The soil borings were performed utilizing an ATV-mounted auger-drilling rig, which utilized continuous flight, hollow stem augers to advance the borehole. Drilling fluid was not used in this process. After completion of the borings, each was backfilled with grout in general accordance with DDOE regulations. The drilling spoils were then containerized and were removed from the site.

Representative soil samples were 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 or 24 inches by means of a 140-pound hammer falling 30 inches. The number of blows required to drive the sampler through the last for the 12-inch interval for 18-inch sample or the middle 12-inch interval for the 24-inch sample 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, visually classified, and placed in glass jars. Representative portions of each sample were (placed in the glass jars) brought to our laboratory for further visual classification and select laboratory testing.

In-Situ Infiltration Testing

At the infiltration test locations, an auger probe boring (no samples taken) was advanced to the approximate infiltration test elevation provided to us by you and a temporary solid PVC pipe was installed and seated near the bottom of the hole to keep the bore hole from collapsing prior to infiltration testing. ECS used the Johnson Permeameter™ to perform a constant head infiltration test which is in general accordance with the publication entitled “DDOE (District Department of the Environment) Stormwater Guidebook, Appendix O.”

Each hole is prepared in general accordance with the information contained in the *Johnson Permeameter™ Instruction Manual* dated June 14, 2014. A schematic of the equipment used is included in the Appendix of this report for reference. The test is then peformed in general accordance with the same manual and the test results are recorded during testing of each location. The final design rate chosen is ultimately the discretion of the design engineer; however, is typically the average of the last three to four readings taken during the test or the last reading, as appropriate, based on the test results. The results of each infiltration test are included in the Appendix of this report for reference.

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 performed included visual classifications, moisture content tests, Atterberg Limits hydrometer, organic content tests, and grain size distribution analysis. USDA classification was performed to aid in the design of the infiltration management areas. The data obtained from the laboratory tests is included in the Appendix of this report.

An engineer/geologist classified each soil sample 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 soil boring logs. The stratification lines designating the interfaces between earth materials on the soil boring logs and profiles are approximate; in situ, the transitions may be gradual, rather than distinct.

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

EXPLORATION RESULTS

Regional Geology

The proposed site is located in the Coastal Plain Physiographic Province of Washington, DC. The near surface soils in the Washington, D.C. area typically consist of man-placed fill soils or natural soils which have been disturbed by previous construction.

Beneath these near surface fill or disturbed soils, Pliocene and Pleistocene river terrace deposits were generally encountered. These deposits vary in their percentages of sand, silt, clay and gravel, both laterally and vertically, and contain localized areas of organics. Beneath the Coastal river terrace deposits, the area is typically underlain by lower and upper Cretaceous, or Potomac Formation soils. The Potomac formation is generally characterized by silty clay beds inter-bedded with irregular sand and gravel lenses.

Soil Conditions

During the time of our exploration, the site consisted of the existing Fort Dupont Ice Arena and the borings were performed in the existing parking lot and grassy areas around the existing structure. The surface materials encountered at the site generally consisted of asphalt pavement approximately 2 to 12 inches thick and topsoil less than 6 inches thick. The subsurface profile can generally be subdivided into three different and distinct strata, (I) Stratum I – Existing Fill, (II) Stratum II – Alluvial Terrace Formation, and (III) Stratum III – Potomac Deposits. The following sections describe each soil strata in more detail and two cross-sections (referenced as A-A’ and B-B’) showing the subsurface conditions are included in the Appendix of this report.

Stratum I – Existing Fill

Fill soils were observed in borings B-2 through B-8, B-10, and B-11 to depths ranging from 2.0± feet to 12± feet below existing site grades. The fill soils typically consisted of varying mixtures of silty sand, sandy clay and silty clay. The existing fills encountered are most likely associated with the construction of the existing ice arena on and around the site and generally appear to be consistent with the original site drawings. SPT N-values in the fill soils varied greatly between 4 blows per foot (bpf) to 33 bpf.

Stratum II – Alluvial River Terrace Deposits (Pleistocene Deposits)

Stratum II was encountered in each of the borings directly beneath the existing fill materials of Stratum I (where encountered) or below the surface cover materials. Stratum II soils generally consisted of various amounts of silt, clay, and sand but were typically classified as Lean CLAY (CL) or Silty/Clayey SAND (SM/SC). The river terrace deposits contained trace (less than 4%) amounts of organics as confirmed by laboratory testing. SPT N-Values with in the Stratum II soils generally ranged from 4 bpf to 20 bpf. Stratum II generally extended to elevations ranging from EL. 96 to EL. 66 feet based on the depths explored.

Stratum III – Potomac Group Formation (Cretaceous Deposits)

Stratum III was encountered directly beneath the Stratum II in the deeper borings; however, was most likely not encountered in the borings terminated at a depth of 60 feet or less. The Potomac deposits generally consisted of clay, and clayey/silty sand (CH/SC/SM) with varying amounts of gravels encountered. SPT N-Values with in the Stratum III soils generally ranged from 30 bpf to greater than 50 bpf.

Groundwater Observations

During the subsurface exploration, the boreholes were observed for the presence of groundwater during drilling, before removal of the augers, and after the removal of the augers prior to grouting. In hollow-stem auger drilling operations, water is not introduced into the boreholes, and the groundwater position can often be determined by observing water flowing into or out of the boreholes. Visual observation of the soil samples retrieved during the auger drilling exploration can often be used in evaluating the groundwater conditions. A summary of groundwater observations is summarized in the table below; however, groundwater was not observed in borings B-1 through B-3.

Table 1: Summary of Groundwater Observations

Boring	Water Level During Drilling (Depth, ft)	Water Level During Drilling (Elevation, ft)	Water Level Before Pulling Augers (Depth, ft)	Water Level Before Pulling Augers (Elevation, ft)
B-1	DRY	DRY	DRY	DRY
B-2	DRY	DRY	DRY	DRY
B-3	DRY	DRY	DRY	DRY
B-4	6.5	87	39	112
B-5	48.5	110.5	57	102
B-6	33.5	111.5	45	100
B-7	23.5	119.5	55	88
B-8	18.5	111.5	67	63
B-9	18.5	115.5	N/A	N/A
B-10	18.5	105	N/A	N/A
B-11	18.5	106.5	N/A	N/A

Variations in the location of the long-term water table may occur as a result of changes in precipitation, evaporation, surface water runoff, and other factors not immediately apparent at the time of this exploration. Free and/or “perched” water may also be encountered at the interface of fill materials and natural soils.

ANALYSIS AND DESIGN RECOMMENDATIONS

Based on our review of the subsurface conditions encountered in the recently completed borings and on our experience in the project area, the site appears suited for the proposed development from a geotechnical perspective. The conclusions and recommendations presented in this report should be incorporated in the design and construction of the project to minimize possible soil and/or foundation related problems during construction; however, only limited details regarding the proposed buildings were provided at this time. Once the design advances further ECS should be provided with the design documents to confirm the recommendations included herein are still applicable and/or provide alternate recommendations (if necessary).

The following sections present more specific recommendations with regard to the design of the proposed building and site improvements. These include recommendations with regard to building foundations, below-grade walls and drainage (if necessary), earthwork, ground slabs, construction dewatering, temporary excavation support, seismic design parameters, and global stability. 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 the earthwork and foundation recommendations presented in this report have been properly interpreted and implemented in the design and specifications. Depending on if a ground improvement method is utilized on the site, the variable fill thickness encountered will be a critical component of the site development.

Foundations

Based on our understanding of the project and the provided estimate of the design loads (exterior column loads on the order of 400 kips and interior column loads on the order of 125 kips), the proposed finished floor elevations (ranging from 130 for the lobby and support areas of the building to 142 for the ice rinks and locker areas) for the development and the soil profile observed in the vicinity of the project site, we recommend that the proposed development be supported on a shallow foundation system consisting of spread and/or continuous footings bearing on natural soils or improved ground as further described below.

As previously noted, existing fills were encountered in a majority of borings within the arena footprint. These fill materials are **not** suitable for support of the building foundations. The manner in which the existing fills were placed is unknown and we therefore consider them to be undocumented. As is typical for most existing fills, we have assumed they were placed in an uncontrolled manner with little to no compactive effort. Therefore, foundations supported on these materials are susceptible to differential settlements, adversely affecting building performance which is why we recommend their removal or ground improvement technique(s) be performed. To limit the risk of settlement problems, we are providing two foundation alternatives for the proposed ice arena.

- Undercut and Replace: One alternative would be to undercut the existing fill at the footing locations (column and wall), extending each to natural soils, and replace the undocumented fill with lean concrete or compacted fill. As described in subsequent paragraphs, the undercut/replace alternative reduces the risk of fill induced settlement issues. As summarized pictorially in the cross-sections developed, it appears undercut and replacement would be necessary for a majority of the south edge of the elevated ice rink, on the order of about 0 to 12 feet. It may be economical to perform a series of test pits around the proposed building footprint to further understand the subsurface conditions (e.g. existing fill depth) and help determine budget estimates. Considering the fill depths at the boring locations, this option may not be the most economical or feasible.

- Intermediate Foundations Supported on Aggregate Piers: Another option which may be more economical is the use of intermediate foundations which would consist of spread footings bearing on densified aggregate piers installed to improve the soil conditions. This will eliminate the need for the removal of the existing fills. Other options (helical anchors, micropiles, etc). are feasible; however, are not included herein as we anticipate aggregate piers a more viable option based on the building loads. Should other options be considered, we should be notified as additional design/construction recommendations can be provided.

- Combination of Both Systems: It is also possible that ground improvement could be used in the deeper fill areas on the western side of the site and traditional shallow footings on the eastern site areas. If this option is chosen, we recommend a series of test pits to delineate the ground improvement zone.

Spread footings should be designed for the bearing pressure outlined below depending on the site conditions encountered and if densified aggregate piers are used. Based on our experience, the decision between undercut and replacement or rammed aggregate piers is typically based on schedule and economics. Either option is suitable from a geotechnical perspective and will have similar structural performance. We therefore recommend both options be considered and discussed further once a general contractor joins the project team.

Spread Footings – Undercut and Replace

Considering the condition of the existing fill, we do not recommend supporting the foundations directly on the existing fill soils with shallow/spread footing foundations, since undesirable total and differential settlements may occur. Therefore, based upon the subsurface information collected during the current exploration, and in light of the anticipated footing elevations (EL. 127± feet), the footings could bear on suitable natural soils of Stratum II, compacted approved soils or lean concrete over suitable nature soils, after the removal and replacement of the existing fill materials underlying foundation areas. Footing undercuts between about 0 to 12 feet should be expected. Footings bearing on these natural materials or engineered fill can be designed with a maximum net allowable bearing pressure of 3,500 pounds per square foot (psf). Undercutting natural soils in some footings by several feet may be required to achieve the design psf bearing values. Where undercutting is required, the foundation subgrade shall be restored with compacted engineered fill or lean concrete (1,000 psi at 28 days) which is allowed to harden before casting the design structural footing. Materials placed as engineered fill below spread footings should be placed in accordance with the recommendations provided in the Fill Placement section of this report

While feasible, this option carries a higher level of difficulty and coordination during construction, along with variable undercuts at each footing, the costs and timing for which may be difficult to budget for. However, we have provided this option for your consideration as an alternative to ground improvements since it may be more economical. If this option is chosen, ECS should be contacted to help coordinate the expected construction design and field undercutting/sequencing. Should this option be chosen, we would also recommend a series of test pits be performed to better understand and estimate the undercut depths throughout the proposed building footprint.

Based on our considerable experience with foundation construction in the Washington Metro area, we recommend ECS be retained to examine all footing subgrades prior to concrete placement. In areas where individual footings are stepped down and founded at different elevations, it is important to provide a minimum slope of 1H:1V between the bottom edges of each foundation at their closest point. Both the drainage layer for the below grade wall and underslab gravel layers should be hydraulically connected in areas were footings are lowered. Please refer to the Appendix of this report for a Zone of Influence Diagram.

Settlement of the structure is a function of the compressibility of the natural soils, the design bearing pressure, column loads, and the elevation of the footing with respect to the original ground surface. We estimate total foundation settlements will be on the order of one inch, with differential settlements about one-half this value. Should the existing fill materials remain in place, the settlement information provided is not accurate and greater total or differential settlements may be observed.

Intermediate Foundations Supported on Aggregate Piers

In order to eliminate the need for undercutting of the existing fill within the footing areas, and to increase the allowable contact pressure of the shallow foundations, we recommend using a ground improvement system consisting of aggregate piers. Densified aggregate piers (DAPs) are a ground improvement technique in which a column of soil is replaced with crushed stone that is densified with vibratory or ramming techniques. Site soils are graded to planned finish floor subgrade levels (approximately), followed by installation of the DAPs and the shallow foundations. The footings are then designed for a bearing pressure appropriate for the densified aggregate pier and remaining soil surrounding the pier. The aggregate piers are extended through existing fill bearing into natural soils and generally consist of 24-inch to 30-inch minimum diameter drilled excavations. The soil reinforcement occurs as a result of the excavation of soft/loose unsuitable soils and replacement by vibrated or compacted dense granular aggregate, such as No. 57, 21A, or 21B.

The aggregate piers can be utilized under the building foundations to support walls and columns. Based on our experience with similar subsurface profiles, we anticipate that an allowable bearing pressure on the order of 4,000 psf to 6,000 psf may be feasible after the installation of aggregate piers.

The drilled aggregate pier system should be designed by a design-build contractor and the proposed soil improvement plan should be reviewed by the Geotechnical Engineer of Record (GER) before construction begins. While design of this system would be performed by others, the design should be such that total and differential settlements would be limited to 1 inch and 0.5 inch, respectively considering the actual building loads. The prospective aggregate pier contractor should be aware of the existing fill materials and be provided with a copy of this report when evaluating the project site. The piers should extend through the existing fill to bear into natural soils.

General

For either option chosen, in order to prevent disproportionately small footing sizes, we recommend that continuous footings have a minimum width of 2.0 feet and that isolated column footings have a minimum lateral dimension of 3.0 feet. The minimum dimensions recommended above help reduce the possibility of foundation bearing failure and excessive settlement due to local shear or "punching" action. **All footings should bear at a minimum depth of 2.5 feet below finished grade;** this footing embedment depth is necessary for the allowable bearing pressure recommended in the subsequent sections and for frost protection.

Based on our past experience with similar projects in this area, uncontrolled groundwater can result in disturbing an otherwise acceptable foundation subgrade. If groundwater is not effectively controlled and lowered at least five feet below the lowest foundation subgrade levels, frequent foundation subgrade undercutting may be needed. In addition to water disturbing the foundation subgrade, the teeth on the machinery excavating the foundations have a potential to disturb the subgrade soils. Therefore, it maybe necessary to either use a flat brimmed bucket on the excavator and/or tamp the surface subgrade soils prior to testing and mud-mat placement.

Floor Slab Design

For the design and construction of the floor slabs of the proposed structure, we recommend the subgrade be prepared in accordance with our recommendations outlined in the sections entitled Subgrade Preparation and Earthwork Operations and Fill Placement, which includes stripping and fill placement recommendations. Although existing fills are not suitable for structural support of the foundations, the existing fills may be suitable for slab support after they are re-worked. Prior to sub-slab stone placement for soil fill (in areas where grades need to be raised), the slab on grade subgrade should be visually observed for soft/loose and/or excessively wet soils and the subgrade should be proofrolled utilizing a fully loaded tandem axle dump truck (minimum axle weight of 10 tons). Before the proofrolling, the subgrade should be densified in place to 95% maximum dry density). Although the existing fills may be suitable for support of the slab loads, the owner/contractor should plan on undercutting these materials where necessary and replacing with engineered fill. In addition to the existing fills, relatively soft natural soils were encountered which may not be suitable for slab support. To determine the thickness of the slab, a modulus of subgrade reaction of 75 kcf can be assumed; however, the slab thickness should not be less than four inches.

After densifying and proofrolling, we recommend any soft or unsuitable materials remaining be removed from slab bearing areas. The stripped area should be observed by the Geotechnical Engineer of Record (GER) or their authorized representative during the time of construction in order to aid in locating all such unsuitable materials, which should be removed. Materials placed as engineered fill below the floor slab should be placed in accordance with the recommendations provided in the Fill Placement section of this report.

We recommend the floor slab be isolated from the foundation footings so differential settlement of the structure will not induce shear stresses in the floor slab. Furthermore, in order to minimize the crack width of any shrinkage cracks that may develop near the surface of the slab, we recommend welded-wire mesh reinforcement be included in the design of the floor slab and we recommend the mesh be in the top half of the slab to be effective. Special attention should be given to the surface curing of the slab in order to minimize uneven drying of the slab and associated cracking.

We also recommend the floor slab be underlain by a minimum of 8 inches of granular material having a maximum aggregate size of 1.5 inches and no more than 2% soil fines passing the No. 200 sieve. The granular layer will facilitate the fine grading of the subgrade and help prevent the rise of water through the floor slab. Prior to placing the granular material, the floor subgrade soil should be properly compacted, proofrolled, and free of standing water, mud, and frozen soil. Before the placement of concrete, a vapor barrier may be placed on top of the granular material to provide additional moisture protection.

Underslab Drainage

We recommend that the below grade areas for the structure be provided with a perimeter and underslab subdrainage system (i.e., a “drained” basement condition). This recommendation applies to all areas within the building footprint that are below existing site grades. A sketch titled “Below-Grade Wall Waterproofing and Underslab Drainage Details” provides a graphical summary of our recommendations and is included in the Appendix. The system may consist of perforated or porous wall, closed joint drain tiles located around the interior perimeter of the below-grade areas, as close as feasible to the exterior wall, below the finished floor level. It is currently unknown if an earth retention system is required for construction, but it is anticipated that “lot line” construction will be used, if necessary. Weep holes (which convey drainage from behind the walls to the underslab subdrainage system) should be placed at a spacing of no greater than 8 feet on center, generally designed to align between the soldier piles of the earth retention system. The weep holes should be a minimum of four inches in diameter, and should freely drain from the exterior drainage medium to be collected by the interior perimeter drain line just inside the base of the wall. The drain lines should be surrounded by a minimum of 6 inches of gravel or clean sand material having a gradation compatible with the size of the opening utilized in the drain lines and the surrounding soils to be retained.

We recommend that the perimeter and underslab drain system for the proposed structure be designed to flow to at least one permanent sump or via gravity to an adjacent storm structure (if feasible). Should gravity not be feasible, we recommend the permanent sump(s) be designed with a full duplex capability (i.e., two pumps per pit), with each individual pump rated at no less than 25 gpm. With this configuration, under emergency conditions, these individual sumps would have the capacity to pump 50 gpm. The contractor should monitor the pumping rate of the construction dewatering system in order to verify that the permanent sump pump has been adequately sized. Smaller or conversely larger pumps may ultimately be needed. Once the plans are further developed, please contact ECS so that we can refine our pumping estimates.

Lateral drain lines under the floor slab should be placed at no more than 60 feet on center. Underslab drain lines should have a minimum diameter of 4 inches, and they should be slotted or appropriately perforated. For the filter fabric we recommend a non-woven product such as Mirafi 140N with an AOS of 70 (U.S. Sieve). An equivalent geotextile fabric can also be used if approved by the Geotechnical Engineer of Record. Clean out access should be installed at all sharp bends and at approximately every 100 feet for straight runs. A grit collection chamber should be installed upstream of the sump to reduce the amount of granular materials reaching the pumps. Drain leaks should be undercut by 2 inches and have 6 inches of cover. Drain lines should be underlain by 2 inches and have 6 inches of cover.

Retaining Walls

Site Retaining Walls

At this time no site retaining walls are shown on the plans; therefore, they are not addressed in our report; however, should walls that are free to rotate at the top be planned, a lateral earth pressure of 50 psf per feet of wall depth can be used for preliminary design. Should site retaining walls be incorporated into the design, we should be notified to provide additional/alternate recommendations for their design and construction.

Below-Grade Walls

At this time we understand there are no anticipated "below-grade levels"; however, due to grade changes on the site, we some walls will be partially buried. Walls should be designed to withstand lateral earth pressures and surcharge loads. Where a below-grade drainage system is utilized that effectively eliminates hydrostatic pressures, we recommend that the below-grade walls be designed for a linearly increasing lateral earth pressure of 60 psf per foot of wall depth. This lateral earth pressure assumes that the below grade walls are fully drained (i.e., hydrostatic pressures) and does not include any surcharge loads. Any surcharge loads imposed within a 45 degree slope of the base of the wall should be considered in the below-grade wall design. The influence of these surcharge loads on the below-grade walls should be based on an at-rest pressure coefficient, k_0, of 0.5. The below-grade walls are recommended to be fully waterproofed as well. A Lateral Earth Pressure (LEP) Diagram-Drained is included in the Appendix of this report. In addition to these recommendations, the General section provides additional information.

General

Suitable man-made drainage materials may be used in lieu of the granular backfill, adjacent to the site retaining and/or below-grade walls. The LEP Diagram provided is applicable where drainage board is used to drain water from the wall and behind the walls. Examples of suitable materials include Enka Mat, Mira Drain, or Geotec Drains. These materials should be covered with a filter fabric having an Apparent Opening Size (AOS) consistent with the size of the soil to be retained. The material should be placed in accordance with the manufacturer's recommendations and should be discharged to a suitable outlet.

If appropriate and where a space exists between the outside of the walls and the excavation, granular backfill may be placed in lieu of manmade drainage material. Granular fill should extend to a level of approximately two feet below the final outside grade. The remaining two feet should consist of a clayey material to reduce the amount of surface water infiltration into the granular material. The ground surface adjacent to the walls should be kept properly graded to prevent ponding of water adjacent to the walls.

Infiltration Test Results and Recommendations

The individual infiltration tests and laboratory testing results are included as an attachment to this report and are summarized in Table 2 on the following page.

Table 2: Field Infiltration Rates

Infiltration Test Location	Depth of Infiltration Test (ft)	USDA Soil Classification at Infiltration Soil Horizon	Moisture Content At Elevation of Infiltration Test (%)	Measured Field Infiltration Rate (in/hr)
I-1	10.25	Sandy Clay Loam	16.5	13.77 [1]
I-2	10.0	Loamy Sand	5.8	14.01 [1]
I-3	10.5	Sandy Clay Loam	13.9	0.00 [2]
I-4	10.0	Sandy Clay Loam	12.5	0.00 [2]
I-5	10.0	Sandy Clay Loam [3]	17.3	0.00 [2]

1. Site conditions are highly variable and the project civil engineer should consider applying a factor of safety to these higher field infiltration rates to account for the different soil horizons encountered.
2. The measured infiltration rate is less than 0.50 in/hr; the project civil engineer should review the enclosed data to determine feasibility of the proposed infiltration facilities.
3. USDA soil classification based upon visual classification only.

Site Seismic Considerations

The subsurface exploration completed for the proposed development included the drilling of 11 borings to depths ranging from 15 to 80 feet below the existing surface elevation. The International Building Code (IBC) 2012 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.

Three methods are utilized in classifying sites, the shear wave velocity (v_s) method; the unconfined compressive strength (s_u) method; and the Standard Penetration Resistance (N-value) method. The Standard Penetration Resistance method was used in classifying this site. Based on our interpretation of IBC 2012 and Section 1613.3.2, the project is defined as “Site Class D” for seismic design considerations. The Site Class definition should not be confused with the Seismic Design Category designation, which the Structural Engineer typically assesses.

In addition to the seismic site class noted above, ECS has determined the design spectral response acceleration parameters following the IBC 2012 methodology. The Mapped Reponses were estimated from the free Java Ground Motion Parameter Calculator available from the USGS website. The design responses for the short and 1-second period (SDS and SD1) are noted at the far right end of the Table 3.

Table 3: Ground Motion Parameters (IBC 2012 Method)

Period (sec)	Mapped Spectral Response Accelerations (g)	Values of Site Coefficient for Site Class D	Maximum Spectral Response Acceleration Adjusted for Site Class (g)	Design Spectral Response Acceleration (g)
Reference	Figures 1613.3.1 (1) & (2)	Tables 1613.3.3 (1) & (2)	Eqs. 16-37 & 16-38	Eqs. 16-39 & 16-40

Period (sec)	**Mapped Spectral Response Accelerations (g)**		**Values of Site Coefficient for Site Class D**		**Maximum Spectral Response Acceleration Adjusted for Site Class (g)**		**Design Spectral Response Acceleration (g)**	
0.2	S_S	0.118	F_a	1.6	S_{MS}	0.189	***S_{DS}***	*0.126*
1.0	S_1	0.051	F_v	2.4	S_{M1}	0.122	***S_{D1}***	*0.081*

Underpinning Considerations

Based on the proximity of the proposed structure footings to the existing structure, we anticipate some of these structures will be within a 1H:1V zone of influence of the proposed construction. Depending on the site specific constraints of the project including the foundations of the existing building, traditional underpinning methods such as pits, support walls, or micropiles, etc. may be necessary. Footings of the existing adjacent structure may need to be protected against undermining during excavation of this site, depending on the existing building's foundation type and lowest building level; however, should be studied by the project structural engineer. Special protection is not required if the footings of the existing building are outside a 3H:1V slope up from the bottom of the new footings. These criteria should also be maintained for existing utilities and for adjacent footings within the new construction.

PROJECT CONSTRUCTION RECOMMENDATIONS

Subgrade Preparation and Earthwork Operations

Initial preparation of the site should consist of complete removal of any existing building elements to be demolished during construction, building foundations, pavements, sidewalks, and abandoned utilities as well as any trees, shrubs, and other deleterious organic or refuse material. Further excavation to the design subgrade level should be limited to about 1 foot above the design subgrade for the lowest level subgrade elevation. This remaining 1-foot of material should remain in place during foundation installation just until the slab is ready for placement. This can reduce the amount of subgrade undercutting necessary due to disturbance from construction activities.

As previously stated, existing fills were encountered and will most likely be present throughout the site below the slab of the proposed building. Based on the borings performed, undercut and replacement of the existing fills should be anticipated in slab areas to remove any wet/loose materials encountered. In addition, the existing fills are **not** suitable for foundation support and the contract/owner should budget for removal and replacement of these materials prior to grading operation should the rammed aggregate pier alternative not be selected. The presence of wet/loose soils should be confirmed by the GER using both visual observations of the subgrade as well as observing the proofrolling of the slab subgrade areas. Proofrolling should be performed using a dump truck with a minimum axle weight of 10 tons. Footings will require 100% undercut of fill soils, except in case where an alternative foundation support system is used (such as aggregate piers). Should excessively soft subgrade materials be encountered it may be necessary to use reinforcing geogrids/geotextiles (e.g. Mirafi HP270 or HP570) on the slab subgrade to support the slabs or pavements. Unit prices for additional stone and reinforcing grids/fabrics should be established prior to commencing construction.

Fill Placement

Engineered fills are anticipated for the project and all engineered fill should consist of an approved material (approved by the GER), free of organic matter and debris, cobbles greater than 4-inches, and have a Liquid Limit and Plasticity Index less than 40 and 20, respectively. Unacceptable engineered fill materials include topsoil and organic materials (OH, OL), and high plasticity silts and clays (CH, MH). Under no circumstances should high plasticity soils be used as engineered fill material. Wall (retaining walls or below-grade walls) backfill will require a maximum Liquid Limit and Plasticity Index of 40 and 15, respectively. Undercuts beneath footings should be replaced with lean concrete or approved engineered fill.

Based on the materials encountered during the subsurface exploration, a majority of the on-site soils will not be suitable for reuse as engineered fill or will be difficult to work with due to their moisture sensitive properties. Alternative sources for engineered fill materials will most likely be necessary for grading of the site. The use of lime or similar materials may be a suitable alternative to manipulate the onsite soils so they are suitable for reuse; however, based on the working area for this property, use of lime or similar materials is most likely not an economical alternative. Should this option be considered, ECS can provide additional information upon your request.

Engineered fill materials should be placed in lifts not exceeding 8-inches in loose thickness and moisture conditioned to within ±2 percentage points of the optimum moisture content. Soil bridging lifts should not be used, since excessive settlement of overlying structures will likely occur. Controlled engineered fill soils should be compacted to a minimum of 95% of the maximum dry density obtained in accordance with ASTM Standard D-698, Standard Proctor Method. However, the upper one foot of engineered fill soils supporting pavements, sidewalks, or gutters should be compacted to a minimum of 100% of the maximum dry density obtained in accordance with ASTM Standard D-698.

To minimize excessive pressures against the below-grade walls and to reduce the settlement of the wall backfill, it is recommended the wall backfill (if required) be compacted to 95% of the maximum dry density determined in accordance with ASTM Standard D-698, Standard Proctor Method. Heavy earthwork equipment should maintain a minimum horizontal distance away from the below-grade walls of 1 foot per foot of vertical wall height. Lighter compaction equipment should be used close to the below-grade walls.

The footprint of the proposed pavement and engineered fill areas should be well defined, including the limits of the engineered fill zones at the time of engineered fill placement. Grade control should be maintained throughout the engineered fill placement operations. All engineered fill operations should be observed on a full-time basis by the GER or their authorized representative to determine the compaction requirements specified are being met. A minimum of one compaction test per 2,500 square-foot 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 engineered fill should be used to compact the engineered 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 engineered fill should be graded to facilitate positive drainage from the building pad and pavement areas of any free water associated with precipitation and surface runoff.

Prior to the commencement of fill operations and/or utilization of any off-site borrow materials, the GER should be provided with representative samples to determine the material’s suitability for use in a controlled compacted fill and to develop moisture-density relationships (minimum of 5-days prior to use). In order to expedite the earthwork operations, if off-site borrow materials are required for use as engineered fill, it is recommended they consist of a select granular material which will provide suitable support and be easily compacted and well drained.

Engineered fill materials should not be placed on frozen soils or frost-heaved soils and/or soils that have been recently subjected to precipitation. All frozen soils should be removed prior to continuation of fill operations. Borrow fill materials, if required, should not contain frozen materials at the time of placement. All frost-heaved soils should be removed prior to placement of controlled, compacted fill, granular subbase materials, foundation or slab concrete, and asphalt pavement materials.

Earth Retention System and Adjacent Construction Monitoring

At this time we do not anticipate an earth retention system or adjacent construction monitoring will be necessary. However, should it be required, a free draining system consisting of soldier piles and wood lagging is recommended. The system should be braced externally using tiebacks, if possible. Spacing of the soldier piles and braces should be determined by a structural analysis. However, we recommend that the maximum center line to center line spacing of the soldier piles not exceed 8 feet. In addition, wooden lagging should have a minimum thickness of 3 inches. The final design of the system should be performed by a specialist in this area and is not part of the scope of this report. The earth retention system should be designed for both global stability as well as stability at the face of the excavation.

The temporary earth retention system should allow for “stepping down” of the perimeter footings to a maximum of 5 feet below the proposed bearing elevations. In this way, in the event that a step down is required, construction difficulties can be avoided with regard to undermining the installed soldier beams when the footing is being placed.

If tiebacks are used, we recommend a “performance test” be performed on 10% of randomly selected tiebacks (or a minimum of three tiebacks, whichever is greater). The performance test evaluates the tieback load carrying capacity, deflections during loading, and movements with respect to time. The tieback capacity should be considered adequate when a stable condition is obtained under a particular test load for a duration of 15 minutes. In addition, we recommend that each tieback be “proof tested” to at least 120% of its design load.

In areas where tiebacks are not feasible, an internal bracing system of rakers would be required. Rakers should be braced against toe blocks or other reaction points that have been designed to carry the load.

The contractor should avoid stockpiling excavated materials immediately adjacent to the excavation walls. We recommend that stockpile materials be kept back from the excavation a minimum distance equal to one-half the excavation depth to avoid 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 loading.

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. Jack calibration data for any equipment utilized to tension tieback anchors. Calibration records must be current within a 12 month period of the time of anchor stressing.

6. Proposed Performance Test Locations and elevations (for tieback anchors).

7. If not stated on the plans, the method of soldier 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

1. 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 (±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:

   - Once to twice weekly during the excavation and construction of all below grade levels.

- Monitoring frequency will remain at once to twice per week until the structural engineer (SER) 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, or a weekly or twice monthly basis.

Adjacent Construction and Monitoring

Footings of adjacent structures may need to be protected against undermining during excavation of this site, depending on the adjacent building's foundation type and lowest building level. Evaluating underpinning requirements for this project was not within our scope of services. Special protection is not required if the footings of the existing building are outside a 3H:1V slope up from the bottom of the new footings. These criteria should also be maintained for existing utilities and for adjacent footings within the new construction.

Because of the proximity of adjacent structures and roadways, we recommend that a preconstruction survey of the adjacent structures be performed prior to excavation and building activities. We recommend that the adjacent buildings be monitored for settlement and deflection by implementing a three-dimensional/settlement monitoring program during dewatering and construction operations. The monitoring program should consist of monitoring the support of excavation (SOE) and adjacent structures to the below-grade construction for lateral movement and settlement during construction.

Any buildings within a 3H:1V zone of influence from the edge of excavation and dewatering system should be monitored for settlement and lateral deflection during construction. The installation of a minimum number of three-dimensional monitoring points should be considered. Typically, the monitoring points are created by taking ongoing survey shots, periodically during the construction dewatering, excavation and construction to grade to see if there are any building impacts.

Our experience in this area has indicated that settlement due to temporary dewatering operations is not a major concern. However, settlements induced from lateral deformation of the temporary earth retention system can cause significant settlement of adjacent structures. 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 dismissed. We are capable of providing monitoring of the braced excavation system at this site, as well as adjacent structures, for lateral and vertical movements during construction. We would be pleased to provide these services, as well as adjacent settlement monitoring services, during construction.

Underpinning

Based on the proximity of the proposed construction to the existing ice arena building, some of the existing foundations may be within a 1H:1V zone of influence of the proposed construction. Depending on the site specific constraints of the project including the foundations of the surrounding buildings, traditional underpinning methods such as pits, support walls, or micropiles, etc. may be necessary. Evaluating underpinning requirements are beyond the scope of this analysis. We recommend that structures founded within the zone of influence be reviewed by the structural engineer to determine if underpinning prior to the final design.

Construction Dewatering

As noted previously in this report, groundwater was encountered in eight of the eleven borings performed and where encountered, it was below the site development limits. We anticipate construction phase dewatering operations can be handled by the use of conventional sump pit and pump operations in conjunction with trenching. It may be necessary to use several sump pits and pumps around the site along with temporary trenches or french drains consisting of free draining granular stone wrapped in filter fabric to direct the flow of water and to remove water from the excavation. A French Drain installation detail is included in the Appendix of this report for reference. We recommend that the sump pits be established at an elevation at least 2 to 3 feet below the design footing subgrade elevation on the excavation. A perforated 55 gallon drum, or other temporary structures could be used to house the pump. Regardless of the water control techniques ultimately selected, the soils at the design subgrade elevation will be both water and disturbance sensitive. ECS should be retained to review the final dewatering system chosen.

Pavement Recommendations

For the design and construction of exterior pavements, we recommend the subgrade be prepared following the recommendations included in the previous sections of this report. The stripped surface should be proofrolled and carefully observed by the GER at the time of construction in order to aid in identifying the localized soft or unsuitable materials, which would be removed. In addition, the guidelines provided in the section entitled Subgrade Preparation and Earthwork Operations should be followed. A the time of subgrade preparation, additional laboratory testing, consisting of California Bearing Ratio (CBR) and Atterberg limit tests, should be performed on representative subgrade materials in the proposed pavement areas to confirm final design of these pavements prior to installation.

CBR testing was not performed during the previous exploration; however, based on the materials encountered, and our experience with similar soils, we recommend a design CBR value of 6 be used for **preliminary** design. We recommend CBR samples be obtained within the upper 12 inches of the subgrade soils during construction for final pavement design. The value(s) obtained during construction should be used to confirm and/or change the design of the pavements. If the results of the CBR tests performed during construction differ from that mentioned above, the pavement design should be modified as necessary. Pavements and subgrades should have a minimum cross-slope of 2% and where the pavement base course does not daylight, underdrains should be installed on the low side of pavements.

The pavement recommendations provided herein are for preliminary planning purposed only. A detailed pavement design and analysis is required to be performed by the site civil engineer prior to construction.

Temporary and Permanent Slopes

Temporary slopes constructed of on-site native clayey soils or cut slopes should be limited to a maximum gradient of approximately 2.5H:1V. The GER should be retained to review any such slopes prior to construction. The temporary slopes should also be thoroughly vegetated to help minimized erosion of the surficial soils. Permanent slopes constructed of native soils should generally be flatter than 3H:1V. Any fill slopes steeper than 3H:1V should be evaluated for stability, and may require additional reinforcement in order to maintain stability. These slopes should be designed by a geotechnical engineer. Small landscape beams may be as steep as 1.5H:1V but should be compacted as structural fill and thoroughly vegetated immediately upon completion. All temporary and permanent slopes should be aggressively protected, such as by seeding and mulching as soon as possible after placement, to prevent from sloughing and erosion.

Closing

In addition to geotechnical engineering services, ECS Capitol Services, PLLC has the in-house capability to perform multiple additional services as this project moves forward. These services include the following:

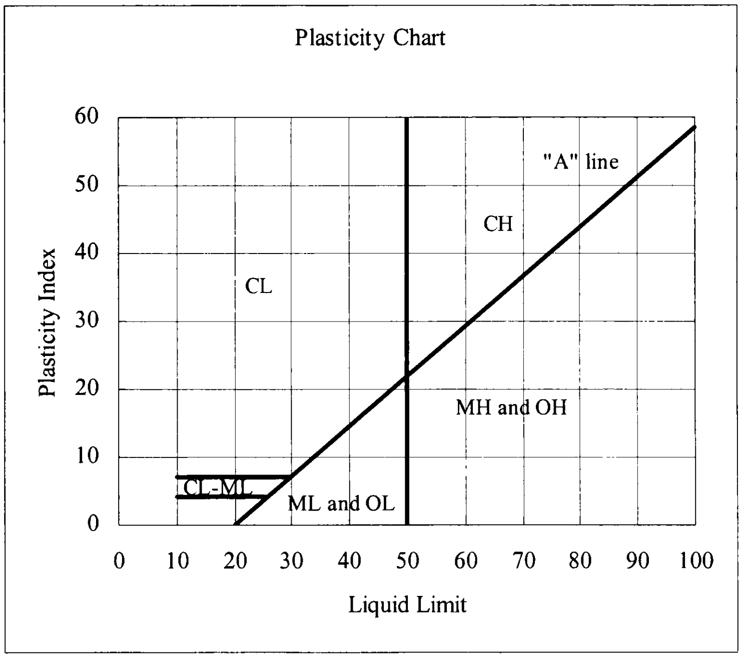
- Environmental Consulting;
- Pre-Construction and Post-Construction Surveys;
- 3-D Monitoring of the SOE and adjacent structures;
- Construction Material Testing / Special Inspections; and,
- Third Party Inspections / Code Compliance for MEP, Elevators, etc.

We would be pleased to provide these services for you. If you have any questions with regard to this information or need any further assistance during the design and construction of the project please feel free to contact us.

This report only provides recommendations for early design and early construction planning and ECS should be provided with the design documents as the project progresses to confirm the recommendations included herein are applicable. Depending on the final building layout/elevation, additional/alternate recommendations may apply.

APPENDIX

UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D 2487)

Major Divisions			Group Symbols		Typical Names	Laboratory Classification Criteria		
Coarse-grained soils (More than half of material is larger than No. 200 Sieve size)	Gravels (More than half of coarse fraction is larger than No. 4 sieve size)	Clean gravels (Little or no fines)	GW		Well-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: 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[b]	$C_u = D_{60}/D_{10}$ greater than 4 $C_c = (D_{30})^2/(D_{10}xD_{60})$ between 1 and 3	
			GP		Poorly graded gravels, gravel-sand mixtures, little or no fines		Not meeting all gradation requirements for GW	
		Gravels with fines (Appreciable amount of fines)	GM[a]	d	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
				u				
			GC		Clayey gravels, gravel-sand-clay mixtures		Atterberg limits below "A" line or P.I. less than 7	
	Sands (More than half of coarse fraction is smaller than No. 4 sieve size)	Clean sands (Little or no fines)	SW		Well-graded sands, gravelly sands, little or no fines		$C_u = D_{60}/D_{10}$ greater than 6 $C_c = (D_{30})^2/(D_{10}xD_{60})$ between 1 and 3	
			SP		Poorly graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for SW	
		Sands with fines (Appreciable amount of fines)	SM[a]	d	Silty sands, sand-silt mixtures		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
				u				
			SC		Clayey sands, sand-clay mixtures		Atterberg limits above "A" line with P.I. greater than 7	
Fine-grained soils (More than half material is smaller than No. 200 Sieve)	Silts and clays (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	 Plasticity Chart		
			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			
	Silts and clays (Liquid limit greater than 50)		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			
	Highly Organic soils		Pt		Peat and other highly organic soils			

[a] 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.

[b] 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)

Density		*Relative Properties*	
Under 4 blows/ft	Very Loose	Adjective Form	12% to 49%
5 to 10 blows/ft	Loose	With	5% to 12%
11 to 30 blows/ft	Medium Dense		
31 to 50 blows/ft	Dense		
Over 51 blows/ft	Very Dense		

		Particle Size Identification
Boulders		8 inches or larger
Cobbles		3 to 8 inches
Gravel	Coarse	1 to 3 inches
	Medium	½ to 1 inch
	Fine	¼ to ½ 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)

Blows/ft	*Consistency*	*Unconfined Comp. Strength Q_p (tsf)*	*Degree of Plasticity*	*Plasticity Index*
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 Quinn Evans Architects	JOB # 37:1383	BORING # B-1	SHEET 1 OF 1
PROJECT NAME Fort DuPont Ice Arena	ARCHITECT-ENGINEER Quinn Evans Architects		
SITE LOCATION 3779 Ely Place, SE, Washington, District of Columbia			
NORTHING	EASTING	STATION	

-○- CALIBRATED PENETROMETER TONS/FT²

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

PLASTIC LIMIT% ✕ WATER CONTENT% ● LIQUID LIMIT% △

⊗ STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

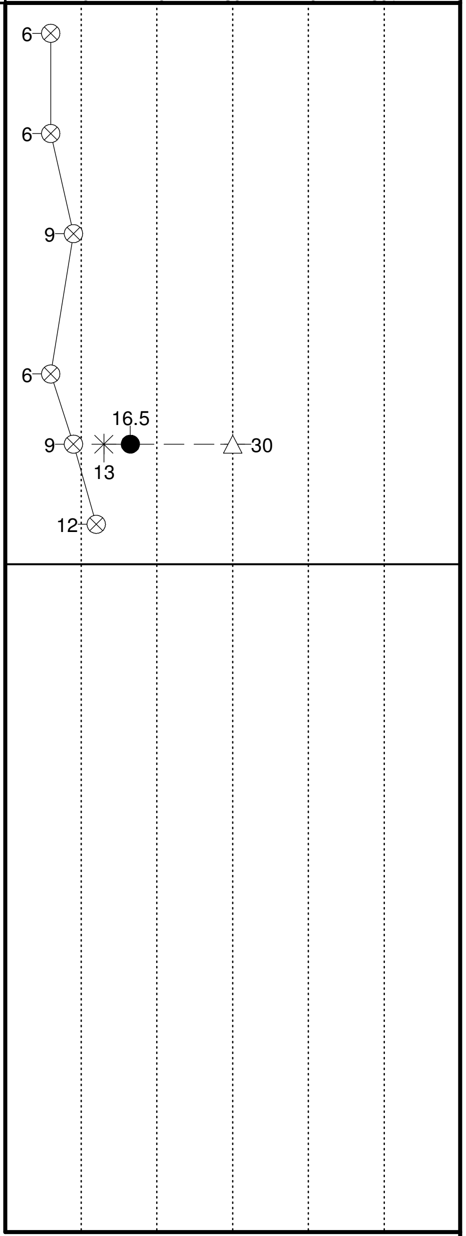
BOTTOM OF CASING — LOSS OF CIRCULATION

SURFACE ELEVATION 117.5

SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	BLOWS/6"
				Asphalt Depth [10"]	
S-1	SS	18	8	(CL) SILTY CLAY WITH SAND, Trace Gravel, Contains Trace Organics, Brown, Moist, Medium Stiff to Stiff	2 3 3
S-2	SS	18	0		3 3 3
S-3	SS	18	16		5 4 5
S-4	SS	18	12		3 3 3
S-5	SS	24	16	(SC) CLAYEY SAND, Tan and Red, Moist, Loose to Medium Dense	2 5 4 5
S-6	SS	24	14		3 5 7 5
				END OF BORING @ 14.00'	

DEPTH (FT): 0, 5, 10, 15, 20, 25, 30

ELEVATION (FT): 115, 110, 105, 100, 95, 90



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

WL WS☐ WD☐	BORING STARTED 09/03/14	
WL(BCR) WL(ACR)	BORING COMPLETED 09/03/14	CAVE IN DEPTH @ 14.00'
WL	RIG CME 75 FOREMAN J. Martinez	DRILLING METHOD 2.25 HSA

CLIENT	JOB #	BORING #	SHEET
Quinn Evans Architects	37:1383	B-2	1 OF 1

PROJECT NAME: Fort DuPont Ice Arena

ARCHITECT-ENGINEER: Quinn Evans Architects

SITE LOCATION: 3779 Ely Place, SE, Washington, District of Columbia

NORTHING

EASTING

STATION

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ➡ LOSS OF CIRCULATION

SURFACE ELEVATION 119

-○- CALIBRATED PENETROMETER TONS/FT^2

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

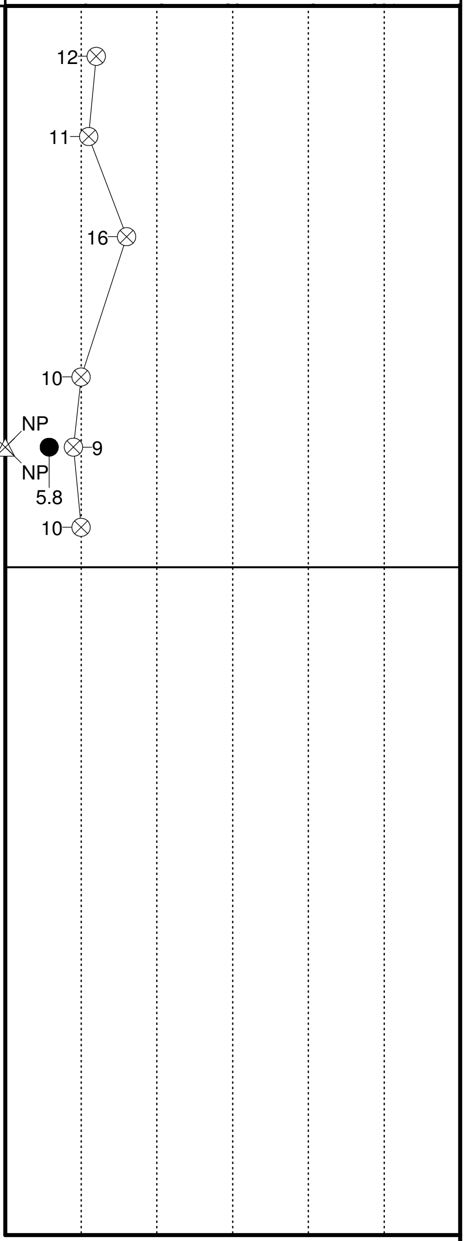
PLASTIC LIMIT% ✕ WATER CONTENT% ● LIQUID LIMIT% △

⊗ STANDARD PENETRATION BLOWS/FT

SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	BLOWS/6"
				Asphalt Depth [6"]	
S-1	SS	18	16	(SM FILL) SILTY SAND, Trace Gravel,Trace Clay, Brown, Moist, Medium Dense	3 5 7
S-2	SS	18	18	(CL) SILTY CLAY WITH SAND, Trace Gravel, Contains Trace Organics, Brown, Moist, Stiff to Very Stiff	3 5 6
S-3	SS	18	14		4 8 8
S-4	SS	18	16	(SM) SILTY SAND, Trace Clay, Tan and Red, Moist, Loose	4 5 5
S-5	SS	24	16		4 5 4 7
S-6	SS	24	18		6 5 5 7
				END OF BORING @ 14.00'	

DEPTH (FT): 0, 5, 10, 15, 20, 25, 30

ELEVATION (FT): 115, 110, 105, 100, 95, 90



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

WL WS ☐ WD ☐	BORING STARTED 09/03/14	
WL(BCR) WL(ACR)	BORING COMPLETED 09/03/14	CAVE IN DEPTH @ 14.00'
WL	RIG CME 75 FOREMAN J. Martinez	DRILLING METHOD 2.25 HSA

CLIENT Quinn Evans Architects	JOB # 37:1383	BORING # B-3	SHEET 1 OF 1
PROJECT NAME Fort DuPont Ice Arena	ARCHITECT-ENGINEER Quinn Evans Architects		
SITE LOCATION 3779 Ely Place, SE, Washington, District of Columbia			
NORTHING	EASTING	STATION	

-○- CALIBRATED PENETROMETER TONS/FT²

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

PLASTIC LIMIT% ✕ WATER CONTENT% ● LIQUID LIMIT% △

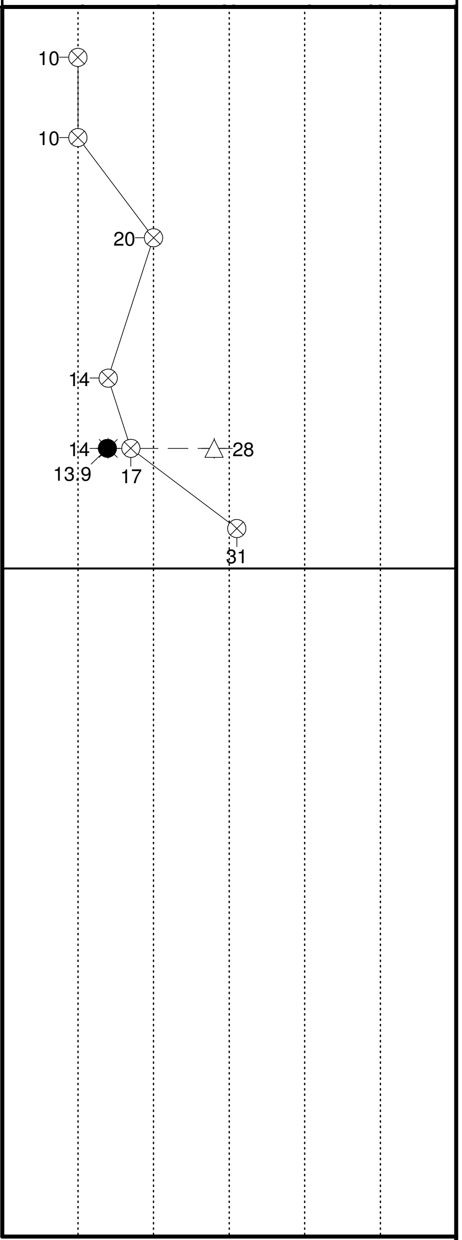
⊗ STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL ENGLISH UNITS

BOTTOM OF CASING LOSS OF CIRCULATION

SURFACE ELEVATION 120

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0					Asphalt Depth [6"]		120	
	S-1	SS	18	8	(SM FILL) SILTY SAND, Trace Gravel,Trace Clay, Brown, Moist, Loose			4 5 5
	S-2	SS	18	16	(CL) SILTY CLAY WITH SAND, Trace Gravel, Contains Trace Organics, Brown, Moist, Stiff to Very Stiff			3 4 6
5	S-3	SS	18	18			115	3 10 10
					(CL) SANDY LEAN CLAY, Tan and Red, Moist, Stiff to Hard			
	S-4	SS	18	16				6 7 7
10	S-5	SS	24	18			110	4 7 10 11
	S-6	SS	24	18				7 16 15 12
					END OF BORING @ 14.00'			
15							105	
20							100	
25							95	
30							90	



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

WL WS ☐ WD ☐	BORING STARTED 09/03/14	
WL(BCR) WL(ACR)	BORING COMPLETED 09/03/14	CAVE IN DEPTH @ 14.00'
WL	RIG CME 75 FOREMAN J. Martinez	DRILLING METHOD 2.25 HSA

CLIENT	JOB #	BORING #	SHEET
Quinn Evans Architects	37:1383	B-4	1 OF 3

PROJECT NAME: Fort DuPont Ice Arena

ARCHITECT-ENGINEER: Quinn Evans Architects

SITE LOCATION: 3779 Ely Place, SE, Washington, District of Columbia

NORTHING

EASTING

STATION

-○- CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY

RQD% — — — REC% ———

PLASTIC LIMIT% ✕ — WATER CONTENT% ● — LIQUID LIMIT% △

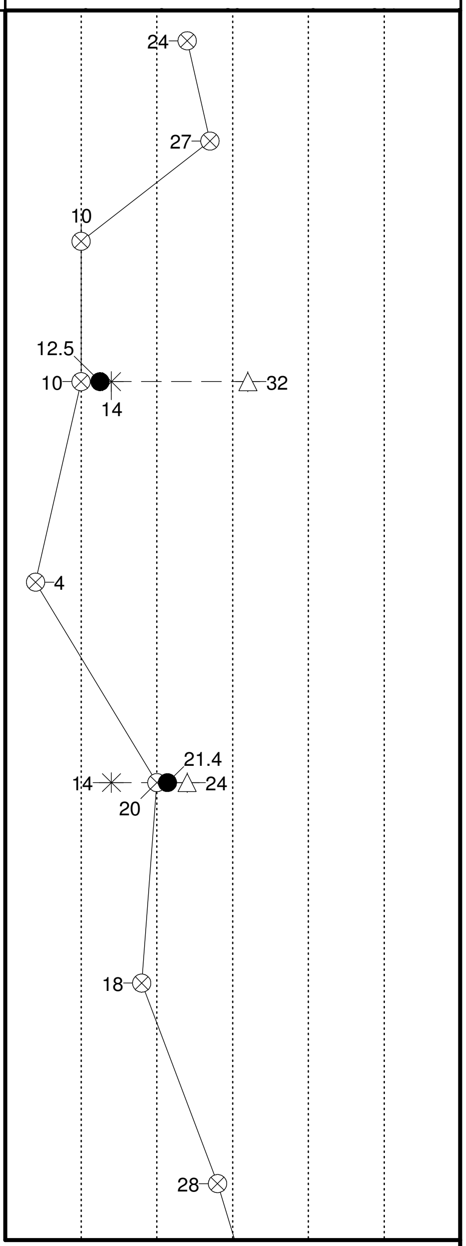
⊗ STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ➤ LOSS OF CIRCULATION

SURFACE ELEVATION 151

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0	S-1	SS	18	14	Topsoil Depth [3"] (SM FILL) SILTY SAND, Trace Gravel,Trace Clay, Brown, Moist, Loose to Medium Dense		150	5 10 14
	S-2	SS	18	16				14 14 13
5	S-3	SS	18	18		▽	145	5 5 5
	S-4	SS	18	12	(SC) Clayey Sand, Trace Gravel, Contains Trace Organics, Brown, Moist, Soft to Stiff			6 5 5
10							140	
	S-5	SS	18	3				2 2 2
15							135	
	S-6	SS	18	6	(CL) SILTY CLAY WITH SAND, Trace Gravel, Contains Trace Organics, Brown, Moist, Very Stiff			6 10 10
20							130	
	S-7	SS	18	18	(SM) SILTY SAND, Tan and Reddish Brown, Wet, Medium Dense to Dense			4 6 12
25							125	
	S-8	SS	18	18				4 10 18
30								



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

▽ WL 6.50 WS ☐ WD ☐	BORING STARTED 09/05/14	
▽ WL(BCR) 39.00 ▼ WL(ACR)	BORING COMPLETED 09/05/14	CAVE IN DEPTH
▽ WL	RIG CME 75 FOREMAN Zach M.	DRILLING METHOD 3.25 HSA

CLIENT	JOB #	BORING #	SHEET
Quinn Evans Architects	37:1383	B-4	2 OF 3

PROJECT NAME: Fort DuPont Ice Arena

ARCHITECT-ENGINEER: Quinn Evans Architects

SITE LOCATION: 3779 Ely Place, SE, Washington, District of Columbia

NORTHING

EASTING

STATION

-○- CALIBRATED PENETROMETER TONS/FT^2

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

PLASTIC LIMIT% ✕   WATER CONTENT% ●   LIQUID LIMIT% △

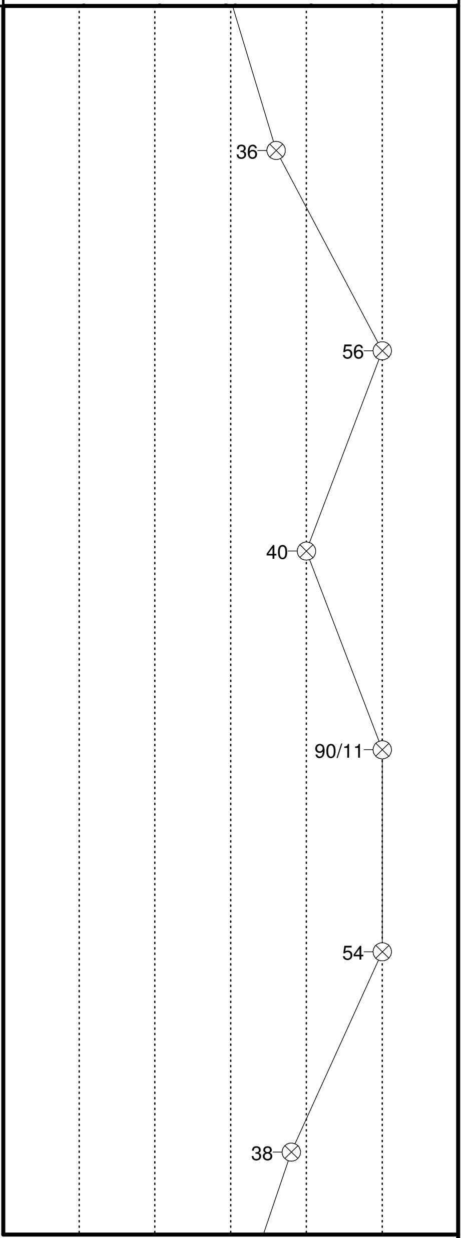
⊗ STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ➤   LOSS OF CIRCULATION

SURFACE ELEVATION 151

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
					(SM) SILTY SAND, Tan and Reddish Brown, Wet, Medium Dense to Dense		120	
	S-9	SS	18	18				9 17 19
35								
							115	
					(SC) CLAYEY SAND, Tan and Red, Moist, Dense to Very Dense			
						▽		
	S-10	SS	18	18				11 20 36
40								
							110	
	S-11	SS	18	18				12 26 14
45								
							105	
	S-12	SS	17	17				11 40 50/5
50								
							100	
	S-13	SS	18	18				5 22 32
55								
							95	
					(CH) SILTY CLAY WITH SAND, Reddish Brown, Moist, Very Stiff to Hard			
	S-14	SS	18	10				6 15 23
60								
							90	



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

▽ WL 6.50 WS ☐ WD ☐	BORING STARTED 09/05/14	
▽ WL(BCR) 39.00 ▼ WL(ACR)	BORING COMPLETED 09/05/14	CAVE IN DEPTH
▽ WL	RIG CME 75 FOREMAN Zach M.	DRILLING METHOD 3.25 HSA

CLIENT
Quinn Evans Architects

JOB #
37:1383

BORING #
B-4

SHEET
3 OF 3

PROJECT NAME
Fort DuPont Ice Arena

ARCHITECT-ENGINEER
Quinn Evans Architects

SITE LOCATION
3779 Ely Place, SE, Washington, District of Columbia

NORTHING

EASTING

STATION

-○- CALIBRATED PENETROMETER TONS/FT^2

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

PLASTIC LIMIT% ✕   WATER CONTENT% ●   LIQUID LIMIT% △

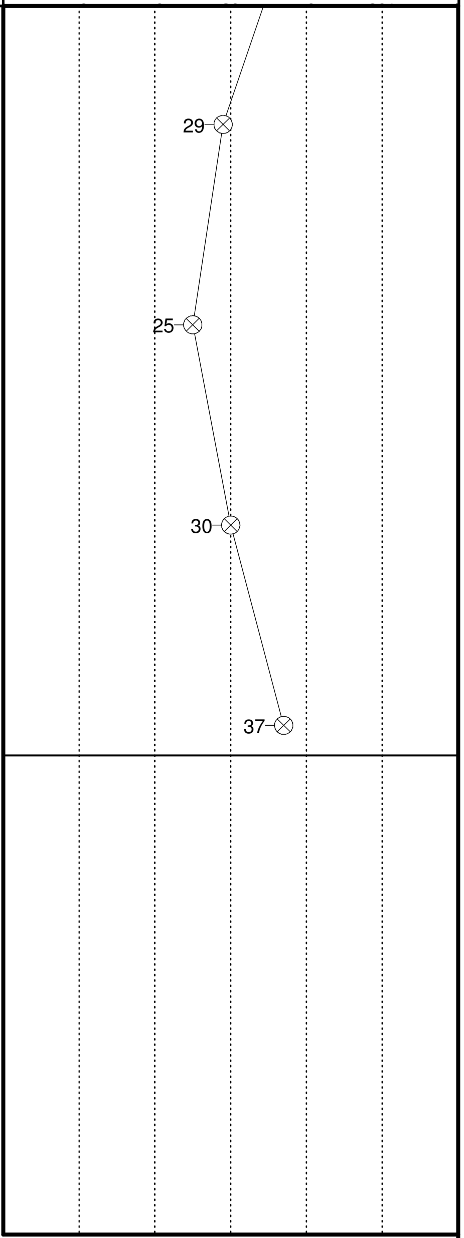
⊗ STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL   ENGLISH UNITS

BOTTOM OF CASING   LOSS OF CIRCULATION

SURFACE ELEVATION 151

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
					(CH) SILTY CLAY WITH SAND, Reddish Brown, Moist, Very Stiff to Hard			
	S-15	SS	18	18				7 12 17
65							85	
	S-16	SS	18	18				7 10 15
70							80	
	S-17	SS	18	18				7 12 18
75							75	
	S-18	SS	18	18				8 15 22
80					END OF BORING @ 80.00'		70	
85							65	
90							60	



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

WL 6.50   WS ☐   WD ☐

BORING STARTED 09/05/14

WL(BCR) 39.00   WL(ACR)

BORING COMPLETED 09/05/14

CAVE IN DEPTH

WL

RIG CME 75   FOREMAN Zach M.

DRILLING METHOD 3.25 HSA

CLIENT	JOB #	BORING #	SHEET
Quinn Evans Architects	37:1383	B-5	1 OF 2

PROJECT NAME: Fort DuPont Ice Arena

ARCHITECT-ENGINEER: Quinn Evans Architects

SITE LOCATION: 3779 Ely Place, SE, Washington, District of Columbia

NORTHING

EASTING

STATION

-○- CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY

RQD% – — –   REC% ———

PLASTIC LIMIT% ✕   WATER CONTENT% ●   LIQUID LIMIT% △

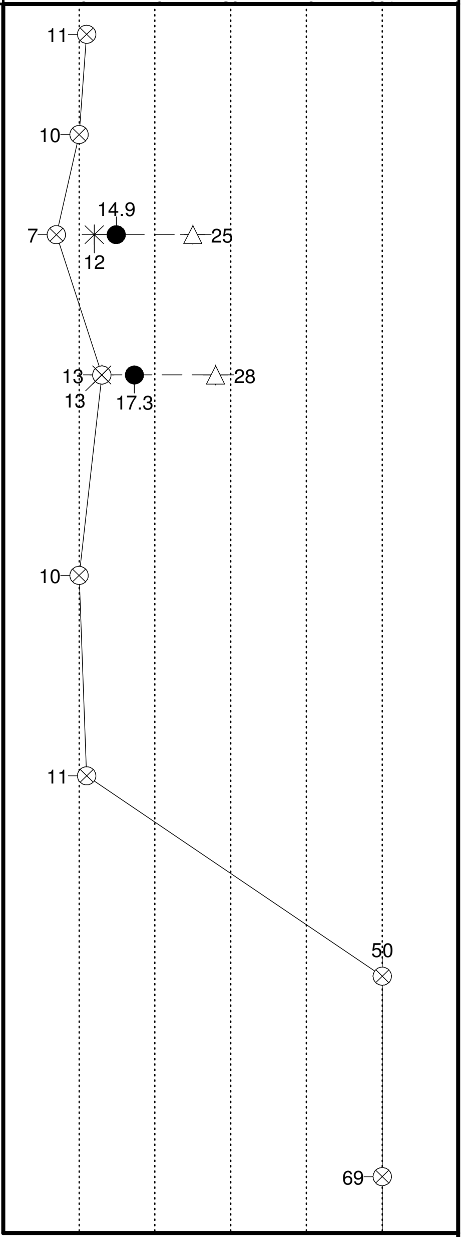
⊗ STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL   ENGLISH UNITS

BOTTOM OF CASING   LOSS OF CIRCULATION

SURFACE ELEVATION 159

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0	S-1	SS	18	14	Topsoil Depth [5"] (SM FILL) SILTY SAND, Trace Gravel,Trace Clay, Brown, Moist, Medium Dense			3 5 6
	S-2	SS	18	18	(CL) LEAN CLAY WITH SAND, Trace Gravel, Contains Trace Organics, Brown, Moist, Medium Stiff to Stiff			3 5 5
							155	
5	S-3	SS	18	18				3 4 3
	S-4	SS	18	18			150	3 6 7
10								
	S-5	SS	18	12			145	4 5 5
15								
	S-6	SS	18	18			140	3 5 6
20								
					(SM) SILTY SAND, Tan and Reddish Brown, Wet, Dense to Very Dense			
	S-7	SS	18	18			135	18 22 28
25								
	S-8	SS	18	18			130	11 22 47
30								



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

WL 48.50 WS ☐ WD ☐	BORING STARTED 09/05/14	
WL(BCR) 57.00 WL(ACR)	BORING COMPLETED 09/05/14	CAVE IN DEPTH
WL	RIG CME 75 FOREMAN Zach M.	DRILLING METHOD 3.25 HSA

CLIENT	JOB #	BORING #	SHEET
Quinn Evans Architects	37:1383	B-5	2 OF 2

PROJECT NAME: Fort DuPont Ice Arena

ARCHITECT-ENGINEER: Quinn Evans Architects

SITE LOCATION: 3779 Ely Place, SE, Washington, District of Columbia

NORTHING

EASTING

STATION

-○- CALIBRATED PENETROMETER TONS/FT^2

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

PLASTIC LIMIT% × WATER CONTENT% ● LIQUID LIMIT% △

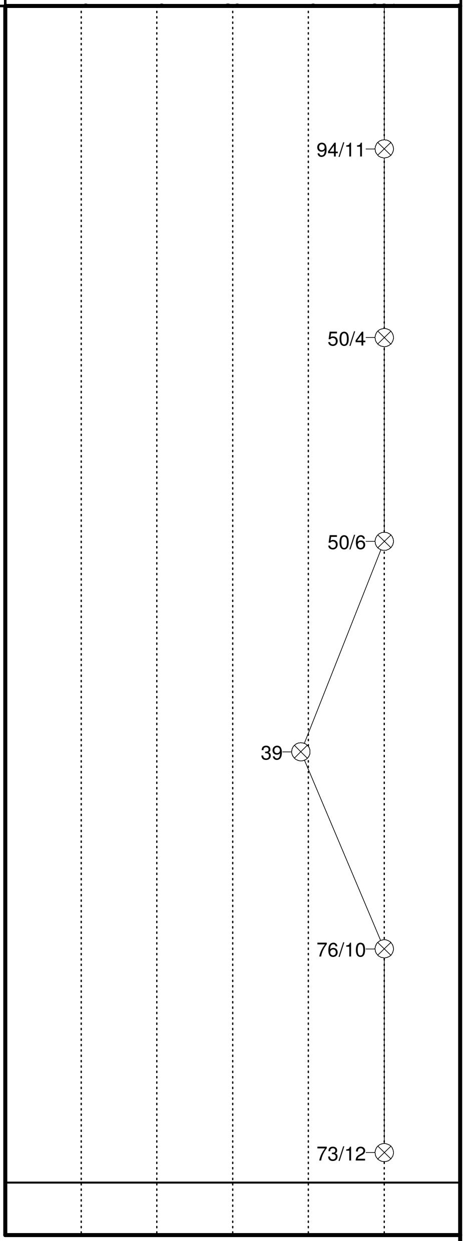
⊗ STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ➤ LOSS OF CIRCULATION

SURFACE ELEVATION 159

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
					(SM) SILTY SAND, Tan and Reddish Brown, Wet, Dense to Very Dense			
	S-9	SS	17	17			125	18 44 50/5
35								
	S-10	SS	10	10			120	28 50/4
40								
	S-11	SS	12	12			115	32 50/6
45								
						▽		
	S-12	SS	18	18			110	4 19 20
50								
	S-13	SS	16	16			105	22 26 50/4
55								
						▽		
	S-14	SS	18	18			100	15 23 50/6
60					END OF BORING @ 60.00'			



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

▽ WL 48.50 WS ☐ WD ☐	BORING STARTED 09/05/14	
▽ WL(BCR) 57.00 ▼ WL(ACR)	BORING COMPLETED 09/05/14	CAVE IN DEPTH
▽ WL	RIG CME 75 FOREMAN Zach M.	DRILLING METHOD 3.25 HSA

CLIENT	JOB #	BORING #	SHEET
Quinn Evans Architects	37:1383	B-6	1 OF 2

PROJECT NAME: Fort DuPont Ice Arena

ARCHITECT-ENGINEER: Quinn Evans Architects

SITE LOCATION: 3779 Ely Place, SE, Washington, District of Columbia

NORTHING

EASTING

STATION

-○- CALIBRATED PENETROMETER TONS/FT^2

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

PLASTIC LIMIT% ×   WATER CONTENT% ●   LIQUID LIMIT% △

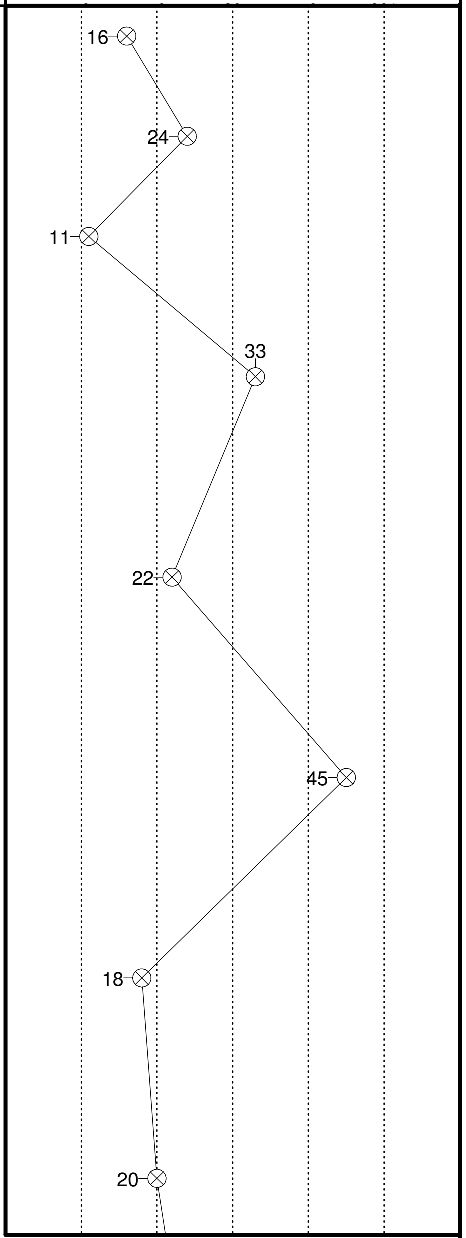
⊗ STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL   ENGLISH UNITS

BOTTOM OF CASING ➡   LOSS OF CIRCULATION

SURFACE ELEVATION 145

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0	S-1	SS	18	6	Topsoil Depth [2"] (SM FILL) SILTY SAND, Trace Gravel,Trace Clay, Brown, Moist, Medium Dense		145	3 6 10
	S-2	SS	18	18	(CL) SILTY CLAY WITH SAND, Trace Gravel, Contains Trace Organics, Brown, Moist, Stiff to Hard			8 11 13
5	S-3	SS	18	18			140	4 5 6
10	S-4	SS	18	18			135	10 14 19
					(CL) SILTY CLAY WITH SAND, Reddish Brown, Moist, Very Stiff to Hard			
15	S-5	SS	18	18			130	6 10 12
20	S-6	SS	18	18			125	13 19 26
					(SM) SILTY SAND, Tan and Reddish Brown, Wet, Loose to Dense			
25	S-7	SS	18	15			120	5 7 11
30	S-8	SS	18	18			115	5 8 12



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

WL 33.50   WS ☐   WD ☐

BORING STARTED 09/09/14

WL(BCR) 45.00   WL(ACR)

BORING COMPLETED 09/09/14

CAVE IN DEPTH

WL

RIG CME 75   FOREMAN J. Leatherman

DRILLING METHOD 3.25 HSA

CLIENT
Quinn Evans Architects

JOB #
37:1383

BORING #
B-6

SHEET
2 OF 2

PROJECT NAME
Fort DuPont Ice Arena

ARCHITECT-ENGINEER
Quinn Evans Architects

SITE LOCATION
3779 Ely Place, SE, Washington, District of Columbia

NORTHING

EASTING

STATION

-○- CALIBRATED PENETROMETER TONS/FT^2

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

PLASTIC LIMIT% ╳ — WATER CONTENT% ● — LIQUID LIMIT% △

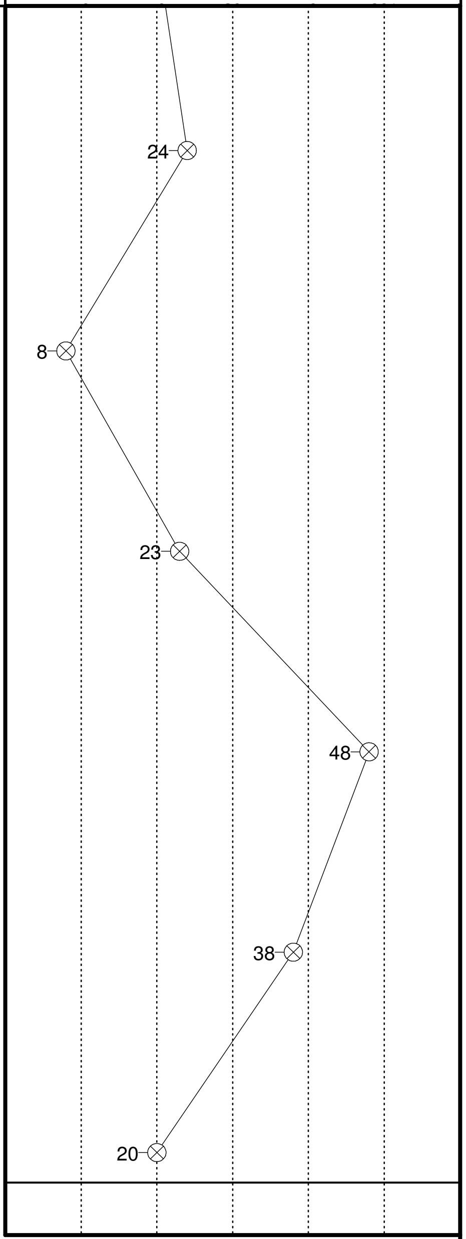
⊗ STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 145

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
					(SM) SILTY SAND, Tan and Reddish Brown, Wet, Loose to Dense			
						▽		
	S-9	SS	18	18				2 6 18
35							110	
	S-10	SS	18	18				2 3 5
40							105	
	S-11	SS	18	18				4 10 13
45						▽	100	
	S-12	SS	18	18				7 22 26
50							95	
	S-13	SS	18	18				11 15 23
55							90	
	S-14	SS	18	18				6 8 12
60					END OF BORING @ 60.00'		85	



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

▽ WL 33.50 WS ☐ WD ☐	BORING STARTED 09/09/14	
▽ WL(BCR) 45.00 ▼ WL(ACR)	BORING COMPLETED 09/09/14	CAVE IN DEPTH
▽ WL	RIG CME 75 FOREMAN J. Leatherman	DRILLING METHOD 3.25 HSA

CLIENT	JOB #	BORING #	SHEET
Quinn Evans Architects	37:1383	B-7	1 OF 3

PROJECT NAME	ARCHITECT-ENGINEER
Fort DuPont Ice Arena	Quinn Evans Architects

SITE LOCATION

3779 Ely Place, SE, Washington, District of Columbia

NORTHING	EASTING	STATION

-○- CALIBRATED PENETROMETER TONS/FT^2

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

PLASTIC LIMIT% ✕ — WATER CONTENT% ● — LIQUID LIMIT% △

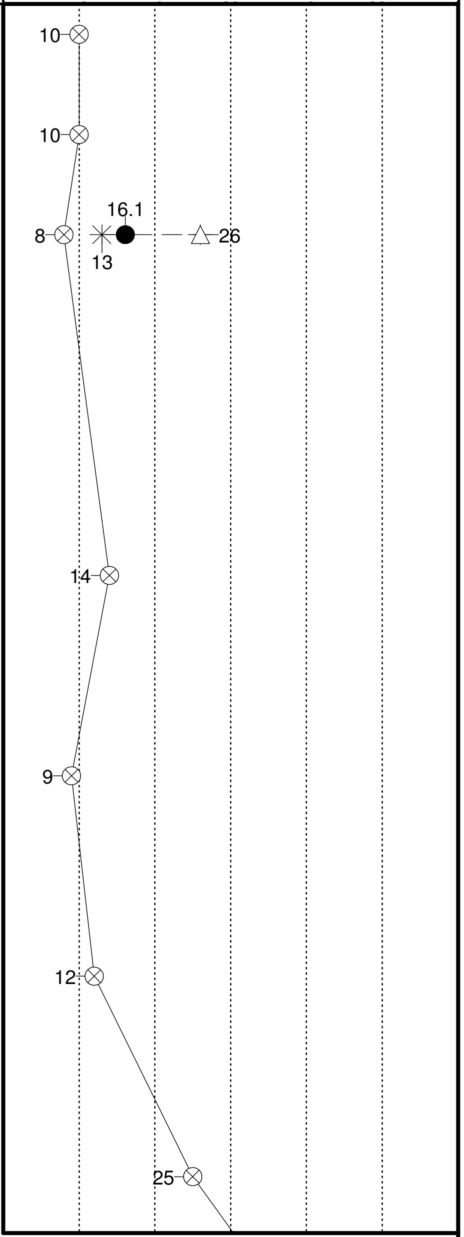
⊗ STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 143

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0	S-1	SS	18	10	Topsoil Depth [4"] (SM FILL) SILTY SAND, Trace Gravel,Trace Clay, Brown, Moist, Loose			3 4 6
	S-2	SS	18	18	(CL) LEAN CLAY WITH SAND, Trace Gravel, Contains Trace Organics, Brown, Moist, Medium Stiff to Stiff		140	2 4 6
5	S-3	SS	18	10				2 4 4
	S-4	SS	12	11			135	1 23
10					(CL) SILTY CLAY WITH SAND, Reddish Brown, Moist, Stiff		130	
	S-5	SS	18	4				4 5 9
15							125	
	S-6	SS	18	15				2 3 6
20					(SM) SILTY SAND, Tan and Reddish Brown and Gray, Wet, Loose to Very Dense	▽	120	
	S-7	SS	18	12				5 6 6
25							115	
	S-8	SS	18	18				3 9 16
30								



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

▽ WL 23.50 WS ☐ WD ☐	BORING STARTED 09/08/14	
▽ WL(BCR) 55.00 ▼ WL(ACR)	BORING COMPLETED 09/08/14	CAVE IN DEPTH
▽ WL	RIG CME 75 FOREMAN J. Leatherman	DRILLING METHOD 3.25 HSA

CLIENT: Quinn Evans Architects

JOB #: 37:1383

BORING #: B-7

SHEET: 2 OF 3

PROJECT NAME: Fort DuPont Ice Arena

ARCHITECT-ENGINEER: Quinn Evans Architects

SITE LOCATION: 3779 Ely Place, SE, Washington, District of Columbia

NORTHING:

EASTING:

STATION:

-○- CALIBRATED PENETROMETER TONS/FT^2

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

PLASTIC LIMIT% ✕ WATER CONTENT% ● LIQUID LIMIT% △

⊗ STANDARD PENETRATION BLOWS/FT

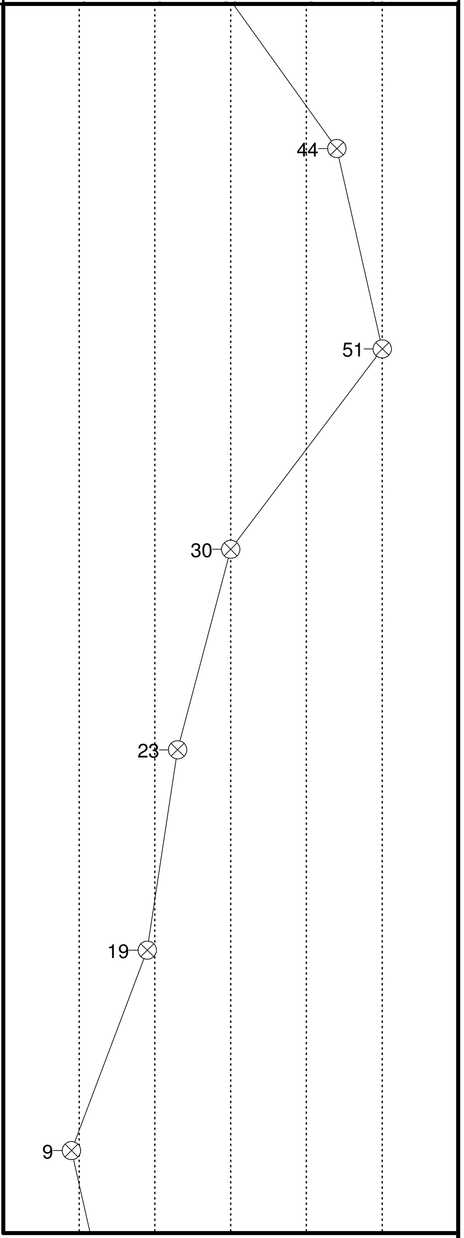
DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING — LOSS OF CIRCULATION

SURFACE ELEVATION 143

(SM) SILTY SAND, Tan and Reddish Brown and Gray, Wet, Loose to Very Dense

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	ELEVATION (FT)	BLOWS/6"
35	S-9	SS	18	18	110	8 16 28
40	S-10	SS	18	18	105	12 24 27
45	S-11	SS	18	18	100	15 15 15
50	S-12	SS	18	18	95	11 14 9
55	S-13	SS	18	18	90	4 7 12
60	S-14	SS	18	18	85	9 4 5



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

WL 23.50 WS ☐ WD ☐

BORING STARTED 09/08/14

WL(BCR) 55.00 WL(ACR)

BORING COMPLETED 09/08/14

CAVE IN DEPTH

WL

RIG CME 75 FOREMAN J. Leatherman

DRILLING METHOD 3.25 HSA

CLIENT	JOB #	BORING #	SHEET
Quinn Evans Architects	37:1383	B-7	3 OF 3

PROJECT NAME: Fort DuPont Ice Arena

ARCHITECT-ENGINEER: Quinn Evans Architects

SITE LOCATION: 3779 Ely Place, SE, Washington, District of Columbia

NORTHING

EASTING

STATION

-○- CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY

RQD% – — –   REC% ———

PLASTIC LIMIT% ✕   WATER CONTENT% ●   LIQUID LIMIT% △

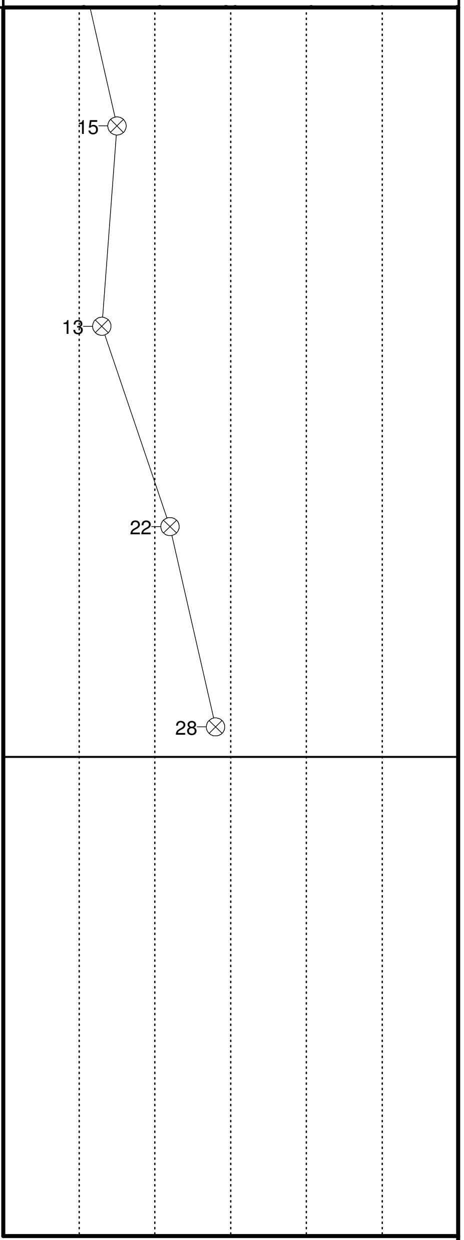
⊗ STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING   LOSS OF CIRCULATION

SURFACE ELEVATION 143

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
							80	
	S-15	SS	18	18				4 6 9
65								
					(CH) SILTY CLAY WITH SAND, Reddish Brown, Moist, Stiff to Very Stiff			
							75	
	S-16	SS	18	18				5 4 9
70								
							70	
	S-17	SS	18	18				6 9 13
75								
							65	
	S-18	SS	18	18				7 12 16
80					END OF BORING @ 80.00'			
							60	
85								
							55	
90								



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

WL 23.50 WS ☐ WD ☐	BORING STARTED 09/08/14	
WL(BCR) 55.00 WL(ACR)	BORING COMPLETED 09/08/14	CAVE IN DEPTH
WL	RIG CME 75 FOREMAN J. Leatherman	DRILLING METHOD 3.25 HSA

CLIENT	JOB #	BORING #	SHEET
Quinn Evans Architects	37:1383	B-8	1 OF 3

PROJECT NAME: Fort DuPont Ice Arena

ARCHITECT-ENGINEER: Quinn Evans Architects

SITE LOCATION: 3779 Ely Place, SE, Washington, District of Columbia

NORTHING

EASTING

STATION

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ➤ LOSS OF CIRCULATION 100%

SURFACE ELEVATION 130

-○- CALIBRATED PENETROMETER TONS/FT²

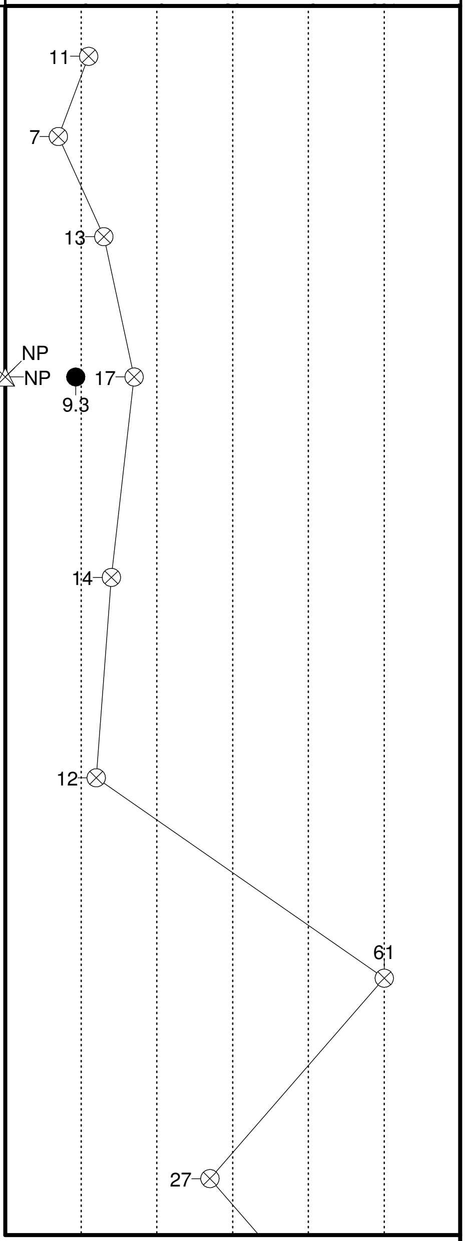
ROCK QUALITY DESIGNATION & RECOVERY

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	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0					Asphalt Depth [2"]		130	
	S-1	SS	18	18	(SM FILL) SILTY SAND, Trace Gravel,Trace Clay, Brown, Moist, Loose to Medium Dense			4 5 6
	S-2	SS	18	3				3 3 4
5					(SM) SILTY SAND, Tan and Red, Moist, Medium Dense		125	
	S-3	SS	18	18				3 6 7
	S-4	SS	18	18				3 7 10
10							120	
	S-5	SS	18	18				6 7 7
15							115	
					(SM) SILTY SAND, Tan and Reddish Brown, Wet, Medium Dense to Very Dense			
						▽		
	S-6	SS	18	18				3 6 6
20							110	
	S-7	SS	18	18				12 24 37
25							105	
	S-8	SS	18	18				10 13 14
30							100	



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

▽ WL 18.50 WS ☐ WD ☐	BORING STARTED 09/09/14	
▽ WL(BCR) 67.00 ▼ WL(ACR)	BORING COMPLETED 09/09/14	CAVE IN DEPTH
▽ WL	RIG CME 75 FOREMAN J. Leatherman	DRILLING METHOD 3.25 HSA

CLIENT	JOB #	BORING #	SHEET
Quinn Evans Architects	37:1383	B-8	2 OF 3

PROJECT NAME	ARCHITECT-ENGINEER
Fort DuPont Ice Arena	Quinn Evans Architects

SITE LOCATION

3779 Ely Place, SE, Washington, District of Columbia

NORTHING	EASTING	STATION

-○- CALIBRATED PENETROMETER TONS/FT^2

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

PLASTIC LIMIT% ✕ WATER CONTENT% ● LIQUID LIMIT% △

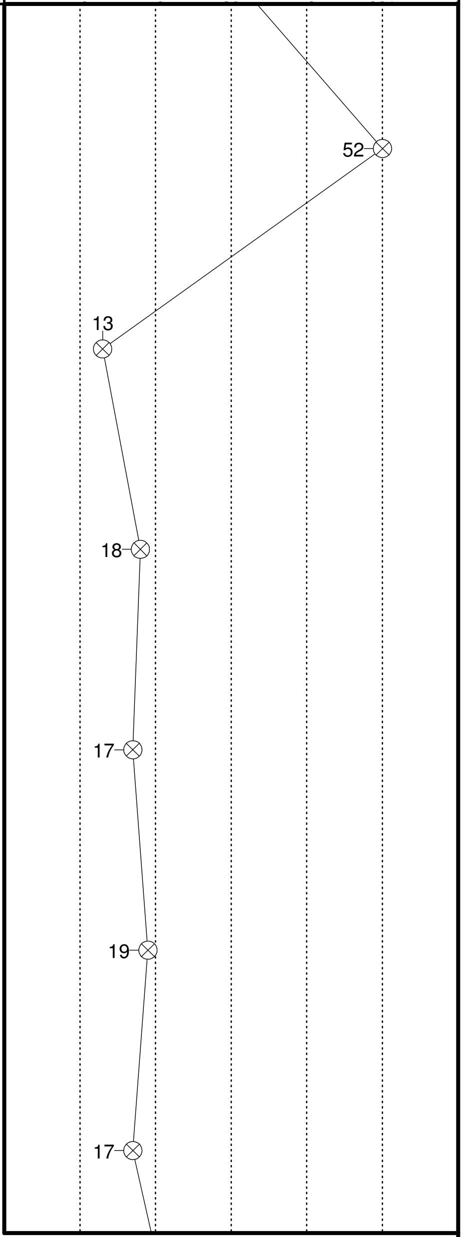
⊗ STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL   ENGLISH UNITS

BOTTOM OF CASING   LOSS OF CIRCULATION

SURFACE ELEVATION 130

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
					(SM) SILTY SAND, Tan and Reddish Brown, Wet, Medium Dense to Very Dense			
	S-9	SS	18	18				8 25 27
35							95	
					(CL) SILTY CLAY WITH SAND, Reddish Brown, Moist, Stiff to Very Hard			
	S-10	SS	18	18				2 5 8
40							90	
	S-11	SS	18	18				4 7 11
45							85	
	S-12	SS	18	18				5 7 10
50							80	
	S-13	SS	18	18				5 6 13
55							75	
	S-14	SS	18	18				5 7 10
60							70	



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

WL 18.50 WS ☐ WD ☐	BORING STARTED 09/09/14	
WL(BCR) 67.00 WL(ACR)	BORING COMPLETED 09/09/14	CAVE IN DEPTH
WL	RIG CME 75 FOREMAN J. Leatherman	DRILLING METHOD 3.25 HSA

CLIENT	JOB #	BORING #	SHEET
Quinn Evans Architects	37:1383	B-8	3 OF 3

PROJECT NAME Fort DuPont Ice Arena

ARCHITECT-ENGINEER Quinn Evans Architects

SITE LOCATION 3779 Ely Place, SE, Washington, District of Columbia

NORTHING

EASTING

STATION

-○- CALIBRATED PENETROMETER TONS/FT^2

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

PLASTIC LIMIT% × WATER CONTENT% ● LIQUID LIMIT% △

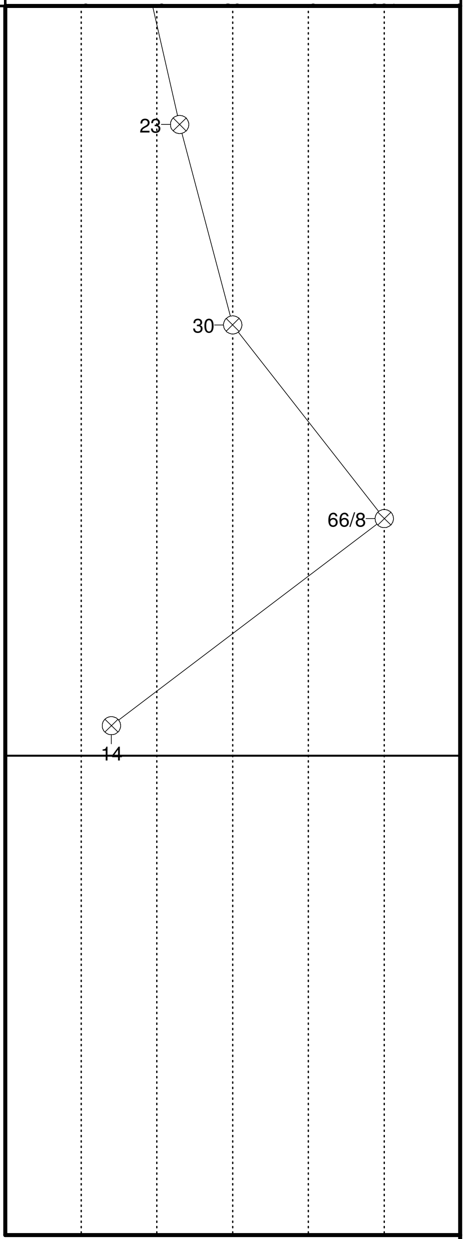
⊗ STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL ENGLISH UNITS

BOTTOM OF CASING LOSS OF CIRCULATION 100%

SURFACE ELEVATION 130

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
					(CL) SILTY CLAY WITH SAND, Reddish Brown, Moist, Stiff to Very Hard			
	S-15	SS	18	18				6 9 14
65							65	
					(CH) SILTY CLAY WITH SAND, Reddish Brown, Moist, Stiff to Very Hard			
						▽		
	S-16	SS	18	18				10 15 15
70							60	
	S-17	SS	14	14				8 16 50/2
75							55	
	S-18	SS	18	18				4 6 8
80					END OF BORING @ 80.00'		50	
85							45	
90							40	



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

▽ WL 18.50 WS ☐ WD ☐	BORING STARTED 09/09/14	
▽ WL(BCR) 67.00 ▼ WL(ACR)	BORING COMPLETED 09/09/14	CAVE IN DEPTH
▽ WL	RIG CME 75 FOREMAN J. Leatherman	DRILLING METHOD 3.25 HSA

CLIENT	JOB #	BORING #	SHEET
Quinn Evans Architects	37:1383	B-9	1 OF 2

PROJECT NAME: Fort DuPont Ice Arena

ARCHITECT-ENGINEER: Quinn Evans Architects

SITE LOCATION: 3779 Ely Place, SE, Washington, District of Columbia

NORTHING

EASTING

STATION

-○- CALIBRATED PENETROMETER TONS/FT^2

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

PLASTIC LIMIT% ✕   WATER CONTENT% ●   LIQUID LIMIT% △

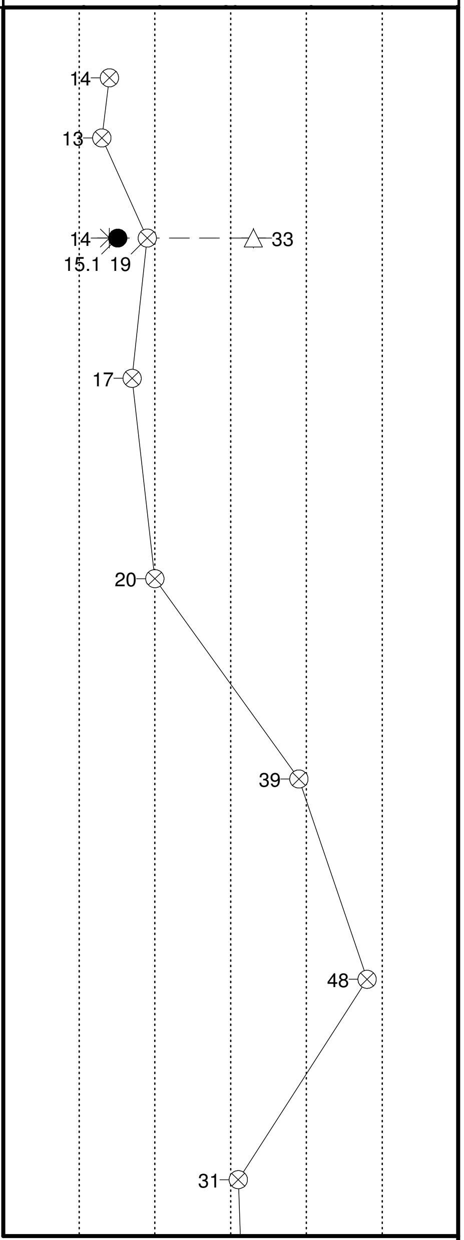
⊗ STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ➤   LOSS OF CIRCULATION

SURFACE ELEVATION 134

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0					Asphalt Depth [12"]			
	S-1	SS	18	12	(CL) SANDY LEAN CLAY, Trace Gravel, Reddish Brown, Moist, Stiff			5 6 8
	S-2	SS	18	14				3 5 8
							130	
5								
	S-3	SS	18	18				5 9 10
					(SM) SILTY SAND, Tan and Reddish Brown, Wet, Medium Dense			
	S-4	SS	18	18			125	4 8 9
10								
	S-5	SS	18	14			120	4 8 12
15								
					(SC) CLAYEY SAND, Tan and Red, Moist, Dense			
						▽		
	S-6	SS	18	18			115	7 15 24
20								
					(CL) SILTY CLAY WITH SAND, Brown, Moist, Medium Stiff to Hard			
	S-7	SS	18	18			110	6 14 34
25								
	S-8	SS	18	18			105	8 14 17
30								



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

▽ WL 18.50 WS ☐ WD ☐	BORING STARTED 09/04/14	
WL(BCR) WL(ACR)	BORING COMPLETED 09/04/14	CAVE IN DEPTH @ 60.00'
▽ WL	RIG CME 75 FOREMAN J. Martinez	DRILLING METHOD 3.25 HSA

CLIENT	JOB #	BORING #	SHEET
Quinn Evans Architects	37:1383	B-9	2 OF 2

PROJECT NAME: Fort DuPont Ice Arena

ARCHITECT-ENGINEER: Quinn Evans Architects

SITE LOCATION: 3779 Ely Place, SE, Washington, District of Columbia

NORTHING

EASTING

STATION

-○- CALIBRATED PENETROMETER TONS/FT^2

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

PLASTIC LIMIT% ✕ WATER CONTENT% ● LIQUID LIMIT% △

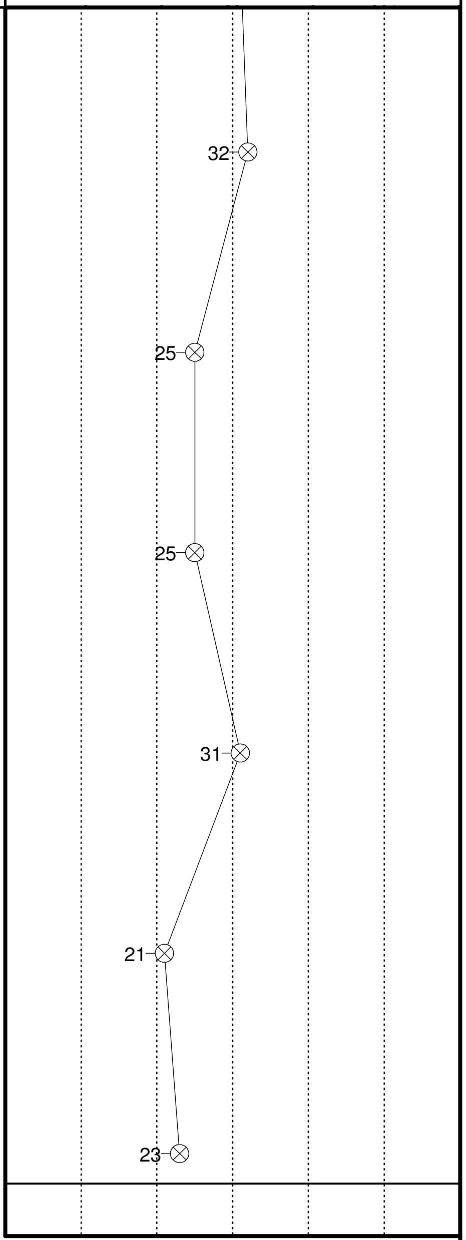
⊗ STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL ENGLISH UNITS

BOTTOM OF CASING LOSS OF CIRCULATION

SURFACE ELEVATION 134

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"	STANDARD PENETRATION BLOWS/FT
					(CL) SILTY CLAY WITH SAND, Brown, Moist, Medium Stiff to Hard				
35	S-9	SS	18	16			100	8 12 20	32
40	S-10	SS	18	18			95	7 11 14	25
45	S-11	SS	18	18			90	7 12 13	25
50	S-12	SS	18	18			85	10 14 17	31
55	S-13	SS	18	16			80	6 10 11	21
60	S-14	SS	18	18			75	5 10 13	23
					END OF BORING @ 60.00'				



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

WL 18.50 WS ☐ WD ☐	BORING STARTED 09/04/14	
WL(BCR) WL(ACR)	BORING COMPLETED 09/04/14	CAVE IN DEPTH @ 60.00'
WL	RIG CME 75 FOREMAN J. Martinez	DRILLING METHOD 3.25 HSA

CLIENT	JOB #	BORING #	SHEET
Quinn Evans Architects	37:1383	B-10	1 OF 2

PROJECT NAME: Fort DuPont Ice Arena

ARCHITECT-ENGINEER: Quinn Evans Architects

SITE LOCATION: 3779 Ely Place, SE, Washington, District of Columbia

NORTHING

EASTING

STATION

-○- CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY

RQD% – – – REC% ———

PLASTIC LIMIT% ✕ — WATER CONTENT% ● — LIQUID LIMIT% △

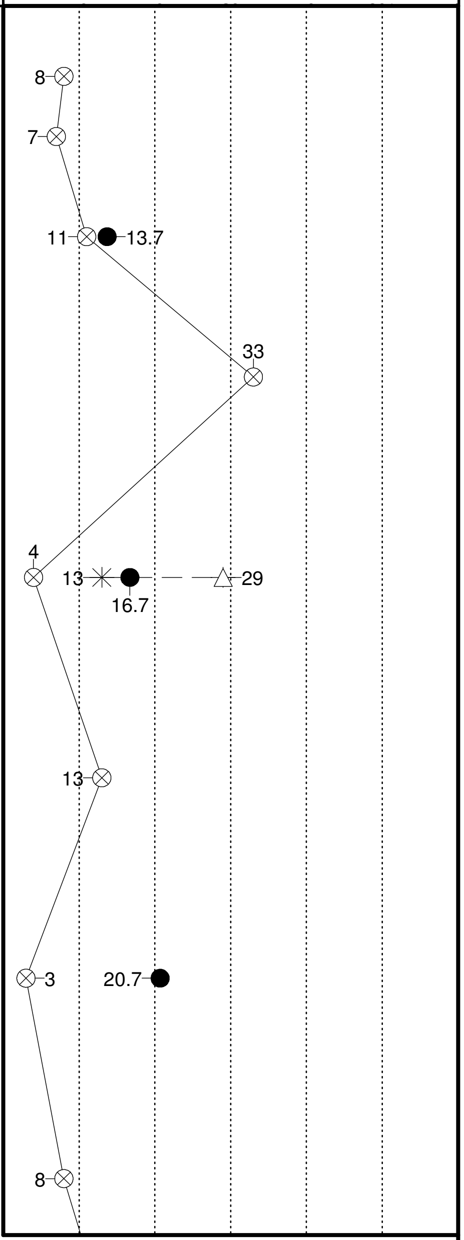
⊗ STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ▶ LOSS OF CIRCULATION

SURFACE ELEVATION 123.5

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0					Asphalt Depth [11"]			
	S-1	SS	18	16	(SM FILL) SILTY SAND, Trace Gravel,Trace Clay, Brown, Moist, Loose to Dense			3 4 4
	S-2	SS	18	16			120	4 3 4
5	S-3	SS	18	16				8 6 5
	S-4	SS	18	10			115	13 19 14
10								
					(CL) SANDY LEAN CLAY, Tan and Red, Moist, Soft to Very Stiff			
	S-5	SS	18	12			110	2 1 3
15								
	S-6	SS	18	10		▽	105	4 8 5
20								
	S-7	SS	18	14			100	1 2 1
25								
	S-8	SS	18	16			95	3 4 4
30								



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

▽ WL 18.50 WS ☐ WD ☐	BORING STARTED 09/04/14	
▽ WL(BCR) ▼ WL(ACR)	BORING COMPLETED 09/04/14	CAVE IN DEPTH @ 60.00'
▽ WL	RIG CME 75 FOREMAN J. Martinez	DRILLING METHOD 325 HSA

CLIENT
Quinn Evans Architects

JOB #
37:1383

BORING #
B-10

SHEET
2 OF 2

PROJECT NAME
Fort DuPont Ice Arena

ARCHITECT-ENGINEER
Quinn Evans Architects

SITE LOCATION
3779 Ely Place, SE, Washington, District of Columbia

NORTHING
EASTING
STATION

-○- CALIBRATED PENETROMETER TONS/FT^2

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

PLASTIC LIMIT% ✕ WATER CONTENT% ● LIQUID LIMIT% △

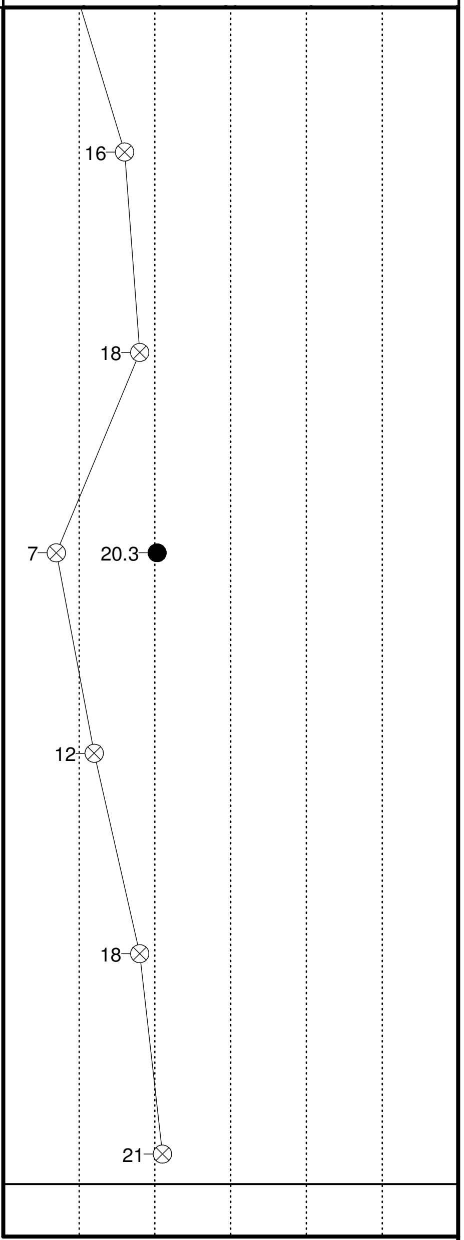
⊗ STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL ENGLISH UNITS

BOTTOM OF CASING ➤ LOSS OF CIRCULATION 100%

SURFACE ELEVATION 123.5

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
					(CL) SANDY LEAN CLAY, Tan and Red, Moist, Soft to Very Stiff			
							90	
	S-9	SS	18	18				5 7 9
35								
					(CL) SILTY CLAY WITH SAND, Reddish Brown, Moist, Medium Stiff to Very Stiff			
							85	
	S-10	SS	18	14				7 7 11
40								
							80	
	S-11	SS	18	18				3 3 4
45								
							75	
	S-12	SS	18	14				4 5 7
50								
							70	
	S-13	SS	18	18				6 7 11
55								
							65	
	S-14	SS	18	16				7 9 12
60					END OF BORING @ 60.00'			



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

WL 18.50 WS ☐ WD ☐

BORING STARTED 09/04/14

WL(BCR) WL(ACR)

BORING COMPLETED 09/04/14

CAVE IN DEPTH @ 60.00'

WL

RIG CME 75

FOREMAN J. Martinez

DRILLING METHOD 325 HSA

CLIENT
Quinn Evans Architects

JOB #
37:1383

BORING #
B-11

SHEET
1 OF 3

PROJECT NAME
Fort DuPont Ice Arena

ARCHITECT-ENGINEER
Quinn Evans Architects

SITE LOCATION
3779 Ely Place, SE, Washington, District of Columbia

NORTHING

EASTING

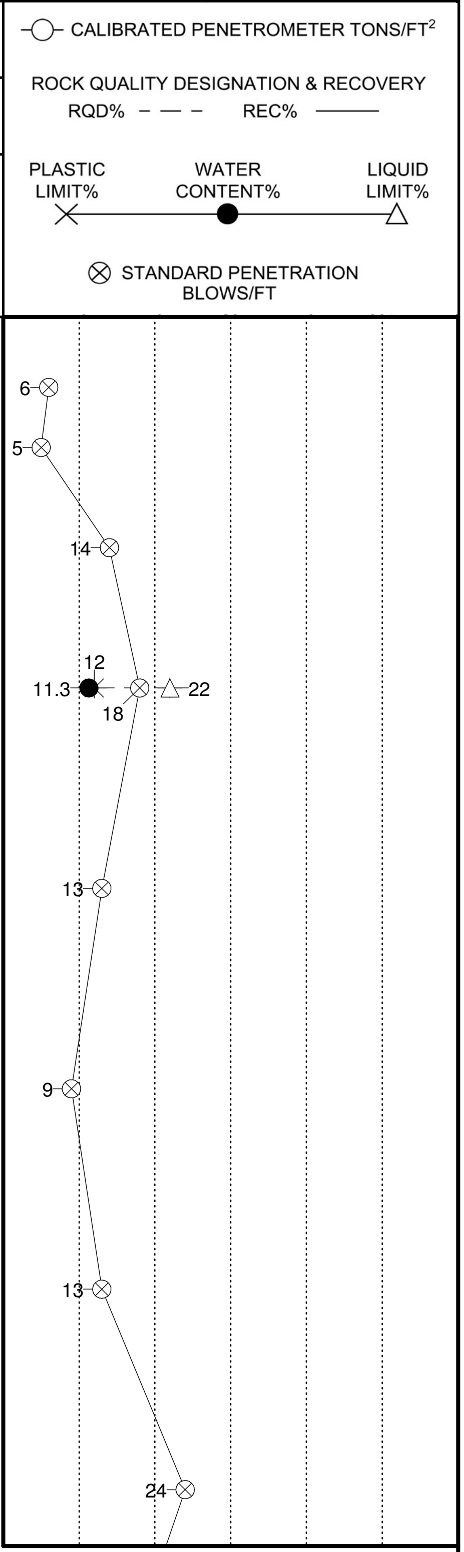
STATION

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ➡ LOSS OF CIRCULATION 100%

SURFACE ELEVATION 125

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0					Asphalt Depth [10"]		125	
	S-1	SS	18	10	(SC FILL) CLAYEY SAND, Brown, Moist, Loose to Medium Dense			3 3 3
	S-2	SS	18	12				3 2 3
5							120	
	S-3	SS	18	16				5 7 7
	S-4	SS	18	14				6 8 10
10							115	
					(CL) SILTY SAND WITH CLAY, Trace Gravel, Contains Trace Organics, Brown, Moist, Stiff			
	S-5	SS	18	14				3 5 8
15							110	
						▽		
	S-6	SS	18	12				3 4 5
20							105	
	S-7	SS	18	10				5 5 8
25							100	
					(CL) SILTY CLAY WITH SAND, Reddish Brown, Moist, Stiff to Hard			
	S-8	SS	18	16				9 11 13
30							95	



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

▽ WL 18.50 WS ☐ WD ☐	BORING STARTED 09/04/14	
WL(BCR) WL(ACR)	BORING COMPLETED 09/04/14	CAVE IN DEPTH @ 80.00'
▽ WL	RIG CME 75 FOREMAN J. Martinez	DRILLING METHOD 3.25 HSA

CLIENT Quinn Evans Architects	JOB # 37:1383	BORING # B-11	SHEET 2 OF 3
PROJECT NAME Fort DuPont Ice Arena	ARCHITECT-ENGINEER Quinn Evans Architects		
SITE LOCATION 3779 Ely Place, SE, Washington, District of Columbia			
NORTHING	EASTING	STATION	

-○- CALIBRATED PENETROMETER TONS/FT^2

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

PLASTIC LIMIT% ×   WATER CONTENT% ●   LIQUID LIMIT% △

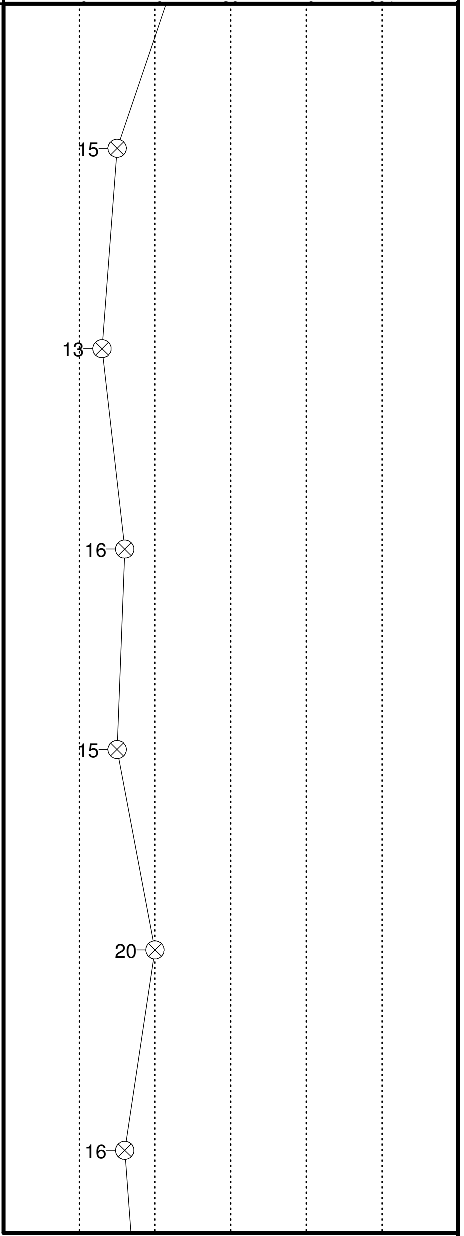
⊗ STANDARD PENETRATION BLOWS/FT

BOTTOM OF CASING   LOSS OF CIRCULATION

SURFACE ELEVATION 125

ENGLISH UNITS

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
					(CL) SILTY CLAY WITH SAND, Reddish Brown, Moist, Stiff to Hard			
	S-9	SS	18	14				10 1 14
35							90	
	S-10	SS	18	16				5 6 7
40							85	
	S-11	SS	18	18				7 9 7
45							80	
	S-12	SS	18	18				4 7 8
50							75	
	S-13	SS	18	14				4 9 11
55							70	
	S-14	SS	18	18				5 7 9
60							65	



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

WL 18.50 WS ☐ WD ☐	BORING STARTED 09/04/14	
WL(BCR) WL(ACR)	BORING COMPLETED 09/04/14	CAVE IN DEPTH @ 80.00'
WL	RIG CME 75 FOREMAN J. Martinez	DRILLING METHOD 3.25 HSA

CLIENT Quinn Evans Architects
JOB # 37:1383
BORING # B-11
SHEET 3 OF 3
PROJECT NAME Fort DuPont Ice Arena
ARCHITECT-ENGINEER Quinn Evans Architects
SITE LOCATION 3779 Ely Place, SE, Washington, District of Columbia
NORTHING
EASTING
STATION

-○- CALIBRATED PENETROMETER TONS/FT^2

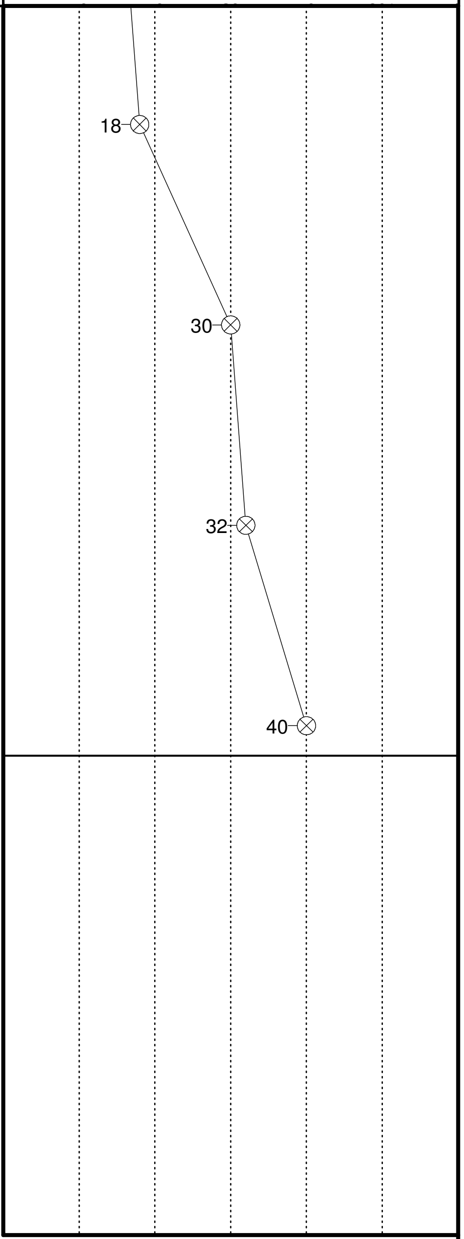
ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% ✕ WATER CONTENT% ● LIQUID LIMIT% △

⊗ STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS
BOTTOM OF CASING — LOSS OF CIRCULATION
SURFACE ELEVATION 125

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
	S-15	SS	18	18				7 8 10
65							60	
					(CH) SILTY CLAY WITH SAND, Reddish Brown, Moist, Very Stiff to Hard			
	S-16	SS	18	18				9 14 16
70							55	
	S-17	SS	18	18				11 14 18
75							50	
	S-18	SS	18	18				8 20 20
80					END OF BORING @ 80.00'		45	
85							40	
90							35	



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

WL 18.50 WS ☐ WD ☐
BORING STARTED 09/04/14
WL(BCR) WL(ACR)
BORING COMPLETED 09/04/14
CAVE IN DEPTH @ 80.00'
WL
RIG CME 75 FOREMAN J. Martinez
DRILLING METHOD 3.25 HSA

Laboratory Testing Summary

Sample Source	Sample Number	Depth (feet)	MC[1] (%)	Soil Type[2]	Atterberg Limits[3]			Percent Passing No. 200 Sieve[4]	Moisture - Density (Corr.)[5]		CBR Value[6]	Other
					LL	PL	PI		Maximum Density (pcf)	Optimum Moisture (%)		
B-1												
	S-5	10.00 - 12.00	16.5	SC	30	13	17	49.3				
B-2												
	S-5	10.00 - 12.00	5.8	SM	NP	NP	NP	15.8				
B-3												
	S-5	10.00 - 12.00	13.9	CL	28	14	14	57.1				
B-4												
	S-4	8.50 - 10.00	12.5	SC	32	14	18	28.3				
	S-6	18.50 - 20.00	21.4	CL	24	14	10	51.2				OC=3.76
B-5												
	S-3	5.00 - 6.50	14.9	CL	25	12	13	71.6				OC=3.81
	S-4	8.50 - 10.00	17.3	CL	28	13	15	84.1				
B-6												
B-7												
	S-3	5.00 - 6.50	16.1	CL	26	13	13	81.3				
B-8												
	S-4	8.50 - 10.00	9.3	SM	NP	NP	NP	19.3				
B-9												
	S-3	5.00 - 6.50	15.1	CL	33	14	19	50.0				
B-10												
	S-3	5.00 - 6.50	13.7									
	S-5	13.50 - 15.00	16.7	CL	29	13	16	57.3				
	S-7	23.50 - 25.00	20.7									
	S-11	43.50 - 45.00	20.3									
B-11												
	S-4	8.50 - 10.00	11.3	SC	22	12	10	29.4				OC=1.85

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.	**37:1383**
Project Name:	**Fort Dupont Ice Arena**
PM:	**Daniel J. Spielvogel**
PE:	**Stephen F. Patt**
Printed On:	**Monday, September 29, 2014**

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

Constant-Head Borehole Permeameter Test

Glover Solution (Deep WT or Impervious Layer)

File Name.....: GloverRE-deep-WT

Project Name........: Fort Dupont Ice Arena
Project No.............: 1383
Project Location...: 3779 Ely Place SE, Washington DC 20019
Boring No...........: IT-1
Investigators......: SWF
Date..................: 9-3-14

Boring Depth.........: 10.25 Ft **(m, cm, ft, in)**
Boring Diameter...: 11.4 **cm**
Boring Radius r.....: 5.72 **cm**
Soil/Water Tmp. T: 30 **°C**
Dyn. Visc. @ T......: 0.000798 **kg/m·s**
WCU Base Ht. h: 10.0 **cm*****
WCU Susp. Ht. S: 0.0 **cm**
Const. Wtr. Ht. H: 10.0 **cm**
H/r..................:** 1.7
Dyn. Visc. @ T_B.: 0.001003 **kg/m·s**

Solution and Terminology (R. E. Glover Solution)*

$Ksat = Q[\sinh^{-1}(H/r) - (r^2/H^2+1)^{.5} + r/H]/(2\pi H^2)$ [Basic Glover Solution]

$Ksat_B = QV[\sinh^{-1}(H/r) - (r^2/H^2+1)^{.5} + r/H]/(2\pi H^2)$ [Temperature-corrected]

$Ksat_B$: (Coefficient of Permeability, K) @ Base Tmp. T_B °C: 20
Q: Rate of flow of water from the borehole
H: Constant height of water in the borehole
r: Radius of the cylindrical borehole
V: Dynamic viscosity of water @ T °C/Dyn. Visc. of water @ T_B °C

VOLUME (ml)	Volume Out (ml)	TIME (h:mm:ss A/P)	Interval Elapsed Time		Flow Rate Q (ml/min)	-------------------- $Ksat_B$ Equivalent Values --------------------------				
			(hr:min:sec)	(min)		(µm/sec)	(cm/sec)	(cm/day)	(in/hr)	(ft/day)
3,240		3:33:00 PM								
860	2,380	3:37:00 PM	0:04:00	4.00	595.00	93.6	9.36E-03	808.8	13.27	26.54
3,250		3:37:00 PM								
630	2,620	3:41:00 PM	0:04:00	4.00	655.00	103.1	1.03E-02	890.4	14.61	29.21
3,260		3:41:00 PM								
740	2,520	3:45:00 PM	0:04:00	4.00	630.00	99.1	9.91E-03	856.4	14.05	28.10
3,250		3:45:00 PM								
2,650	600	3:46:00 PM	0:01:00	1.00	600.00	94.4	9.44E-03	815.6	13.38	26.76
1,980	670	3:47:00 PM	0:01:00	1.00	670.00	105.4	1.05E-02	910.8	14.94	29.88
1,320	660	3:48:00 PM	0:01:00	1.00	660.00	103.8	1.04E-02	897.2	14.72	29.43
690	630	3:49:00 PM	0:01:00	1.00	630.00	99.1	9.91E-03	856.4	14.05	28.10
3,150		3:49:00 PM								
2,510	640	3:50:00 PM	0:01:00	1.00	640.00	100.7	1.01E-02	870.0	14.27	28.54
1,940	570	3:51:00 PM	0:01:00	1.00	570.00	89.7	8.97E-03	774.8	12.71	25.42
1,310	630	3:52:00 PM	0:01:00	1.00	630.00	99.1	9.91E-03	856.4	14.05	28.10
700	610	3:53:00 PM	0:01:00	1.00	610.00	96.0	9.60E-03	829.2	13.60	27.20
40	660	3:54:00 PM	0:01:00	1.00	660.00	103.8	1.04E-02	897.2	14.72	29.43

Natural Moisture.........: 16.5
USDA Txt./USCS Class.: Sandy Clay Loam
Struct./% Pass. #200...: 49.3
Consistency...............: Loose
Water Table Depth...: Not Encountered
Init. Saturation Time.:
Total Time (min) 21.00

Enter $Ksat_B$ Value:	**97.2**	**9.72E-03**	**839.4**	**13.77**	**27.54**

Notes: $Ksat_B$ is determ. by averag. and/or Rndng. the results for the final three or four stabilized values and analyzing the Flow Rate Q vs Total Elapsed Time Graph.

*Glover, R. E. l953. Flow from a test-hole located above groundwater level. pp. 69-71. in: Theory and Problems of Water Percolation. (C. N. Zanger. ed.). USBR. The condition for this solution exists when the distance from the bottom of the borehole to the water table or an impervious layer is at least 2X the depth of the water in the borehole. **H/r ≥5 to ≥10. ***JP-M1: h = 15cm, JP-M2: h = 10cm. Johnson Permeameter, LLC Revised 5/26/2014

Constant-Head Borehole Permeameter Test

Glover Solution (Deep WT or Impervious Layer)

File Name.....: GloverRE-deep-WT

Project Name........: Fort Dupont Ice Arena
Project No.............: 1383
Project Location...: 3779 Ely Place SE, Washington DC 20019

Boring No...........: IT-2
Investigators......: SWF
Date...................: 9-3-14

Solution and Terminology (R. E. Glover Solution)*

Ksat = $Q[\sinh^{-1}(H/r) - (r^2/H^2+1)^{.5} + r/H]/(2\pi H^2)$ [Basic Glover Solution]

$Ksat_B$= $QV[\sinh^{-1}(H/r) - (r^2/H^2+1)^{.5} + r/H]/(2\pi H^2)$ [Temperature-corrected]

$Ksat_B$: (Coefficient of Permeability, K) @ Base Tmp. T_B °C: 20

Q: Rate of flow of water from the borehole

H: Constant height of water in the borehole

r: Radius of the cylindrical borehole

V: Dynamic viscosity of water @ T °C/Dyn. Visc. of water @ T_B °C

Boring Depth.........: 10 Ft **(m, cm, ft, in)**
Boring Diameter...: 11.4 **cm**
Boring Radius r.....: 5.72 **cm**
Soil/Water Tmp. T: 30 **°C**
Dyn. Visc. @ T......: 0.000798 **kg/m·s**

WCU Base Ht. h: 10.0 **cm*****
WCU Susp. Ht. S: 0.0 **cm**
Const. Wtr. Ht. H: 10.0 **cm**
H/r..................:** 1.7
Dyn. Visc. @ T_B.: 0.001003 **kg/m·s**

VOLUME (ml)	Volume Out (ml)	TIME (h:mm:ss A/P)	Interval Elapsed Time (hr:min:sec)	(min)	Flow Rate Q (ml/min)	Ksat_B Equivalent Values (µm/sec)	(cm/sec)	(cm/day)	(in/hr)	(ft/day)
3,250		2:35:00 PM								
480	2,770	2:39:00 PM	0:04:00	4.00	692.50	109.0	1.09E-02	941.4	15.44	30.88
2,430		2:39:00 PM								
400	2,030	2:42:00 PM	0:03:00	3.00	676.67	106.5	1.06E-02	919.8	15.09	30.18
3,300		2:42:00 PM								
710	2,590	2:46:00 PM	0:04:00	4.00	647.50	101.9	1.02E-02	880.2	14.44	28.88
3,300		2:46:00 PM								
2,000	1,300	2:48:00 PM	0:02:00	2.00	650.00	102.3	1.02E-02	883.6	14.49	28.99
1,350	650	2:49:00 PM	0:01:00	1.00	650.00	102.3	1.02E-02	883.6	14.49	28.99
700	650	2:50:00 PM	0:01:00	1.00	650.00	102.3	1.02E-02	883.6	14.49	28.99
3,300		2:50:00 PM								
2,020	1,280	2:52:00 PM	0:02:00	2.00	640.00	100.7	1.01E-02	870.0	14.27	28.54
1,380	640	2:53:00 PM	0:01:00	1.00	640.00	100.7	1.01E-02	870.0	14.27	28.54
680	700	2:54:00 PM	0:01:00	1.00	700.00	110.1	1.10E-02	951.5	15.61	31.22
3,250		2:54:00 PM								
2,040	1,210	2:56:00 PM	0:02:00	2.00	605.00	95.2	9.52E-03	822.4	13.49	26.98
1,400	640	2:57:00 PM	0:01:00	1.00	640.00	100.7	1.01E-02	870.0	14.27	28.54
760	640	2:58:00 PM	0:01:00	1.00	640.00	100.7	1.01E-02	870.0	14.27	28.54
				Total Time (min)	Enter Ksat_B Value:	98.9	9.89E-03	854.1	14.01	28.02
				23.00						

Natural Moisture.........: 5.8
USDA Txt./USCS Class.: Loamy Sand
Struct./% Pass. #200...: 15.8

Consistency...............: Loose
Water Table Depth...: Not Encountered
Init. Saturation Time.:

Notes: $Ksat_B$ is determ. by averag. and/or Rndng. the results for the final three or four stabilized values and analyzing the Flow Rate Q vs Total Elapsed Time Graph.

*Glover, R. E. l953. Flow from a test-hole located above groundwater level. pp. 69-71. in: Theory and Problems of Water Percolation. (C. N. Zanger. ed.). USBR. The condition for this solution exists when the distance from the bottom of the borehole to the water table or an impervious layer is at least 2X the depth of the water in the borehole. **H/r ≥5 to ≥10. ***JP-M1: h = 15cm, JP-M2: h = 10cm. Johnson Permeameter, LLC Revised 5/26/2014

Constant-Head Borehole Permeameter Test

Glover Solution (Deep WT or Impervious Layer)

File Name.....: GloverRE-deep-WT

Project Name........: Fort Dupont Ice Arena
Project No.............: 1383
Project Location...: 3779 Ely Place SE, Washington DC 20019
Boring No...........: IT-3
Investigators......: SWP
Date..................: 9-3-14

Boring Depth.........: 10.5 Ft **(m, cm, ft, in)**
Boring Diameter...: 11.4 **cm**
Boring Radius r.....: 5.72 **cm**
Soil/Water Tmp. T: 30 **°C**
Dyn. Visc. @ T......: 0.000798 **kg/m·s**

WCU Base Ht. h: 10.0 **cm*****
WCU Susp. Ht. S: 0.0 **cm**
Const. Wtr. Ht. H: 10.0 **cm**
H/r..................:** 1.7
Dyn. Visc. @ T_B.: 0.001003 **kg/m·s**

Solution and Terminology (R. E. Glover Solution)*

$Ksat = Q[\sinh^{-1}(H/r) - (r^2/H^2+1)^{.5} + r/H]/(2\pi H^2)$ [Basic Glover Solution]

$Ksat_B = QV[\sinh^{-1}(H/r) - (r^2/H^2+1)^{.5} + r/H]/(2\pi H^2)$ [Temperature-corrected]

$Ksat_B$: (Coefficient of Permeability, K) @ Base Tmp. T_B °C: 20
Q: Rate of flow of water from the borehole
H: Constant height of water in the borehole
r: Radius of the cylindrical borehole
V: Dynamic viscosity of water @ T °C/Dyn. Visc. of water @ T_B °C

VOLUME (ml)	Volume Out (ml)	TIME (h:mm:ss A/P)	Interval Elapsed Time (hr:min:sec)	(min)	Flow Rate Q (ml/min)	-------------------- $Ksat_B$ Equivalent Values ------------------------- (µm/sec)	(cm/sec)	(cm/day)	(in/hr)	(ft/day)
3,210		1:29:00 PM								
3,205	5	1:39:00 PM	0:10:00	10.00	0.50	0.1	7.87E-06	0.7	0.01	0.02
3,205	0	1:55:00 PM	0:16:00	16.00	0.00	0.0	0.00E+00	0.0	0.00	0.00
3,205	0	2:05:00 PM	0:10:00	10.00	0.00	0.0	0.00E+00	0.0	0.00	0.00

Natural Moisture.........: 13.9
USDA Txt./USCS Class.: Sandy Clay Loam
Struct./% Pass. #200...: 57.1
Consistency...............: Stiff
Water Table Depth...: Not Encountered
Init. Saturation Time.:
Total Time (min) 36.00

Enter $Ksat_B$ Value: 0.0 | 2.62E-06 | 0.2 | 0.00 | 0.01

Notes: $Ksat_B$ is determ. by averag. and/or Rndng. the results for the final three or four stabilized values and analyzing the Flow Rate Q vs Total Elapsed Time Graph.

*Glover, R. E. l953. Flow from a test-hole located above groundwater level. pp. 69-71. in: Theory and Problems of Water Percolation. (C. N. Zanger. ed.). USBR. The condition for this solution exists when the distance from the bottom of the borehole to the water table or an impervious layer is at least 2X the depth of the water in the borehole. **H/r ≥5 to ≥10. ***JP-M1: h = 15cm, JP-M2: h = 10cm. Johnson Permeameter, LLC Revised 5/26/2014

Constant-Head Borehole Permeameter Test

Glover Solution (Deep WT or Impervious Layer)

File Name.....: GloverRE-deep-WT

Project Name........:	Fort Dupont Ice Arena	**Boring No...........:**	IT-4	**Solution and Terminology (R. E. Glover Solution)***	
Project No.............:	1383	**Investigators......:**	RPH	$Ksat = Q[\sinh^{-1}(H/r) - (r^2/H^2+1)^{.5} + r/H]/(2\pi H^2)$ [Basic Glover Solution]	
Project Location...:	3779 Ely Place SE, Washington DC 20019	**Date..................:**	9-8-14	$Ksat_B= QV[\sinh^{-1}(H/r) - (r^2/H^2+1)^{.5} + r/H]/(2\pi H^2)$ [Temperature-corrected]	
Boring Depth.........:	10 Ft **(m, cm, ft, in)**	**WCU Base Ht. h:**	10.0 **cm*****	$Ksat_B$: (Coefficient of Permeability, K) @ Base Tmp. T_B °C:	20
Boring Diameter...:	11.4 **cm**	**WCU Susp. Ht. S:**	0.0 **cm**	Q: Rate of flow of water from the borehole	
Boring Radius r.....:	5.72 **cm**	**Const. Wtr. Ht. H:**	10.0 **cm**	H: Constant height of water in the borehole	
Soil/Water Tmp. T:	24 **°C**	**H/r**..................:**	1.7	r: Radius of the cylindrical borehole	
Dyn. Visc. @ T......:	0.000911 **kg/m·s**	**Dyn. Visc. @ T_B.:**	0.001003 **kg/m·s**	V: Dynamic viscosity of water @ T °C/Dyn. Visc. of water @ T_B °C	

VOLUME (ml)	Volume Out (ml)	TIME (h:mm:ss A/P)	Interval Elapsed Time		Flow Rate Q (ml/min)	-------------------- $Ksat_B$ Equivalent Values -------------------------				
			(hr:min:sec)	(min)		(µm/sec)	(cm/sec)	(cm/day)	(in/hr)	(ft/day)
130		12:02:00 PM								
127	3	12:12:00 PM	0:10:00	10.00	0.30	0.1	5.39E-06	0.5	0.01	0.02
127	0	12:22:00 PM	0:10:00	10.00	0.00	0.0	0.00E+00	0.0	0.00	0.00
127	0	12:42:00 PM	0:20:00	20.00	0.01	0.0	1.80E-07	0.0	0.00	0.00
127	0	1:02:00 PM	0:20:00	20.00	0.00	0.0	4.49E-08	0.0	0.00	0.00
127	0	1:27:00 PM	0:25:00	25.00	0.00	0.0	0.00E+00	0.0	0.00	0.00
127	0	1:52:00 PM	0:25:00	25.00	0.00	0.0	0.00E+00	0.0	0.00	0.00
127	0	2:17:00 PM	0:25:00	25.00	0.00	0.0	0.00E+00	0.0	0.00	0.00

Natural Moisture.........:	12.5	**Consistency...............:**	Stiff	**Total Time (min)**	**Enter $Ksat_B$ Value:**	**0.0**	**0.00E+00**	**0.0**	**0.00**	**0.00**
USDA Txt./USCS Class.:	Sandy Clay Loam	**Water Table Depth...:**	6.5			Notes: $Ksat_B$ is determ. by averag. and/or Rndng. the results for the final three or four stabilized values and analyzing the Flow Rate Q vs Total Elapsed Time Graph.				
Struct./% Pass. #200...:	28.3	**Init. Saturation Time.:**		135.00						

*Glover, R. E. l953. Flow from a test-hole located above groundwater level. pp. 69-71. in: Theory and Problems of Water Percolation. (C. N. Zanger. ed.). USBR. The condition for this solution exists when the distance from the bottom of the borehole to the water table or an impervious layer is at least 2X the depth of the water in the borehole. **H/r ≥5 to ≥10. ***JP-M1: h = 15cm, JP-M2: h = 10cm. Johnson Permeameter, LLC Revised 5/26/2014

Constant-Head Borehole Permeameter Test

Glover Solution (Deep WT or Impervious Layer)

File Name.....: GloverRE-deep-WT

Project Name........: Fort Dupont Ice Arena
Project No.............: 1383
Project Location...: 3779 Ely Place SE, Washington DC 20019
Boring No...........: IT-5
Investigators......: RPH
Date..................: 9-8-14

Boring Depth.........: 10 Ft **(m, cm, ft, in)**
Boring Diameter...: 11.4 **cm**
Boring Radius r.....: 5.72 **cm**
Soil/Water Tmp. T: 24 **°C**
Dyn. Visc. @ T......: 0.000911 **kg/m·s**

WCU Base Ht. h: 10.0 **cm*****
WCU Susp. Ht. S: 0.0 **cm**
Const. Wtr. Ht. H: 10.0 **cm**
H/r..................:** 1.7
Dyn. Visc. @ T_B.: 0.001003 **kg/m·s**

Solution and Terminology (R. E. Glover Solution)*

Ksat = $Q[\sinh^{-1}(H/r) - (r^2/H^2+1)^{.5} + r/H]/(2\pi H^2)$ [Basic Glover Solution]

$Ksat_B$= $QV[\sinh^{-1}(H/r) - (r^2/H^2+1)^{.5} + r/H]/(2\pi H^2)$ [Temperature-corrected]

$Ksat_B$: (Coefficient of Permeability, K) @ Base Tmp. T_B °C: 20

Q: Rate of flow of water from the borehole

H: Constant height of water in the borehole

r: Radius of the cylindrical borehole

V: Dynamic viscosity of water @ T °C/Dyn. Visc. of water @ T_B °C

VOLUME (ml)	Volume Out (ml)	TIME (h:mm:ss A/P)	Interval Elapsed Time (hr:min:sec)	(min)	Flow Rate Q (ml/min)	-------------------- $Ksat_B$ Equivalent Values ------------------------- (µm/sec)	(cm/sec)	(cm/day)	(in/hr)	(ft/day)
130		10:02:00 AM								
119	11	10:12:00 AM	0:10:00	10.00	1.12	0.2	2.01E-05	1.7	0.03	0.06
119	0	10:22:00 AM	0:10:00	10.00	0.00	0.0	8.98E-08	0.0	0.00	0.00
119	0	10:32:00 AM	0:10:00	10.00	0.03	0.0	4.49E-07	0.0	0.00	0.00
119	0	10:42:00 AM	0:10:00	10.00	0.00	0.0	0.00E+00	0.0	0.00	0.00
119	0	10:52:00 AM	0:10:00	10.00	0.00	0.0	0.00E+00	0.0	0.00	0.00
118	0	11:17:00 AM	0:25:00	25.00	0.01	0.0	1.80E-07	0.0	0.00	0.00
118	0	11:42:00 AM	0:25:00	25.00	0.01	0.0	1.08E-07	0.0	0.00	0.00

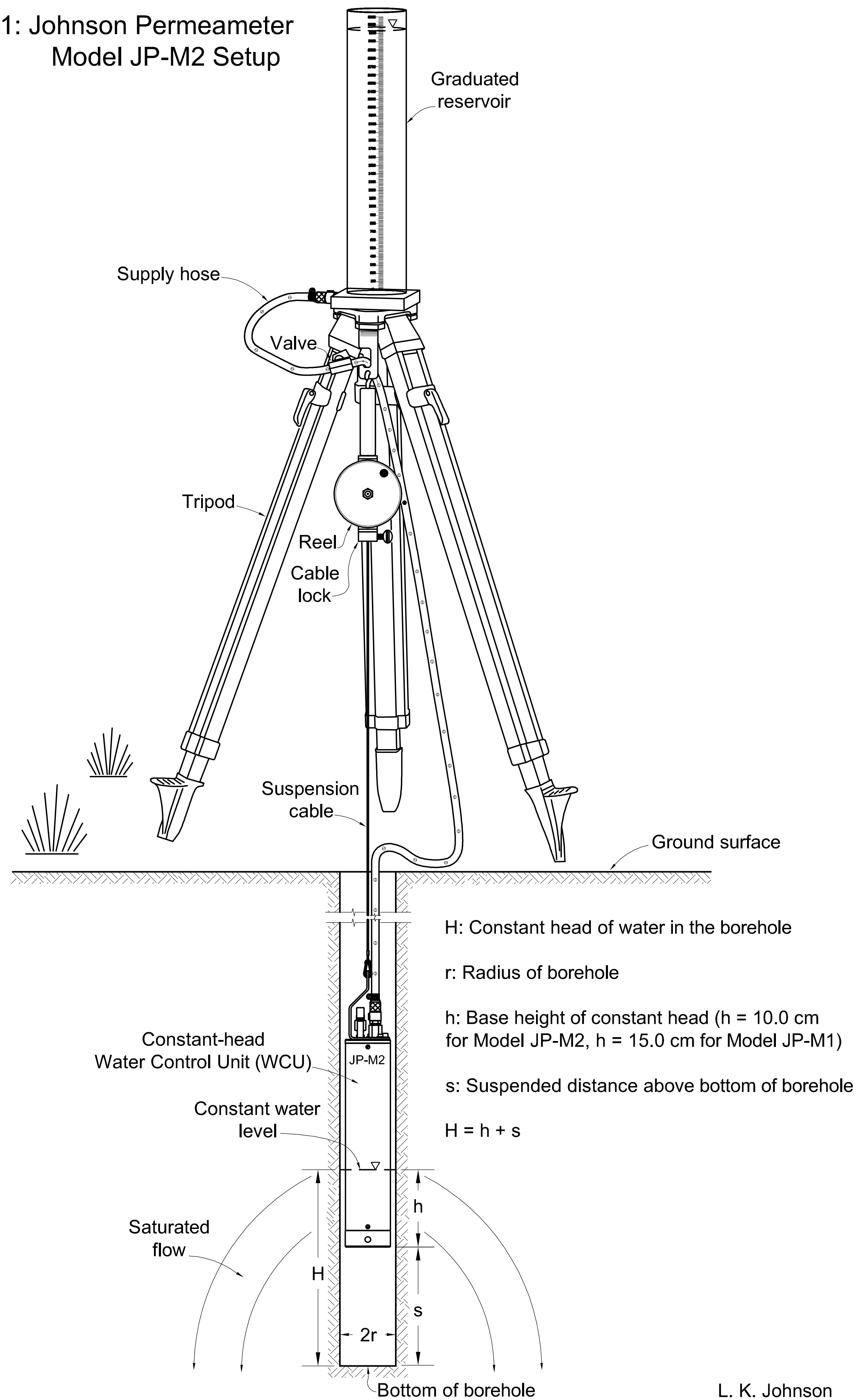
Natural Moisture.........: 17.3
USDA Txt./USCS Class.: Sandy Clay Loam
Struct./% Pass. #200...: 84.1
Consistency...............: Stiff
Water Table Depth...: 48.5
Init. Saturation Time.:
Total Time (min) 100.00

Enter $Ksat_B$ Value: 0.0 | 9.58E-08 | 0.0 | 0.00 | 0.00

Notes: $Ksat_B$ is determ. by averag. and/or Rndng. the results for the final three or four stabilized values and analyzing the Flow Rate Q vs Total Elapsed Time Graph.

*Glover, R. E. l953. Flow from a test-hole located above groundwater level. pp. 69-71. in: Theory and Problems of Water Percolation. (C. N. Zanger. ed.). USBR. The condition for this solution exists when the distance from the bottom of the borehole to the water table or an impervious layer is at least 2X the depth of the water in the borehole. **H/r ≥5 to ≥10. ***JP-M1: h = 15cm, JP-M2: h = 10cm. Johnson Permeameter, LLC Revised 5/26/2014

Drawing 1: Johnson Permeameter Model JP-M2 Setup



H: Constant head of water in the borehole

r: Radius of borehole

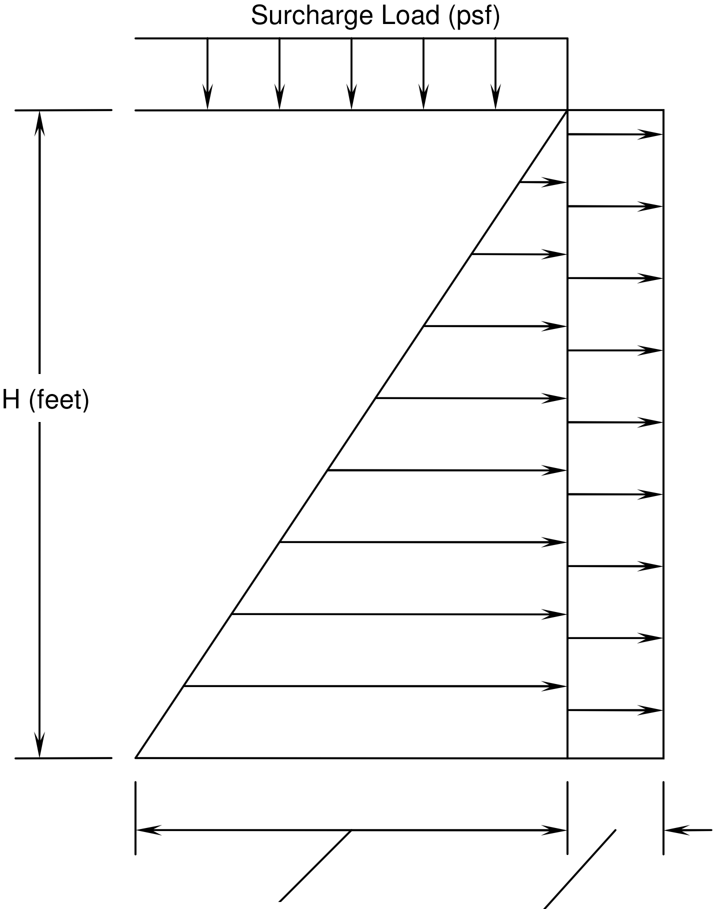
h: Base height of constant head (h = 10.0 cm for Model JP-M2, h = 15.0 cm for Model JP-M1)

s: Suspended distance above bottom of borehole

$H = h + s$

L. K. Johnson

LATERAL EARTH PRESSURE DIAGRAM - DRAINED



Lateral Earth Pressure = 60H psf
(For below grade walls restrained from movement
at top and bottom, drained conditions presumed)

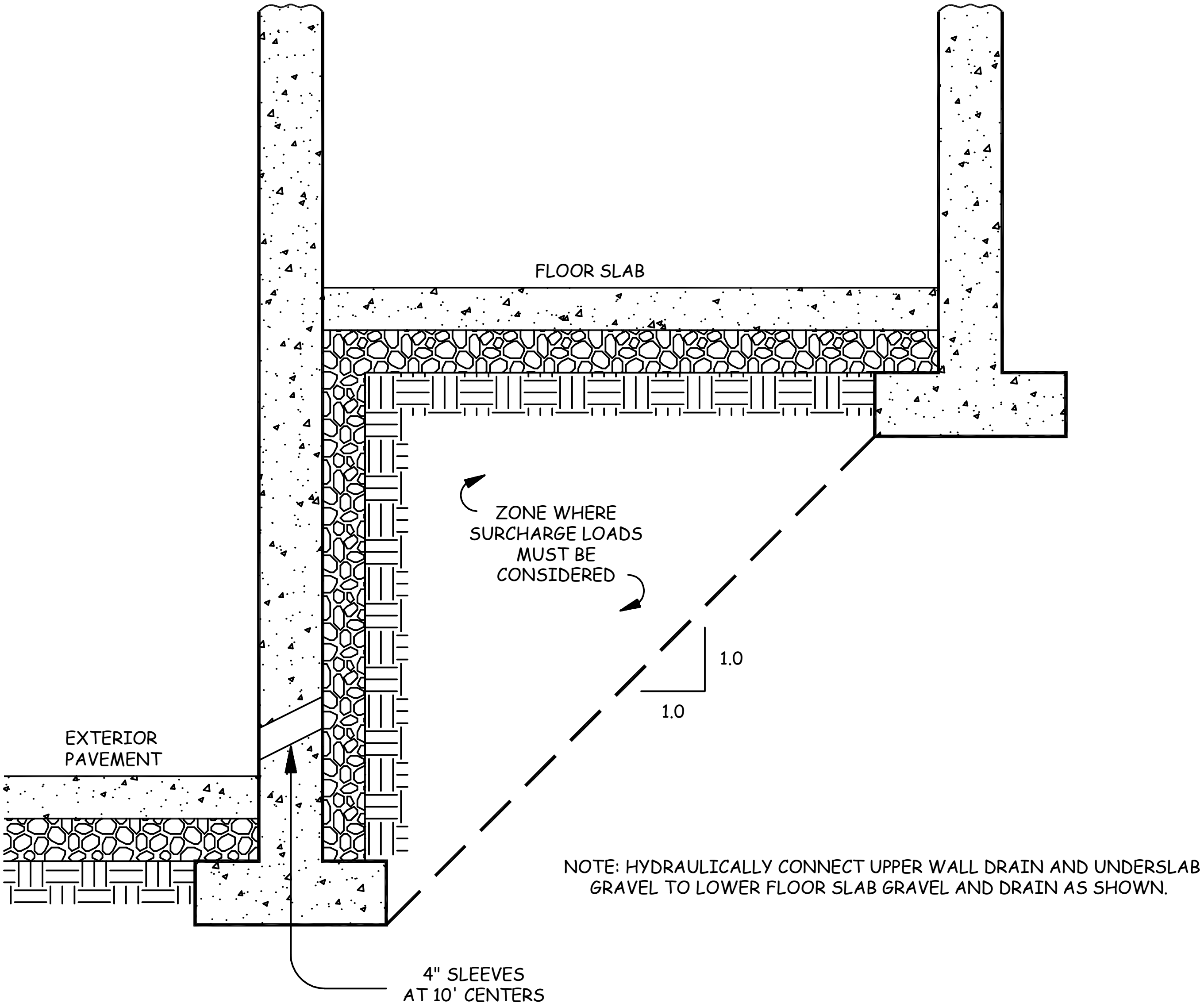
Horizontal Pressure from Surcharge
= 0.5 x Vertical Surcharge

This diagram is not suitable for the design of Support of Excavation or temporary shoring systems.

ZONE OF INFLUENCE DIAGRAM

(EXTERIOR WALLS)

NOT TO SCALE

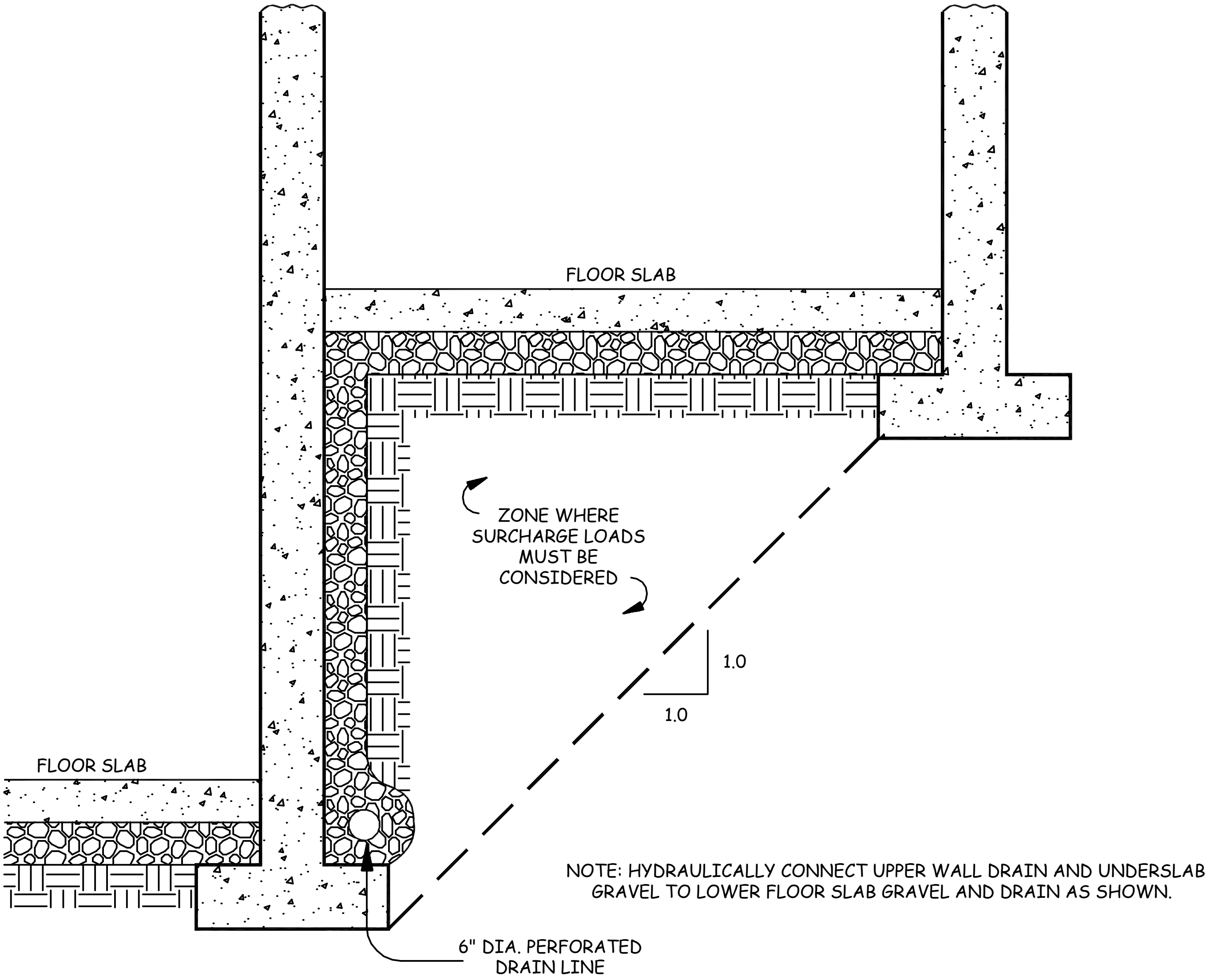


NOTE: HYDRAULICALLY CONNECT UPPER WALL DRAIN AND UNDERSLAB GRAVEL TO LOWER FLOOR SLAB GRAVEL AND DRAIN AS SHOWN.

ZONE OF INFLUENCE DIAGRAM

(INTERIOR WALLS)

NOT TO SCALE

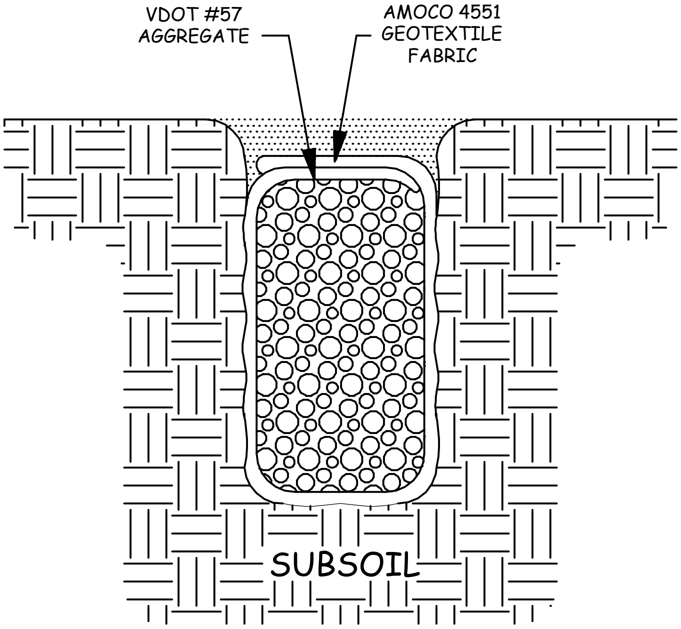


NOTE: HYDRAULICALLY CONNECT UPPER WALL DRAIN AND UNDERSLAB GRAVEL TO LOWER FLOOR SLAB GRAVEL AND DRAIN AS SHOWN.

FRENCH DRAIN
INSTALLATION PROCEDURE

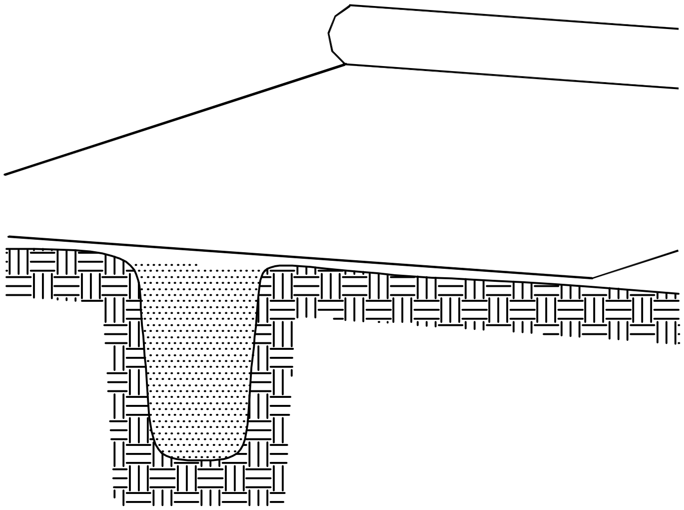
NOT TO SCALE

FINAL CONFIGURATION



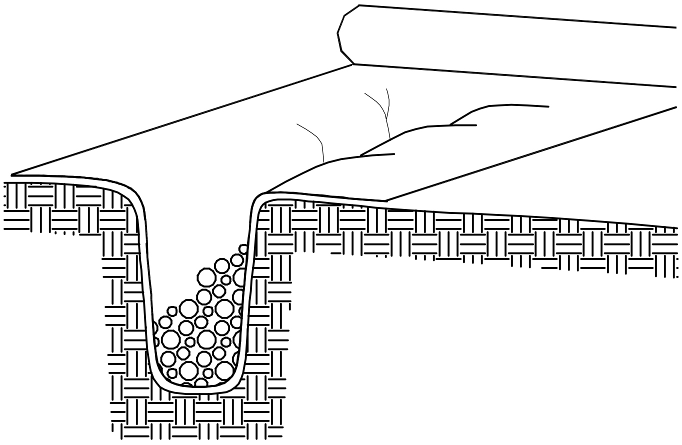
SUBDRAIN USING FILTER FABRIC

STEP 1



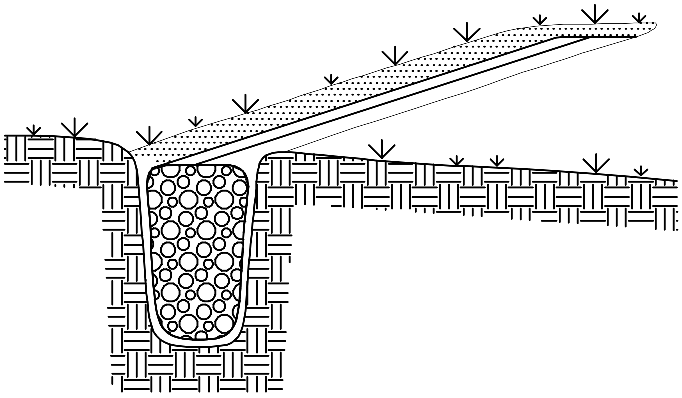
FABRIC IS UNROLLED DIRECTLY OVER TRENCH

STEP 2



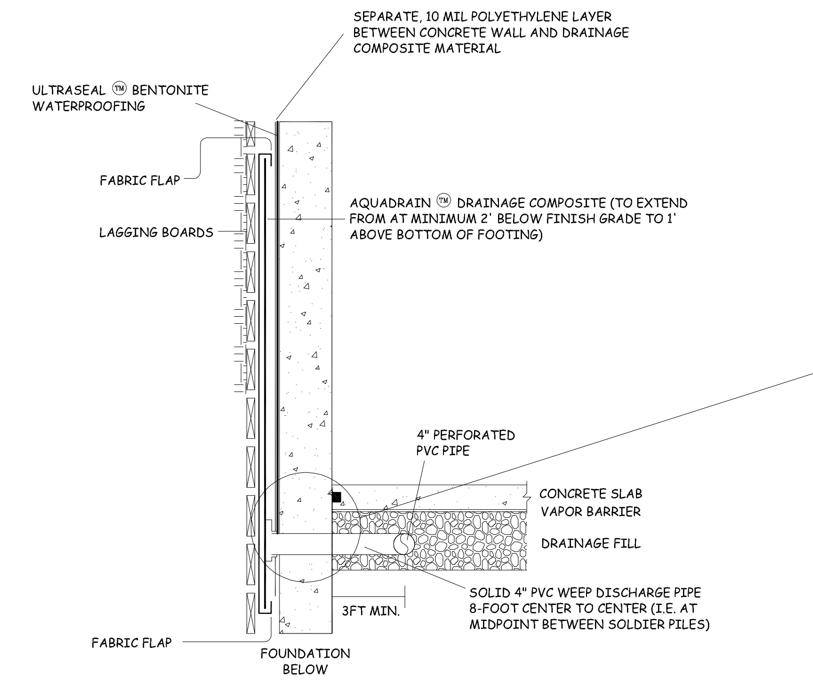
THE TRENCH IS FILLED WITH AGGREGATE

STEP 3



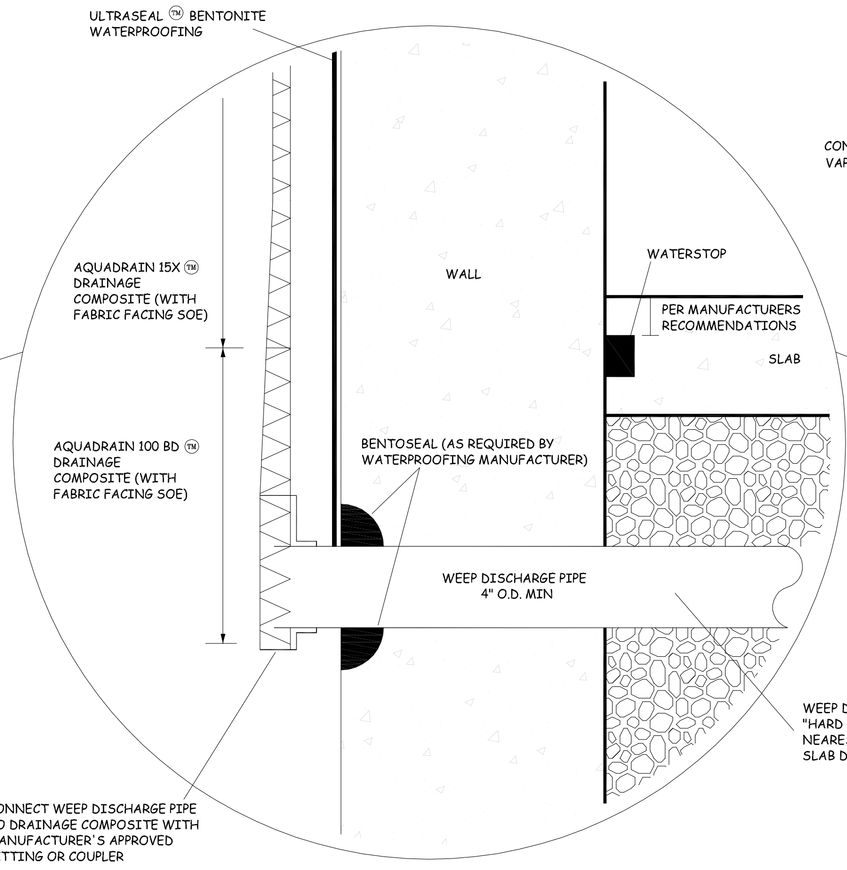
THE FABRIC IS LAPPED CLOSED AND
COVERED WITH BASE STONE

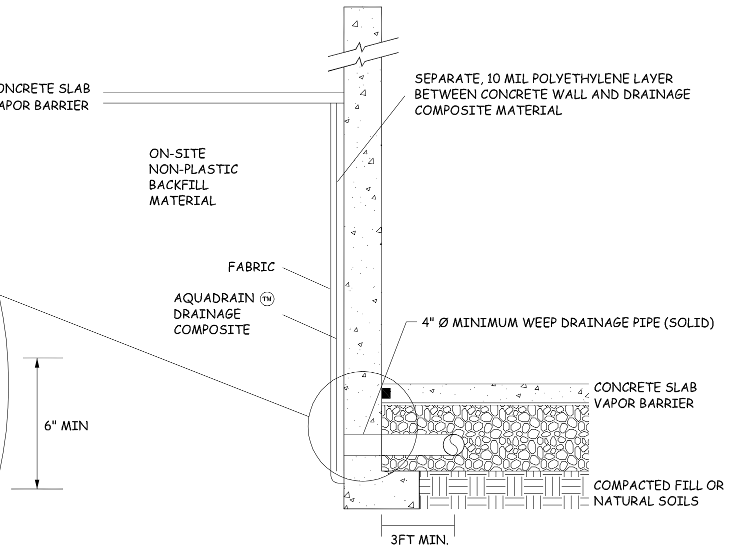
C:\data\dwg\dtls\UNDERSLAB_DTL.dwg, 9/10/2013 2:42:46 PM, ECS Mid-Atlantic, LLC Chantilly, VA



EXTERIOR WALL DRAIN DETAIL (TYPICAL) - DRAINED CONDITION (1.0)

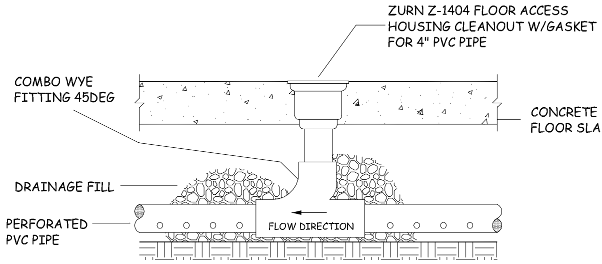
(NTS)





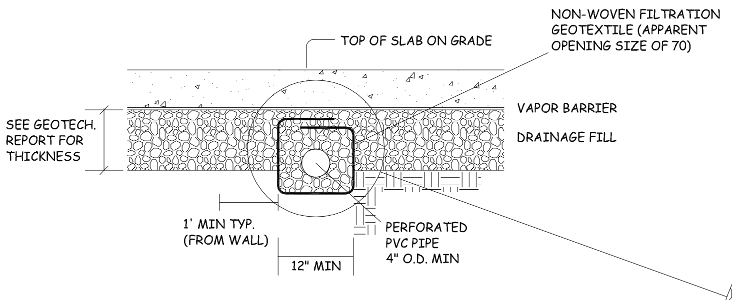
INTERIOR BELOW GRADE WALL DETAIL (2.0)

(NTS)



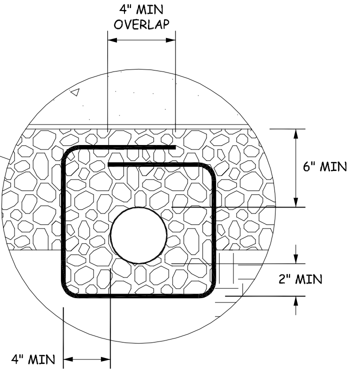
CLEANOUT DETAIL (TYPICAL) - PERFORATED PIPE (3.0)

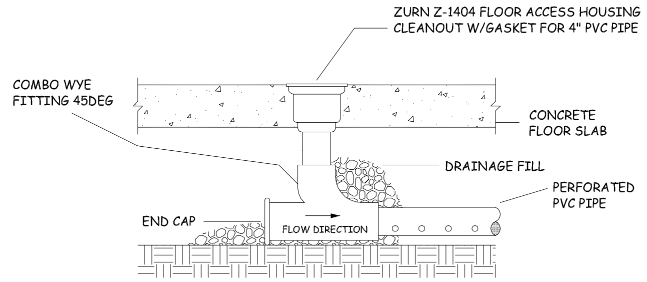
(NTS)



UNDERSLAB DRAIN DETAIL (TYP) (4.0)

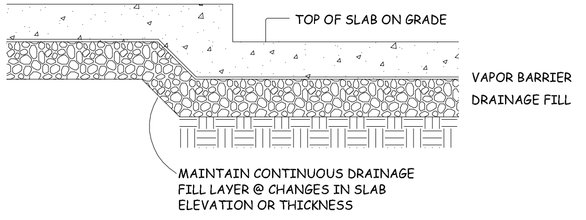
(NTS)





CLEANOUT DETAIL W/END CAP - PERFORATED PIPE (5.0)

(NTS)



DRAINAGE LAYER STEP DETAIL (TYP) (6.0)

(NTS)

NOTES:

1) PRODUCTS SPECIFIED MAY BE SUBSTITUTED WITH AN EQUIVALENT PRODUCT, UPON REVIEW AND APPROVAL OF ECS.

2) GEOTEXTILE FILTER FABRIC TO CONTACT LAGGING OR SOIL, NOT THE CONCRETE WALL.

3) A GEOTEXTILE WRAPPED ADS DRAIN LINE MAY NOT BE SUBSTITUTED IN LIEU OF DETAIL 4.0.

4) 4" MINIMUM DIAMETER WEEP HOLES (SOLID PVC) TO BE LOCATED AT 8 FOOT CENTER TO CENTER (I.E. AT MIDPOINT BETWEEN SOLDIER PILES, ADJUSTED IN THE FIELD AS REQUIRED). THESE WEEPS SHOULD BE "HARD PIPE" CONNECTED TO THE NEAREST PERPINDICULAR UNDERSLAB DRAIN PIPE.

5) DRAINAGE & WATERPROOFING COMPOSITE ON EXTERIOR OF BELOW GRADE WALLS TO BE CONTINUOUS AROUND WALLS AND ALL SIDES OF EXCAVATION.

6) SEE MANUFACTURER'S DETAIL FOR CONNECTION BETWEEN DRAINAGE PANELS.

7) A NON-WOVEN FILTRATION GEOTEXTILE (MIRAFI 140N OR EQUIVALENT) SHOULD BE PLACED IN THE TRENCHES, PRIOR TO THE PLACEMENT OF THE UNDERSLAB DRAINAGE SYSTEM STONE AS SHOWN ON DETAIL 4.0. THE GEOTEXTILE SHOULD HAVE AN APPARENT OPENING SIZE OF 70 AND SHOULD BE PLACED IN ACCORDANCE WITH THE MANUFACTURER'S RECOMMENDATIONS. THE SAME FABRIC SHALL BE USED TO SURROUND THE PERFORATED DRAINAGE PIPE TRENCH.

8) MINIMUM 6-INCH GRAVEL COVER REQUIRED BETWEEN BOTTOM OF SLAB AND TOP OF PVC DRAIN PIPE.

9) MINIMUM OF 2-INCHES OF GRAVEL MUST LIE BELOW THE INVERT OF ALL DRAIN PIPES.

10) ULTRASEAL BENTONITE WATERPROOFING TO BE INSTALLED IN ACCORDANCE WITH MANUFACTURER'S RECOMMENDATIONS. ALTERNATIVE PRODUCT MAY BE SUBSTITUTED UPON REVIEW AND APPROVAL OF ECS.

11) MAINTENANCE OF THE UNDERSLAB DRAINAGE SYSTEM WILL BE REQUIRED. THE BUILDING ENGINEER WILL NEED TO DERIVE A SCHEDULE OF MAINTENANCE. ECS RECOMMENDS A MINIMUM OF MONTHLY INSPECTIONS OF THE SYSTEM DURING CONSTRUCTION, QUARTERLY INSPECTIONS POST-CONSTRUCTION FOR A PERIOD OF TWO YEARS, AND ANNUALLY THEREAFTER. SHOULD EXCESSIVE ACCUMULATION OF GRIT, IRON OCHRE, OR OTHER MATERIALS BE IDENTIFIED, MORE FREQUENT MAINTANANCE MAY BE REQUIRED.

12) UNLESS STEEPER SLOPES ARE IDENTIFIED ON THE LAYOUT PLAN, 4-INCH PERFORATED PVC DRAINS MUST BE SLOPED MINIMUM 0.5% TO APPROPRIATE DRAINAGE COLLECTION POINT.

13) IN CASE OF UTILITY CONFLICTS NOTIFY ENGINEER.

14) ECS SHOULD OBSERVE THE GROUNDWATER CONDITIONS DURING THE EXCAVATION PROCESS TO DETERMINE IF ADDITIONAL MEASURES ARE REQUIRED TO HANDLE ANY IRON OCHRE INTRUSION INTO THE UNDERSLAB DRAINAGE SYSTEM. SUCH MEASUREMENTS MAY INCLUDE BUT ARE NOT LIMITED TO REDUCED WEEP HOLE SPACING, ADDITIONAL CLEANOUTS, PERIODIC FLUSHING & CLEANING, ENLARGED PERFORATED PVC DRAIN LINES, ETC.

15) WATERSTOPS SHALL BE INSTALLED PER MANUFACTURER'S RECOMMENDATIONS.

16) HARD (SOILD) PIPE ONLY TO BE USED AT WEEP LOCATIONS, TO CONNECT WEEP TO PERFORATED UNDERSLAB PIPE & GRADE BEAM/WALL SLEEVES.

17) INSTALL GRIT COLLECTION CHAMBER UPSTREAM AND ADJACENT TO SUMP PUMPS.

BELOW-GRADE WALL WATERPROOFING AND UNDERSLAB DRAINAGE DIAGRAM

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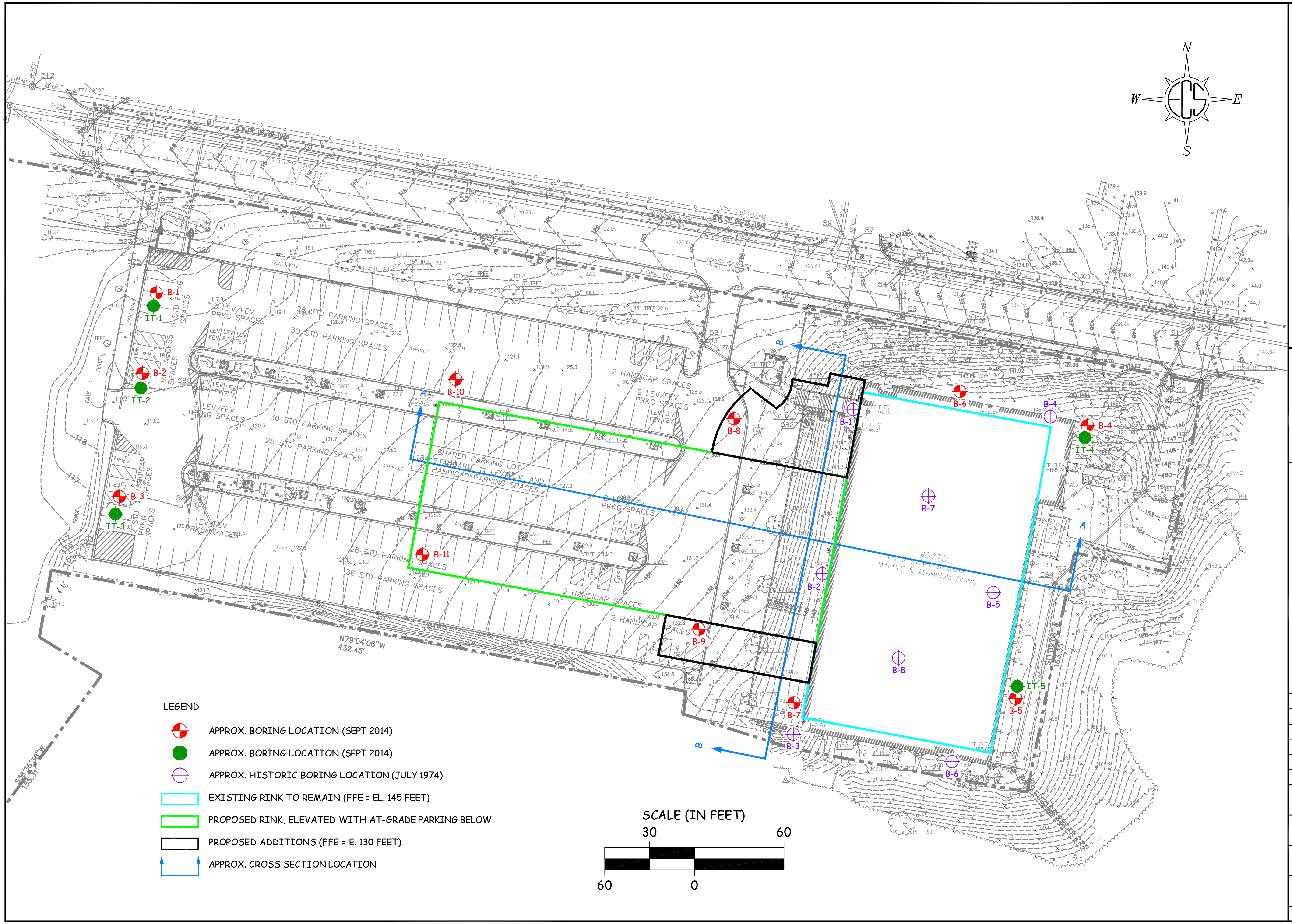


LEGEND

◉ APPROX. BORING LOCATION (SEPT 2014)

● APPROX. BORING LOCATION (SEPT 2014)

⊕ APPROX. HISTORIC BORING LOCATION (JULY 1974)

▭ EXISTING RINK TO REMAIN (FFE = EL. 145 FEET)

▭ PROPOSED RINK, ELEVATED WITH AT-GRADE PARKING BELOW

▭ PROPOSED ADDITIONS (FFE = E. 130 FEET)

↑ ↑ APPROX. CROSS SECTION LOCATION

FORT DUPONT
ICE ARENA
WASHINGTON, DC

BORING LOCATION DIAGRAM

QUINN EVANS ARCHITECTS

ECS REVISIONS

ENGINEER DS	DRAFTING RAC
SCALE 1"=60'	
PROJECT NO. 37:1383	
SHEET 1 OF 3	
DATE 10-01-14	

SOIL CLASSIFICATION LEGEND

ST - SHELBY TUBE
RC - ROCK CORE
PM - PRESSURE METER

- ▨ FILL - FILL (POSS/PROB) OF ALL TYPES.
- ▨ GW - WELL GRADED GRAVEL
- ▨ GM - SILTY GRAVEL
- ▨ GP - POORLY GRADED GRAVEL
- ▨ GC - CLAYEY GRAVEL
- ▨ SW - WELL GRADED SAND
- ▨ ML - LOW PLASTICITY SILT
- ▨ CL - LOW PLASTICITY CLAY
- ▨ MH - HIGH PLASTICITY SILT
- ▨ SM - SILTY SAND
- ▨ SP - POORLY GRADED SAND
- ▨ SC - CLAYEY SAND
- ▨ CH - HIGH PLASTICITY CLAY
- ▨ OH - HIGH PLASTICITY ORGANIC SILTS AND CLAYS
- ▨ OL - LOW PLASTICITY ORGANIC SILTS AND CLAY
- ▨ PT - PEAT
- ▨ WR - WEATHERED ROCK

SURFACE MATERIALS

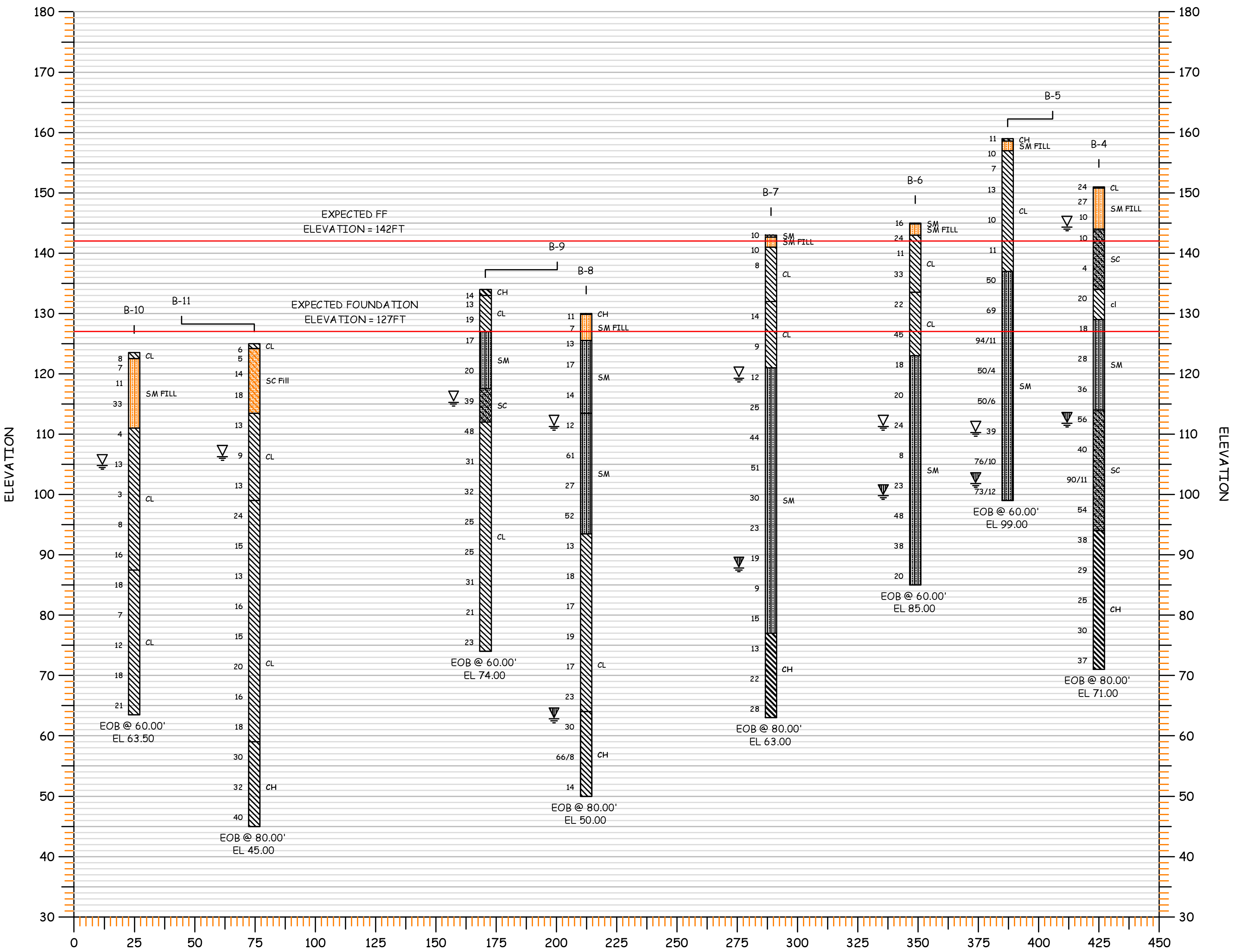
- ▨ TOPSOIL
- ■ ASPHALT
- ▨ GRAVEL
- ▨ CONCRETE
- ☐ VOID

ROCK TYPES

- ▨ IGNEOUS
- ▨ METAMORPHIC
- ▨ SEDIMENTARY

SYMBOL LEGEND

- ▽ WATER LEVEL - DURING DRILLING/SAMPLING
- ▽ WATER LEVEL - BEFORE CASING REMOVAL
- ▼ WATER LEVEL - AFTER CASING REMOVAL
- ▽ WATER LEVEL - AFTER 24 HOURS



SCALE
VERTICAL SCALE 1"=20'
HORIZONTAL SCALE 1"=50'

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FORT DUPONT
ICE ARENA
WASHINGTON, DC

CROSS SECTION
A-A
QUINN EVANS ARCHITECTS

ECS REVISIONS

ENGINEER	DRAFTING
DS	RAC

SCALE: AS NOTED
PROJECT NO. 37:1383
SHEET 2 OF 3
DATE 10-01-14

SOIL CLASSIFICATION LEGEND

ST - SHELBY TUBE
RC - ROCK CORE
PM - PRESSURE METER

- FILL - FILL (POSS/PROB) OF ALL TYPES.
- GW - WELL GRADED GRAVEL
- GM - SILTY GRAVEL
- GP - POORLY GRADED GRAVEL
- GC - CLAYEY GRAVEL
- SW - WELL GRADED SAND
- ML - LOW PLASTICITY SILT
- CL - LOW PLASTICITY CLAY
- MH - HIGH PLASTICITY SILT
- SM - SILTY SAND
- SP - POORLY GRADED SAND
- SC - CLAYEY SAND
- CH - HIGH PLASTICITY CLAY
- OH - HIGH PLASTICITY ORGANIC SILTS AND CLAYS
- OL - LOW PLASTICITY ORGANIC SILTS AND CLAY
- PT - PEAT
- WR - WEATHERED ROCK

SURFACE MATERIALS

- TOPSOIL
- ASPHALT
- GRAVEL
- CONCRETE
- VOID

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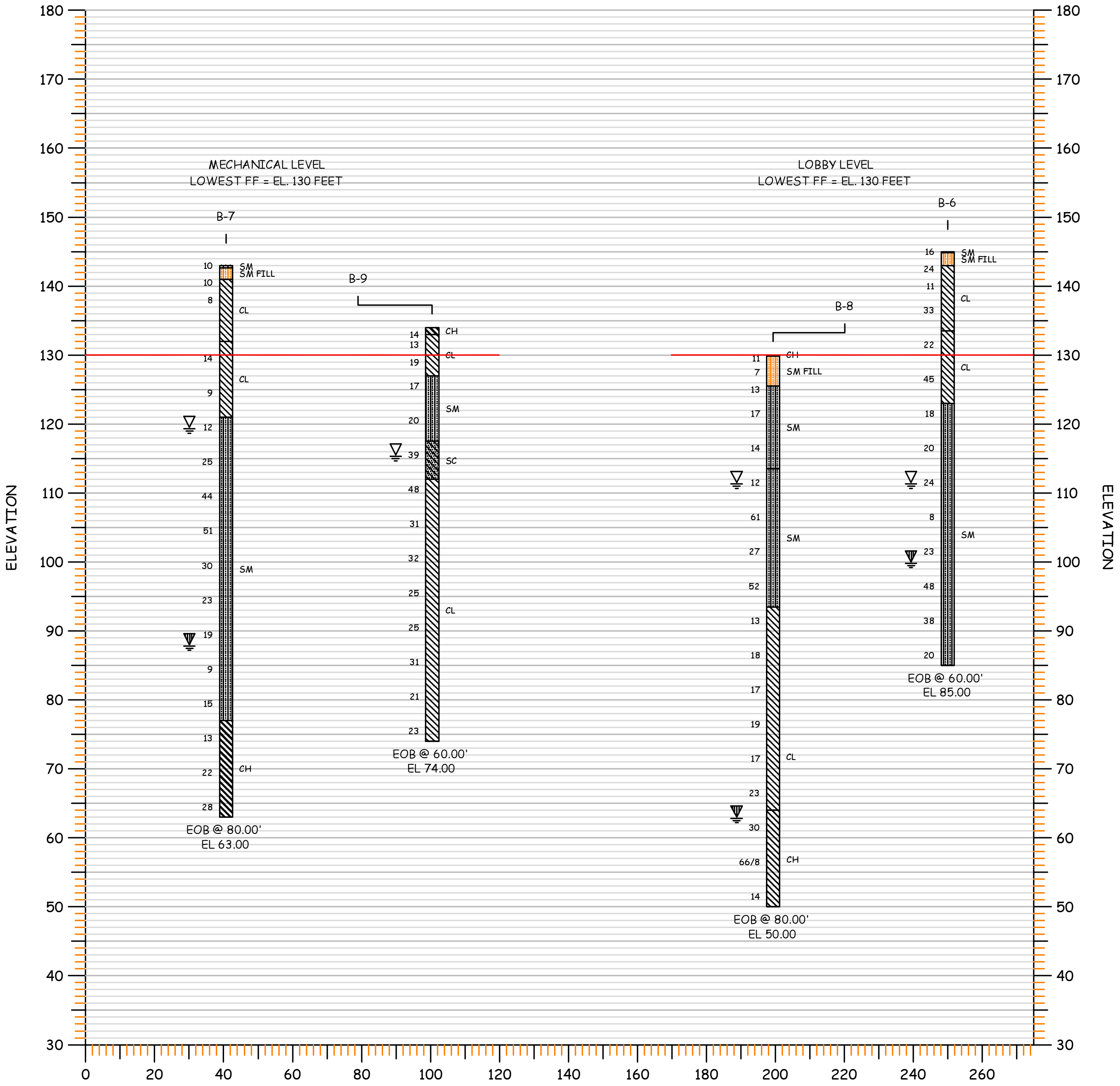
- IGNEOUS
- METAMORPHIC
- SEDIMENTARY

SYMBOL LEGEND

- ▽ WATER LEVEL - DURING DRILLING/SAMPLING
- ▽ WATER LEVEL - BEFORE CASING REMOVAL
- ▼ WATER LEVEL - AFTER CASING REMOVAL
- ▽ WATER LEVEL - AFTER 24 HOURS



SCALE
VERTICAL SCALE 1"=20'
HORIZONTAL SCALE 1"=40'

FORT DUPONT
ICE ARENA
WASHINGTON, DC

CROSS SECTION
B-B

QUINN EVANS ARCHITECTS

ECS REVISIONS

ENGINEER	DRAFTING
DS	RAC

SCALE AS NOTED

PROJECT NO. 37:1383

SHEET 3 OF 3

DATE 10-01-14

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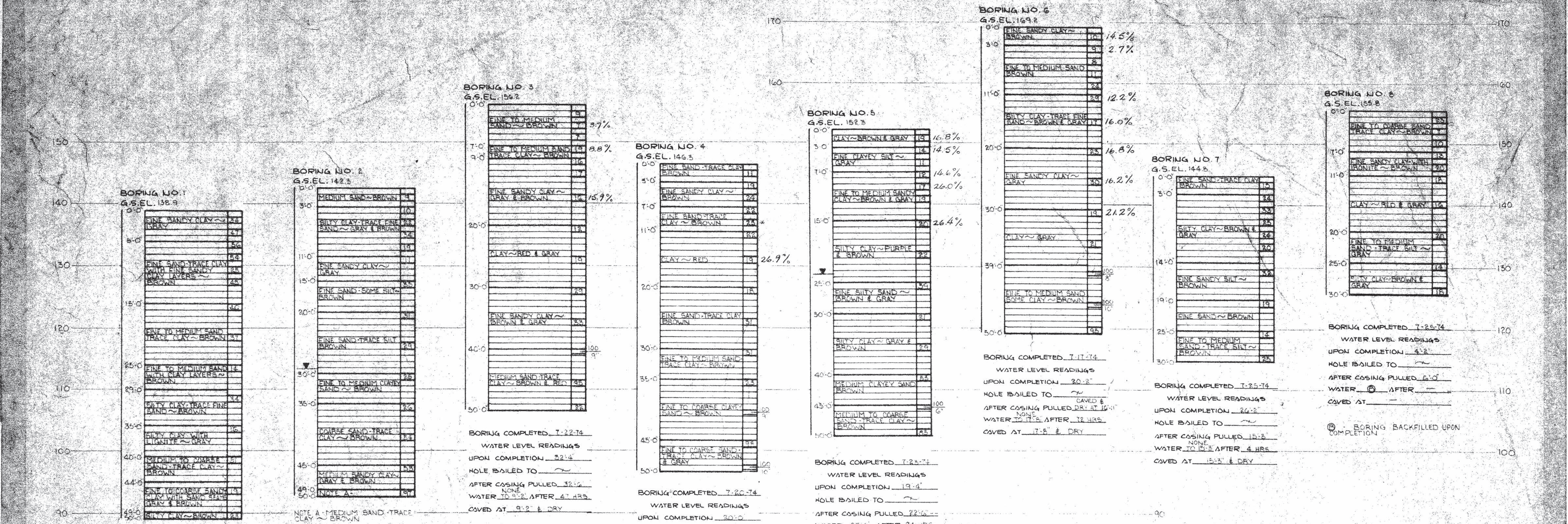


BORING COMPLETED 7-17-74
WATER LEVEL READINGS
UPON COMPLETION 19'-7"
HOLE BAILED TO ~
AFTER CASING PULLED CAVED & DRY AT 25'-9"
WATER NONE TO 24'-9 AFTER 77 HRS.
CAVED AT 24'-9 & DRY

BORING COMPLETED 7-24-74
WATER LEVEL READINGS
UPON COMPLETION 21'-2"
HOLE BAILED TO ~
AFTER CASING PULLED 18'-4
WATER 29'-2" AFTER 24 HRS.
CAVED AT 31'-4

BORING COMPLETED 7-22-74
WATER LEVEL READINGS
UPON COMPLETION 32'-4
HOLE BAILED TO ~
AFTER CASING PULLED 32'-6
WATER NONE TO 9'-2 AFTER 47 HRS.
CAVED AT 9'-2" & DRY

BORING COMPLETED 7-20-74
WATER LEVEL READINGS
UPON COMPLETION 30'-0
HOLE BAILED TO ~
AFTER CASING PULLED 20'-0"
WATER NONE TO 9'-4 AFTER 48 HRS.
CAVED AT 9'-4" & DRY

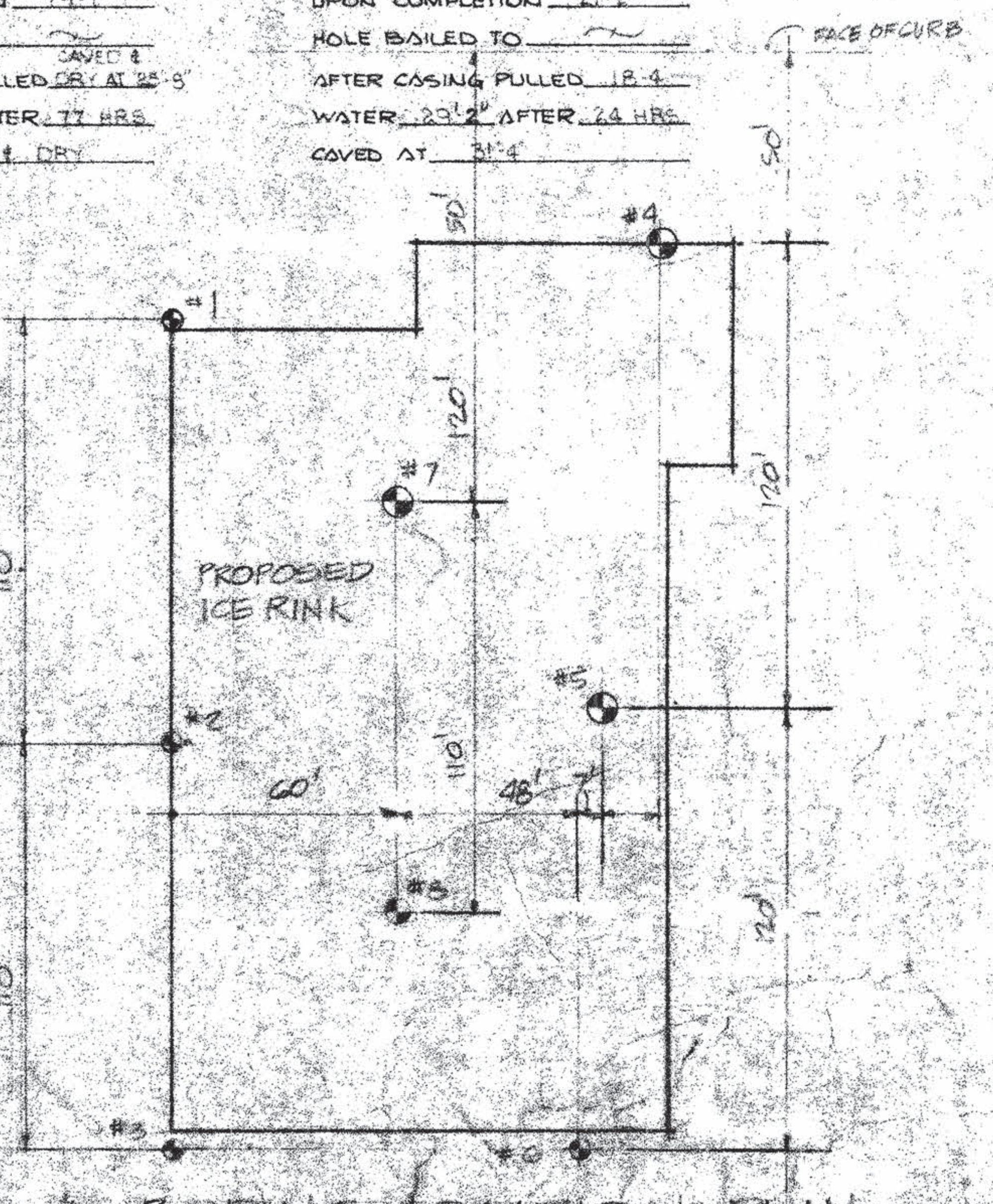
BORING COMPLETED 7-23-74
WATER LEVEL READINGS
UPON COMPLETION 19'-4"
HOLE BAILED TO ~
AFTER CASING PULLED 22'-6"
WATER 23'-6 AFTER 24 HRS.
CAVED AT 29'-4"

BORING COMPLETED 7-17-74
WATER LEVEL READINGS
UPON COMPLETION 20'-2"
HOLE BAILED TO ~
AFTER CASING PULLED CAVED & DRY AT 16'-11"
WATER NONE TO 17'-8 AFTER 72 HRS.
CAVED AT 17'-8" & DRY

BORING COMPLETED 7-25-74
WATER LEVEL READINGS
UPON COMPLETION 26'-2"
HOLE BAILED TO ~
AFTER CASING PULLED 15'-3"
WATER NONE TO 15'-3 AFTER 4 HRS.
CAVED AT 15'-3" & DRY

BORING COMPLETED 7-25-74
WATER LEVEL READINGS
UPON COMPLETION 4'-2"
HOLE BAILED TO ~
AFTER CASING PULLED 6'-0"
WATER Ⓑ AFTER —
CAVED AT —

Ⓑ - BORING BACKFILLED UPON COMPLETION



BORING LOCATION PLAN

1"=40'

GENERAL NOTES

1. NUMBER IN RIGHT HAND COLUMN OF BORING LOG INDICATES BLOWS REQUIRED TO DRIVE A 2 IN.O.D., 1-3/8 IN. I.D. SAMPLING SPOON ONE FOOT USING A 140 POUND HAMMER FALLING 30 INCHES.
2. CLASSIFICATION OF SOIL BY VISUAL INSPECTION AND IN ACCORDANCE WITH THE UNIFIED SOIL CLASSIFICATION SYSTEM.
3. ESTIMATED GROUNDWATER LEVELS INDICATED BY ▼ ; THESE LEVELS ARE ONLY ESTIMATES FROM AVAILABLE DATA AND MAY VARY WITH PRECIPITATION, POROSITY OF THE SOIL, SITE TOPOGRAPHY, ETC.
4. REFUSAL AT THE SURFACE OF ROCK, BOULDER, OR OBSTRUCTION IS DEFINED AS A PENETRATION RESISTANCE OF 100 BLOWS FOR 2 INCHES PENETRATION OR LESS.
5. BORING FOREMAN: R. STIDHAM
6. KEY TO ABBREVIATIONS AND SYMBOLS: G.S. = GROUND SURFACE * NO SAMPLE RECOVERY
7. BENCH MARK FOR ELEVATIONS: TOP OF F.H. ON SOUTH SIDE OF ELY PLACE OPPOSITE [illegible] PLACE AS SHOWN, EL. [illegible]
8. THE BORING LOGS AND RELATED INFORMATION DEPICT SUBSURFACE CONDITIONS ONLY AT THESE SPECIFIC LOCATIONS AND AT THE PARTICULAR TIME WHEN DRILLED. SOIL CONDITIONS AT OTHER LOCATIONS MAY DIFFER FROM CONDITIONS OCCURING AT THESE BORING LOCATIONS. ALSO, THE PASSAGE OF TIME MAY RESULT IN A CHANGE IN THE SUBSURFACE SOIL AND GROUND-WATER CONDITIONS AT THESE BORING LOCATIONS.
9. THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL & ROCK TYPES AS DETERMINED IN THE DRILLING & SAMPLING OPERATION. SOME VARIATION MAY ALSO BE EXPECTED VERTICALLY BETWEEN SAMPLES TAKEN. THE SOIL PROFILE, WATER LEVEL OBSERVATIONS & PENETRATION RESISTANCES PRESENTED ON THIS DRAWING HAVE BEEN MADE WITH REASONABLE CARE & ACCURACY & MUST BE CONSIDERED ONLY AN APPROXIMATE REPRESENTATION OF SUBSURFACE CONDITIONS ENCOUNTERED AT THE PARTICULAR LOCATION.
10. PERCENTAGES TO THE RIGHT OF BORING LOGS INDICATE THE NATURAL MOISTURE CONTENT OF [illegible].

PROJECT NO
3500-0624D

883/41000B

9/27/74

36
X-1
81