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REVISED REPORT OF GEOTECHNICAL EXPLORATION AND REVIEW

Downtown East Pedestrian Bridge

Downtown East LRT Station
Kirby Puckett Place
Minneapolis, Minnesota

AET Report 01-06424.1

Date:

April 8, 2015

Prepared for:

Metro Transit/Met Council
Facilities & Engineering
560 – 6th Avenue North
Minneapolis, Minnesota 55411-4398

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Metro Transit/Met Council
Facilities & Engineering
560 – 6th Avenue North
Minneapolis, Minnesota 55411-4398

Attn: Ms. Carol Hejl (Carol.Hejl@metrotransit.org)

RE: Revised Geotechnical Exploration and Review
Downtown East Pedestrian Bridge
Downtown East LRT Station
Kirby Puckett Place
Minneapolis, Minnesota
AET Report No. 01-06424.1

Dear Ms. Hejl:

American Engineering Testing, Inc. (AET) is pleased to present this revised subsurface exploration program and geotechnical engineering review for the proposed project in Minneapolis, Minnesota. In accordance with Work Order WO-12, Amendment 1, we are revising this report to include design information for use of spread footings for portions of the bridge, and additional soil parameters for design of the drilled piers.

We are submitting one hard copy of this report to you as well as an electronic PDF copy. Additional electronic copies are also being submitted to EVS and HGA, as shown below.

Please contact me if you have any questions about the report. I can also be contacted for arranging engineering observations, special inspections, and testing services during construction.

Sincerely,
American Engineering Testing, Inc.

Michael P. McCarthy

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Michael P. McCarthy, PE
Principal Engineer

Reviewed By:

Jeffery K. Voyen

Jeffery K. Voyen, PE
Vice President

I hereby certify that this report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under Minnesota Statute Section 326.02 to 326.15

Name: Michael P. McCarthy

Date: 4-8-2015 **License #: 16688**

TABLE OF CONTENTS

1.0 INTRODUCTION 1
2.0 SCOPE OF SERVICES 1
3.0 PROJECT INFORMATION 2
4.0 SUBSURFACE EXPLORATION AND TESTING 2
  4.1 Field Exploration Program 2
  4.2 Laboratory Testing 3
5.0 SITE CONDITIONS 3
  5.1 Surface Observations 3
  5.2 Subsurface Soils/Geology 4
  5.3 Ground Water 5
  5.4 Review of Soil Properties 6
6.0 RECOMMENDATIONS 8
  6.1 Approach Discussion 8
  6.2 Bridge Support 9
  6.3 Elevator & Stair Tower Support 12
  6.4 Site Retaining Walls Support 15
7.0 CONSTRUCTION CONSIDERATIONS 16
  7.1 Potential Difficulties 16
  7.2 Excavation Backsloping 16
  7.3 Observations and Testing 17
8.0 LIMITATIONS 17

STANDARD SHEETS
  Floor Slab Moisture/Vapor Protection
  Basement/Retaining Wall Backfill and Water Control
  Freezing Weather Effects on Building Construction

APPENDIX A
  Geotechnical Field Exploration and Testing
  Boring Log Notes
  Unified Soil Classification System
  Figure 1 – Soil Boring Locations
  Figure 2 – Project Lay-Out
  Subsurface Boring Logs (B-1 to B-4)
  Previous Subsurface Boring Log (B11 – from Stadium Project)
  Previous STS Consultants Boring Log (B-05)

APPENDIX B
  Geotechnical Report Limitations and Guidelines for Use

1.0 INTRODUCTION

Construction of a new pedestrian bridge, spanning from the future Vikings Stadium to the Downtown East LRT station is planned over Kirby Puckett Place in Minneapolis, Minnesota. To assist in planning and design, American Engineering Testing, Inc. (AET) was authorized to conduct a subsurface exploration program at the site, conduct soil laboratory testing, and perform a geotechnical engineering review for the project. This report presents the results of the above services, and provides additional engineering recommendations as discussed below.

2.0 SCOPE OF SERVICES

AET's original services were performed according to the Metropolitan Council Contract Number 10P151, and our proposal to you dated February 3, 2015. Our services were officially authorized on February 4, 2015 by issuing the Notice to Proceed for Work Order WO-12. We were recently authorized by Amendment 1 to provide additional information to our original report, dated March 11, 12015. The requested information includes the following:

- Recommendations for design of the elevator and stair towers on spread footings.
- Recommended soil parameters for design of the drilled piers.
- Presenting the additional geotechnical recommendations in this revised report.

These services are intended for geotechnical purposes. The scope is not intended to explore for the presence or extent of environmental contamination.

Our original scope of services included four (4) penetration test borings. In our original report, we also included the log of Boring B11, drilled in August, 2013 at the adjacent Viking Stadium site. This boring was located close to the planned construction and includes bedrock coring information. We were also presented with the STS Consultants Geotechnical Engineering Report dated December 21, 2000 which included logs of borings performed for the LRT station. The log of STS Boring B-05 is also included with this report.

3.0 PROJECT INFORMATION

We understand the pedestrian bridge will span from the future Vikings Stadium on the east side of Kirby Puckett Place to the Downtown East LRT station on the west side of Kirby Puckett Place. The bridge will be a concrete structure supported by three piers. We understand that the loading on each pier will be approximately 800 kips. Stair and elevator towers will be constructed at each end of the bridge. The wall loads for these structures will be 10 kips/foot and the total load for the elevator towers will be 250 kips (assuming single mat footings). The areas around the stair and elevator towers may also include miscellaneous retaining walls and planters. The general lay-out of the project is shown on Figure 2 in Appendix A; which is a reproduction of part of Sheet C3.0 prepared by HKS.

Our foundation design assumptions include a minimum factor of safety of three with respect to localized shear or base failure of the foundations. We assume the structure will be able to tolerate total settlements of up to 1-inch, and differential settlements over a 30 foot distance of up to ½-inch.

The information stated above represents our understanding of the proposed construction. This information is an integral part of our engineering review. It is important that you contact us if there are changes from that described so that we can evaluate whether modifications to our recommendations are appropriate.

4.0 SUBSURFACE EXPLORATION AND TESTING

4.1 Field Exploration Program

We performed four (4) standard penetration test borings, including coring of the bedrock at Boring B-1. At Boring B-2, drilling was obstructed at a depth of 6½ feet. We then drilled Boring B-2A approximately 3 feet south and 3 feet east of Boring B-2. The logs of the borings and details of the methods used appear in Appendix A. The logs contain information concerning soil and bedrock layering, soil and bedrock classification, geologic description, and moisture condition. Relative density or consistency is also noted for the natural soils, which is based on the standard penetration resistance (N-value). The quality of the bedrock is implied by the percent of the bedrock sample which is recovered and the RQD (rock quality designation). The boring locations are shown on Figure 1 in Appendix A. The borings were spotted in the field by AET personnel based on a sketch provided by EVS showing the suggested locations. At the completion of the drilling, the GPS coordinates were obtained (sub-meter accuracy; not surveyor accuracy) by AET personnel. The GPS coordinates are shown at the top of each boring log. Surface elevations at the boring locations were measured in the field by AET personnel using an engineer's level. The benchmark reference was the rim of a storm sewer manhole located on Kirby Puckett Place, about 75 feet south of the borings. The rim of this manhole has an elevation of 844.17, as shown on a plan provided by Metro Transit and EVS.

4.2 Laboratory Testing

The laboratory test program included water content tests of selected plastic soils. The test results appear on the individual boring logs in Appendix A, adjacent to the samples on which the tests were performed.

5.0 SITE CONDITIONS

5.1 Surface Observations

The proposed pedestrian bridge will span over Kirby Puckett Place, just south of its intersection with 4th Street South. The existing Downtown East LRT station is located to the west side of Kirby Puckett Place, and the Vikings stadium is currently under construction on the east side. Concrete and brick paver sidewalks and plaza areas are present on either side of Kirby Puckett Place. The general terrain is relatively flat. The ground surface elevations measured at our boring locations range from 842.6 at Boring B-2 to 843.2 at Boring B-4.

5.2 Subsurface Soils/Geology

The soil profile shown by the borings consists of fill over naturally deposited, interbedded layers of alluvium and till. Limestone bedrock was encountered at depths ranging from about 48½ to 49½ feet below the surface.

5.2.1 Fill

Below the concrete and brick pavers at the surface, the fill consists of a surface layer of crushed limestone base and the underlying fill comprised of a mixture of silty sands, clayey sands, sands with silt, and sands. A layer of bituminous exists between the brick pavers and the limestone base at Borings B-3 and B-4. At Boring B-2, our boring encountered pieces of concrete and possibly concrete slabs from about 5 feet until the boring obstructed at a depth of 6½ feet. The fill soils were frozen to a depth of about 4 feet at the boring locations.

STS Boring B-05 was performed in 2000, near the proposed location of the elevator and stair tower at the LRT station. This boring indicates approximately 13 feet of fill was present above the naturally deposited soils. The Standard Penetrations recorded in this fill were in excess of 24 blows per foot, which would indicate the soils are well compacted. Construction of the LRT Station and other structures may have altered the soil conditions shown by this log.

5.2.2 Alluvium and Till

Layers of naturally deposited alluvium (water deposited soils) and till (glacially deposited soils) exist below the fill and above the bedrock. These soils include coarse alluvial sands, silty sands, and gravelly sands; fine alluvial lean clays; and glacial till silty sands and clayey sands. The coarse alluvial and glacial till soils contain variable amounts of gravel. Cobbles and possibly boulders also exist within some layers.

5.2.3 Bedrock

Limestone bedrock from the Platteville Formation exists below the alluvial and glacial till soils. The bedrock is divided into four distinct layers (in order of increasing depth); the Carimona Member, the Magnolia Member, the Hidden Falls Member, and the Mifflin Member. The Carimona layer is not a consistent layer and was not encountered at the borings completed for this project. The Magnolia layer is light brownish gray, fossiliferous, very thinly to thinly bedded, and varies from slightly to intensely fractured. The Hidden Falls layer is light brownish gray to gray, thinly bedded, and very to moderately to slightly fractured. The underlying Mifflin layer is light gray to gray, crinkly bedded, very thinly bedded, and slightly to very fractured. A summary of the approximate elevations of the tops of the different bedrock layers is presented in Table 5.2.3 below:

Table 5.2.3 – Approximate Elevations of Bedrock Layers

Boring Location	Surface Elevation	Apparent Bedrock Surface	Carimona Member	Magnolia Member	Hidden Falls Member	Mifflin Member
B-1	842.7	793½	--	793½	785½	--
B-2A	842.7	794*				
B-3	842.8	794*				
B-4	843.2	800@				
B11	847.8	793½	--	793½	783½	779

* *Apparent bedrock surface elevation based on refusal to advancement of drilling equipment.*
@ *Bedrock surface was weathered limestone.*

5.3 Ground Water

Ground water was measured in Borings B-1, B-3, and B-4 at depths ranging from about 48½ feet to 49 feet beneath the surface. Because the soils encountered in the borings at these depths of measured ground water consist of slower draining clayey and silty glacial till soils, or weathered bedrock, it may take several hours or even days for a hydrostatic water level to stabilize in an open borehole. Ground water levels can be expected to perch above the slower draining clayey and silty soils, as well as just above the bedrock. Long-term monitoring of the water levels with piezometers is needed to obtain more accurate water level measurements. This was beyond the scope of our services.

Ground water levels will fluctuate due to varying seasonal and annual rainfall and snow melt amounts, as well as other factors.

5.4 Review of Soil Properties

5.4.1 Fill

The upper 4 feet of fill was frozen and N-values were not recorded. Below that, the N-values in the fill soils are generally high indicating the soils were probably compacted in thin lifts during placement. One exception is at Boring B-2A where the fill from about 6½ to 9 feet had a lower N-value of 5 blows per foot (bpf), indicating little compaction was performed. Some of the very high N-values (over 30 bpf) may be due to the presence of debris and rubble – such as at Boring B-2. We judge the fill soils to have moderately high to low strength, and consider them to have low to moderate compressibility. Most of the fill soils consist of sands and silty sands which are judged to be moderately slow to moderately fast draining, and moderately frost susceptible. The clayey sands are generally slow draining soils that are susceptible to freeze-thaw movements.

5.4.2 Alluvium and Till

The sands, silty sands and gravelly sands, and the glacial till silty sands and clayey sands are judged to have moderately high to high strength and low compressibility. The fine alluvial lean clays are also judged to have high strength and low compressibility. The alluvial sands and gravelly sands are judged to be fast draining and have low susceptibility to frost heave. The alluvial silty sands are judged to be moderately fast draining and have moderate susceptibility to freeze-thaw movements. The alluvial clays and the till soils are below normal frost depth.

5.4.3 Bedrock

The limestone bedrock is judged to have high strength and low compressibility. The upper portions of the bedrock are typically weathered and more fractured and have lower strength than the underlying, intact bedrock. The limestone from the Platteville formation typically contains both horizontal and vertical fractures. Evaluation of the quality of the bedrock is based on two methods: 1) core recovery (REC %) and 2) Rock Quality Designation (RQD %), figured from the typical 5-foot long increments of cores that are removed from the bedrock. The core recovery is determined by totaling the lengths of all fragmented and solid pieces of bedrock obtained from each core run, and dividing that by the overall total length of the run, and is then expressed as a percentage of the overall length of the core run on the boring logs.

The RQD is slightly different because it only takes into account segments of the bedrock core that are 4 inches or longer. The cumulative length of these 4-inch or longer segments of bedrock are expressed as a percentage of the overall length of the bedrock core run. The quality of the bedrock is typically considered better if the REC and RQD values are higher.

Based on our review of the RQD values from Borings B-1 and B11, and our observations of the core samples, it appears that the bedrock is relatively sound and consistent in elevation. There are no apparent indications of folds, severe fractures or faults in the bedrock, based on our comparisons of the elevations of the different layers. The RQD values are generally over 65%. Some parts of the Hidden Falls Member at Borings B-1 and B11 are intensely fractured. A fairly thick zone of weathered limestone exists at Boring B-4, from about 43 to 49.7 feet. The bearing capabilities of the weathered limestone is much less than the unweathered limestone below.

6.0 RECOMMENDATIONS

6.1 Approach Discussion

Based on the loads to be exerted by the pedestrian bridge piers, and the soil/bedrock conditions, it is our judgment that the use of drilled piers bearing on the unweathered bedrock is the most feasible method of supporting the bridge. The naturally deposited alluvial and glacial till soils have high N-values; however, the sound and unweathered bedrock is capable of supporting a significantly higher end bearing pressure of up to 50 tons per square foot (tsf). We have also given consideration to using driven piles to support the proposed bridge. The use of driven piles may cause objectionable vibrations to the surrounding structures, as well as considerable noise. Our recommendations for this project will concentrate using drilled piers for structural support.

For the lighter loaded stair and elevator towers, it is our judgment (based on the results of the attached borings) that it may be possible to support these structures on conventional spread footings, provided the existing fill soils are well compacted as indicated by the N-values in most of the fill soils. Because the stair and elevator tower on the west side of Kirby Puckett Place will be located well west of our Borings B-1 and B-2, this requires the assumption that the soils at the location of the stair/elevator tower will be consistent with those shown at these borings. STS Boring B-05 shows well compacted fill soils exist to a depth of about 13 feet, which are then underlain by competent naturally deposited soils. Because the soils at each location consist of existing fill, supporting the structures on these fill soils will require Metro Transit to assume some risks that the fill is consistent and well compacted as can be implied by the higher N-values shown on the boring logs. These risks can be reduced by careful observations of the soils during excavation, as well as performing hand cone penetrometers (HCP's) and dynamic cone penetrometers (DCP's). If these risks are not acceptable, excavation of all fill soils and then placement of new fill should be performed as corrective earthwork procedures.

We have also considered the use of shallow drilled piers to support the elevator and stair towers on competent naturally deposited alluvial and glacial till soils; however, it is our expectation that this alternative may not be necessary.

6.2 Bridge Support

6.2.1 Drilled Pier Foundations

It is our judgment that the proposed pedestrian bridge piers can be supported by drilled pier foundations extending into competent bedrock. The piers should extend through the upper weathered bedrock, and the fractured portions of the limestone bedrock. The estimated depths of bedrock removal at those borings which were advanced into the bedrock, are shown in Table 6.2.1 below:

Table 6.2.1 – Estimated Bedrock Removal Depths

Boring Location	Surface Elevation (ft)	Estimated Bedrock Surface Elev.	Estimated Bedrock Removal (ft)	Estimated Drilled Pier Bottom Elev.
B-1	842.7	793½	2½	791
B-4	843.2	800@	7+@	790½
B11	847.8	793½@	6½@	787

@ *Upper bedrock surface is weathered limestone which should be removed to underlying competent bedrock.*

Based on our past experience in the general area of this construction, we would anticipate an average depth of bedrock coring of about 2½ to 3 feet, after removal of the upper highly weathered and fractured bedrock. The actual amount of bedrock removal for foundation support should be evaluated by AET geotechnical personnel at each drilled pier location. This is usually done by closely observing the bedrock that is removed by the core barrel and by closely watching the movement of the core barrel. Close attention is paid to zones of less resistance during coring, which is an indicator of weathered bedrock, fractured zones, voids, or clay seams. These zones are unacceptable and if encountered, will require deeper bedrock removal. We suggest a contingency be included in your budget for additional bedrock removal for such situations.

6.2.2 Soil Parameters for LPILE Analysis

Table 6.2.2 below provides our recommended soil parameters for LPILE analysis of the drilled piers. These parameters are based on the soils found at the boring locations

Table 6.2.2 – Estimated Soil Parameters

Boring No.	Depths (ft.)	Soil Type	N-Values	Cohesion (psf)	Angle of Internal Friction (°)	Static Soil Modulus k** (pci)	Cyclical Modulus (Kc)** (pci)	ε_{50}	Effective Density (pcf)	Deformation Modulus (ksi)
SB-1	½ - 2*	Base	@	0	35	25	-	-	115	0.5
	2 – 4*	Sand	@	0	30	25	-	-	115	0.5
	4 - 6½	Sand	51	0	30	90	-	-	130	2.0
	6½ - 9	Sand	19	0	30	90	-	-	120	1.7
	9 - 11½	Sand	14	0	10	90	-	-	120	1.4
	11½ - 14	Sand	27	0	30	90	-	-	130	2.1
	14 - 18	Sand	39	0	35	225	-	-	125	3.9
	18 - 28	Sand	50 - 53	0	35	225	-	-	125	4.7
	28 - 33	Sand	35	0	35	225	-	-	125	3.6
	33 - 38	Sand	29	0	35	90	-	-	125	3.1
	38 - 43	Sand	60	0	32	225	-	-	130	3.3
	43 - 49.2	Sand	29	0	30	90	-	-	130	2.2
	49.2 – 57.3	Bedrock	Core	4000	0	2000	800	0.001	100	14.0
	57.3 - 60.8	Bedrock	Core	3000	0	2000	800	0.002	100	10.0
SB-2	½ - 1½*	Base	@	0	35	25	-	-	115	0.5
SB-2A	1½ - 4½*	Sand	@	0	30	25	-	-	115	0.5
	4½ - 6½	Sand	22	0	30	90	-	-	130	1.8
	6½ - 9	Sand	5	0	20	25	-	-	105	0.5
	9 - 11	Sand	19	0	30	90	-	-	120	1.7
	11 - 18	Sand	24 - 27	0	30	90	-	-	130	2.0
	18 - 23	Sand	58	0	35	225	-	-	125	4.7
	23 - 33	Sand	45 - 49	0	32	225	-	-	130	3.0
	33 - 48.8	Sand	55+	0	32	225	-	-	130	3.3
SB-3	½ - 4*	Sand	@	0	30	25	-	-	100	0.5
	4 – 6½	Sand	13	0	30	90	-	-	120	1.3
	6½ - 11½	Sand	17 - 19	0	35	90	-	-	115	2.4
	11½ - 18	Sand	68+#	0	35	225	-	-	125	4.7
	18 - 23	Sand	23	0	30	90	-	-	130	1.9
	23 - 28	Sand	30	0	35	225	-	-	125	3.2
	28 - 33	Clay	57	6000	0	2000	800	0.004	130	2.4
	33 - 38	Sand	58	0	35	225	-	-	125	4.7
	38 - 49	Sand	51 – 69	0	32	225	-	-	130	3.3
	49 – 49.7	Bedrock	100/.4	0	45	125	-	-	80	10.0

Boring No.	Depths (ft.)	Soil Type	N-Values	Cohesion (psf)	Angle of Internal Friction (°)	Static Soil Modulus k** (pci)	Cyclical Modulus (Kc)** (pci)	ε_{50}	Effective Density (pcf)	Deformation Modulus (ksi)
SB-4	½ - 2*	Sand	@	0	30	25	-	-	100	0.5
	2 – 4*	Clay	@	300	0	30	-	-	100	0.4
	4 - 6½	Clay	59	500	15	1000	400	0.005	125	1.0
	6½ - 9	Sand	17	0	30	90	-	-	120	1.6
	9 - 11½	Sand	23	0	30	90	-	-	130	1.9
	11½ - 18	Sand	20	0	30	90	-	-	120	1.7
	18 - 24	Clay	38	2500	25	2000	800	0.004	130	1.8
	24 - 28	Sand	114#	0	35	225	-	-	125	4.7
	28 - 43	Clay	53 - 57	3500	25	2000	800	0.004	130	2.4
	43 - 49	Bedrock	40	0	45	225	-	-	140	2.8
	49 – 49.7	Bedrock	100/.05	0	45	125	-	-	80	10.0

**For drilled pier foundations, we recommend the soil strength (cohesion, internal friction angle, deformation modulus and soil modulus) be disregarded in the upper 4 feet of the soil profile.*
***Soil Modulus Parameter k (p-y) for use with LPILE.*
@ N-values not obtained for these soil layers because the soils were frozen at the time of drilling.
 # N-values influence by cobbles; soil parameters estimated using a lower, interpolated N-value.

6.2.3 Drilled Pier End Bearing Capacity

Drilled piers extending through the weathered and highly fractured portions of the limestone bedrock can be designed for an allowable end bearing capacity of 50 tsf. This loading, on sound and competent bedrock, should provide a factor of safety of about 3 against localized failure of the drilled pier. We judge that total settlements under this loading should not exceed 1-inch. We also judge that differential settlements of conditions depicted by the borings should not exceed ½-inch.

6.2.4 Drilled Pier Installation Considerations

The soils overlying the bedrock include significant layers of granular soils. These soils are subject to caving or sloughing during excavation of the drilled piers. Therefore, we recommend that all drilled piers be advanced using steel casing during to prevent sloughing or caving of the granular soils into the excavations.

Ground water was encountered above the bedrock at three of the four recent borings; therefore, it should be expected to be present during drilling of the piers. We recommend ground water be pumped from the drilled pier excavations prior to the placement of concrete. To reduce the likelihood of concrete segregation when placed, either through introduction into standing water or by striking the reinforcing steel or sides of the steel casing, we recommend using a tremie or pump during concrete placements. We recommend that a positive head of concrete be maintained during steel casing removal so the soils do not slough into the excavations above the concrete and compromise the integrity and strength of the concrete.

6.3 Elevator & Stair Tower Support

6.3.1 Spread Footing Grading

It is our judgment that the use of spread footings can be considered for support of the proposed elevator and stair towers. Excavation to planned footing grades should expose existing fill soils; most of which appear to be moderately well to well compacted. Because the fill soils at and below normal frost protection depth at Boring B-2A are loose, they should be thoroughly surface compacted prior to footing construction. Self-propelled vibratory compaction equipment should make at least 5 passes over the soils in the bottoms of all footing excavations, and then repeat the process in the perpendicular direction. AET geotechnical personnel should then observe the soils in the excavation bottoms to verify if these soils are suitable to support the structural loads.

As mentioned earlier, supporting the structures on the existing fill soils may involve some risks, mainly associated with the possibility of loose zones of fill which maybe present at and below footing grades at locations away from the borings. It is our judgment that thorough compaction and careful observation by AET geotechnical personnel should significantly reduce these risks.

If risks are not acceptable to Metro Transit, we recommend the foundation excavations be extended through all existing fill to the underlying naturally deposited alluvial and till soils, and new fill be placed and compacted back to design footing and slab grades. The excavations that extend below foundation grades must be oversized laterally beyond the outside edges of the foundations to properly support the lateral loads exerted by the foundations. This excavation/engineered fill lateral extension should at least be equal to the vertical depth of fill needed to attain foundation grade at that location (i.e., 1:1 lateral oversize).

We recommend that all fill which is placed below the elevator and stair tower footings and floor slabs consist of inorganic sands (SP), sands with silt (SP-SM), or silty sands (SM) that have no more than 20% of the particles finer than the #200 sieve. The use of clayey sands, clays, or silts as fill below these structures should not be permitted. The granular fill soils should be free of debris and rubble. Fill should not be placed over frozen soils and frozen soils should not be used as fill.

We recommend all fill placed below the elevator and stair tower footings be compacted to a minimum of 100% of the standard maximum dry unit weight per ASTM: D698 (Standard Proctor test). All fill placed above the footings, which will only support floor slab loads, should be compacted to at least 95%. This includes all backfill placed in utility trench excavations and as wall or footing backfill.

6.3.2 Spread Footing Design

Assuming the excavation and backfilling is performed as recommended above, it is our judgment that the elevator and stair towers can be supported on conventional spread footings placed on the well compacted fill soils, the competent naturally deposited alluvial or till soils, or the new compacted fill placed after excavation of the existing fill. We recommend the foundations be placed at least 42 inches below exterior grades if the towers are heated, and interior footings in heated building spaces can be placed at shallow depths below the floor slab. It the towers are not heated, and if any other footings will be in unheated conditions (such as exterior canopy foundations), they should be placed at least 60 inches below exterior grades.

Based on the conditions encountered, it is our opinion the foundations for the elevator and stair towers can be designed using a net maximum allowable soil bearing pressure of 4,000 psf. It is our judgment this design pressure should have a factor of safety of at least three against localized shear or base failure. We judge that total settlements should be 1-inch or less, and differential settlements under these loads should not exceed ½-inch. Up to ½-inch of differential settlement can be expected between the spread footings and the drilled piers supported on bedrock.

6.3.3 Floor Slab Support

The well compacted existing fill, the naturally deposited alluvial or till soils, or the new compacted fill soils can be used to support of the elevator and stair tower floor slabs. After excavating to design slab grades, we recommend the fill soils be surface compacted prior to placement of new fill to establish slab grades or concrete for the slab. The soils should be compacted with self-propelled vibratory compaction equipment which makes at least 5 passes over the soils. We recommend AET geotechnical personnel then perform soil density tests at random locations and elevations to evaluate the compaction levels of the fill and to assist in evaluating their ability to support the floor slab.

After surface compaction of the existing fill soils, and the placement of new fill to establish slab subgrade elevations (if necessary), it is our judgment that the floor slabs can be supported by the compacted fill soils. For improved moisture control, we recommend at least 6 inches of sand backfill be placed immediately below the slabs. This sand should have no more than 5% of the particles finer than the #200 sieve and no more than 40% finer than the #40 sieve. **If the elevator and stair tower structures will not be heated, we recommend at least 4 feet of this**

sand be used as fill to minimize frost heave movements of the slabs. All fill below the floor slab should be compacted to at least 95% of the Standard Proctor maximum dry density (ASTM: D698). Refer to the standard sheet "Floor Slab Moisture/Vapor Protection" at the end of this report.

Assuming that sand fill will be present below the slabs, we recommend designing the floor slab using a Modulus of Subgrade Reaction (k-value) of 225 pci.

6.4 Site Retaining Walls Support

6.4.1 Spread Footing Grading and Design

It is our judgment that spread footings can be used for support of the proposed retaining walls. We recommend excavation and backfilling for these footings be performed as recommended for the elevator and stair towers, as presented in Section 6.3.1. We refer you to 6.3.2 for design of the footings.

6.4.2 Retaining Wall Backfill

Recommendations for backfilling of retaining walls that have unbalanced loads are presented in the sheets entitled "Basement/Retaining Wall Backfill and Water Control" and "Freezing Weather Effects on Building Construction" at the end of this report. Lateral loads to be used for design of these walls are provided, expressed as equivalent fluid weights. The use of sand (SP or SP-SM) fill is recommended. Because the walls will not restrained at the top and will be allowed to deflect, the active condition can be used for design of the walls.

Backfill placed against the walls should be compacted to at least 95% of the Standard Proctor maximum dry density below sidewalks or other pedestrian traffic areas. Below landscaped areas, the backfill should be compacted to at least 90%.

Passive lateral pressures could also act on the foundations. Assuming that sand fill is used as backfill against the footings and walls, and the fill soils are compacted to at least 95% of the Standard Proctor maximum dry density, the walls can be designed using an equivalent fluid weight passive pressure of 400 pcf. An appropriate factor of safety should be applied to this value.

7.0 CONSTRUCTION CONSIDERATIONS

7.1 Potential Difficulties

7.1.1 Water in Excavations

Ground water may accumulate in the bottoms of the drilled pier excavation. The water should be removed prior to placing the concrete.

7.1.2 Cobbles, Boulders, and Rubble

The soils at this site can include cobbles, boulders, and rubble (some of which may be large – such as at Boring B-2). This will make drilling of the piers more difficult. Special methods for oversized obstruction removal may be needed during drilled pier installation.

7.2 Excavation Backsloping

If excavation is needed for foundations, the excavations (if not retained) should maintain maximum allowable slopes in accordance with *OSHA Regulations (Standards 29 CFR), Part 1926, Subpart P, "Excavations"* (can be found on www.osha.gov). Even with the required OSHA sloping, water seepage or surface runoff can potentially induce sideslope erosion or running which could require slope maintenance.

7.3 Observations and Testing

The recommendations in this report are based on the subsurface conditions found at our test boring locations. Since the soil and bedrock conditions can be expected to vary away from the soil boring locations, we recommend AET geotechnical personnel observe all excavations and drilled piers to evaluate the suitability of the soils and bedrock for support of the proposed construction. These observations should be conducted on a full-time basis during drilled pier installation. Soil density testing should also be performed on new fill placed in order to document that project specifications for compaction have been satisfied.

8.0 LIMITATIONS

Within the limitations of scope, budget, and schedule, our services have been conducted according to generally accepted geotechnical engineering practices at this time and location. Other than this, no warranty, either express or implied, is intended.

Important information regarding risk management and proper use of this report is given in Appendix B entitled “Geotechnical Report Limitations and Guidelines for Use”.

FLOOR SLAB MOISTURE/VAPOR PROTECTION

Floor slab design relative to moisture/vapor protection should consider the type and location of two elements, a granular layer and a vapor membrane (vapor retarder, water resistant barrier or vapor barrier). In the following sections, the pros and cons of the possible options regarding these elements will be presented, such that you and your specifier can make an engineering decision based on the benefits and costs of the choices.

GRANULAR LAYER

In American Concrete Institute (ACI) 302.1R-04, a "base material" is recommended over the vapor membrane, rather than the conventional clean "sand cushion" material. The base layer should be a minimum of 4 inches (100 mm) thick, trimmable, compactable, granular fill (not sand), a so-called crusher-run material. Usually graded from 1½ inches to 2 inches (38 to 50 mm) down to rock dust is suitable. Following compaction, the surface can be choked off with a fine-grade material. We refer you to ACI 302.1R-04 for additional details regarding the requirements for the base material.

In cases where potential static water levels or significant perched water sources appear near or above the floor slab, an under floor drainage system may be needed wherein a draintile system is placed within a thicker clean sand or gravel layer. Such a system should be properly engineered depending on subgrade soil types and rate/head of water inflow.

VAPOR MEMBRANE

The need for a vapor membrane depends on whether the floor slab will have a vapor sensitive covering, will have vapor sensitive items stored on the slab, or if the space above the slab will be a humidity controlled area. If the project does not have this vapor sensitivity or moisture control need, placement of a vapor membrane may not be necessary. Your decision will then relate to whether to use the ACI base material or a conventional sand cushion layer. However, if any of the above sensitivity issues apply, placement of a vapor membrane is recommended. Some floor covering systems (adhesives and flooring materials) require installation of a vapor membrane to limit the slab moisture content as a condition of their warranty.

VAPOR MEMBRANE/GRANULAR LAYER PLACEMENT

A number of issues should be considered when deciding whether to place the vapor membrane above or below the granular layer. The benefits of placing the slab on a granular layer, with the vapor membrane placed **below** the granular layer, include **reduction** of the following:

- Slab curling during the curing and drying process.
- Time of bleeding, which allows for quicker finishing.
- Vapor membrane puncturing.
- Surface blistering or delamination caused by an extended bleeding period.
- Cracking caused by plastic or drying shrinkage.

The benefits of placing the vapor membrane over the granular layer include the following:

- A lower moisture emission rate is achieved faster.
- Eliminates a potential water reservoir within the granular layer above the membrane.
- Provides a "slip surface", thereby reducing slab restraint and the associated random cracking.

If a membrane is to be used in conjunction with a granular layer, the approach recommended depends on slab usage and the construction schedule. The vapor membrane should be placed above the granular layer when:

- Vapor sensitive floor covering systems are used or vapor sensitive items will be directly placed on the slab.
- The area will be humidity controlled, but the slab will be placed before the building is enclosed and sealed from rain.
- Required by a floor covering manufacturer's system warranty.

The vapor membrane should be placed below the granular layer when:

- Used in humidity controlled areas (without vapor sensitive coverings/stored items), with the roof membrane in place, and the building enclosed to the point where precipitation will not intrude into the slab area. Consideration should be given to slight sloping of the membrane to edges where draintile or other disposal methods can alleviate potential water sources, such as pipe or roof leaks, foundation wall damp proofing failure, fire sprinkler system activation, etc.

There may be cases where membrane placement may have a detrimental effect on the subgrade support system (e.g., expansive soils). In these cases, your decision will need to weigh the cost of subgrade options and the performance risks.

BASEMENT/RETAINING WALL BACKFILL AND WATER CONTROL

DRAINAGE

Below grade basements should include a perimeter backfill drainage system on the exterior side of the wall. The exception may be where basements lie within free draining sands where water will not perch in the backfill. Drainage systems should consist of perforated or slotted PVC drainage pipes located at the bottom of the backfill trench, lower than the interior floor grade. The drain pipe should be surrounded by properly graded filter rock. A filter fabric should then envelope the filter rock. The drain pipe should be connected to a suitable means of disposal, such as a sump basket or a gravity outfall. A storm sewer gravity outfall would be preferred over exterior gravity drainage, as the latter may freeze during winter. For non-building, exterior retaining walls, weep holes at the base of the wall can be substituted for a drain pipe.

BACKFILLING

Prior to backfilling, dampproofing or waterproofing should be applied on perimeter basement walls. The backfill materials placed against basement walls will exert lateral loadings. To reduce this loading by allowing for drainage, we recommend using free draining sands for backfill. The zone of sand backfill should extend outward from the wall at least 2 feet, and then upward and outward from the wall at a 30 degree or greater angle from vertical. As a minimum, the sands used on this project should contain no greater than 5% of particles (by weight) finer than the #200 sieve and nor more than 40% of the particles (by weight) finer than the #40 sieve. The sand backfill should be placed in lifts and compacted with portable compaction equipment. This compaction should be to the specified levels if slabs or pavements are placed above. Where slab or pavements are not above, we recommend capping the sand backfill with a layer of clayey soil to minimize surface water infiltration. Positive surface drainage away from the building should also be maintained. If surface capping or positive surface drainage cannot be maintained, then the trench should be filled with more permeable soils, such as the Fine Filter or Coarse Filter Aggregates defined in MnDOT Specification 3149. You should recognize that if the backfill soils are not properly compacted, settlements may occur which may affect surface drainage away from the building.

Backfilling with silty or clayey soil is possible but not preferred. These soils can build-up water which increases lateral pressures and results in wet wall conditions and possible water infiltration into the basement. If you elect to place silty or clayey soils as backfill, we recommend you place a prefabricated drainage composite against the wall which is hydraulically connected to a drainage pipe at the base of the backfill trench. High plasticity clays should be avoided as backfill due to their swelling potential.

LATERAL PRESSURES

Lateral earth pressures on below-grade walls vary, depending on backfill soil classification, backfill compaction and slope of the backfill surface. Static or dynamic surcharge loads near the wall will also increase lateral wall pressure. For design, we recommend the following ultimate lateral earth pressure values (given in equivalent fluid pressure values) for a drained soil compacted to 95% of the Standard Proctor density and a level ground surface.

	Equivalent Fluid Density	
Soil Type	**Active (pcf)**	**At-Rest (pcf)**
Sands (SP or SP-SM)	35	50
Silty Sands (SM)	45	65
Fine Grained Soils (SC, CL or ML)	70	90

Basement walls are normally restrained at the top which restricts movement. In this case, the design lateral pressures should be the "at-rest" pressure situation. Retaining walls which are free to rotate or deflect should be designed using the active case. Lateral earth pressures will be significantly higher than that shown if the backfill soils are not drained and become saturated.

FREEZING WEATHER EFFECTS ON BUILDING CONSTRUCTION

GENERAL

Because water expands upon freezing and soils contain water, soils which are allowed to freeze will heave and lose density. Upon thawing, these soils will not regain their original strength and density. The extent of heave and density/strength loss depends on the soil type and moisture condition. Heave is greater in soils with higher percentages of fines (silts/clays). High silt content soils are most susceptible, due to their high capillary rise potential which can create ice lenses. Fine grained soils generally heave about 1/4" to 3/8" for each foot of frost penetration. This can translate to 1" to 2" of total frost heave. This total amount can be significantly greater if ice lensing occurs.

DESIGN CONSIDERATIONS

Clayey and silty soils can be used as perimeter backfill, although the effect of their poor drainage and frost properties should be considered. Basement areas will have special drainage and lateral load requirements which are not discussed here. Frost heave may be critical in doorway areas. Stoops or sidewalks adjacent to doorways could be designed as structural slabs supported on frost footings with void spaces below. With this design, movements may then occur between the structural slab and the adjacent on-grade slabs. Non-frost susceptible sands (with less than 5% passing a #200 sieve) can be used below such areas. Depending on the function of surrounding areas, the sand layer may need a thickness transition away from the area where movement is critical. With sand placement over slower draining soils, subsurface drainage would be needed for the sand layer. High density extruded insulation could be used within the sand to reduce frost penetration, thereby reducing the sand thickness needed. We caution that insulation placed near the surface can increase the potential for ice glazing of the surface.

The possible effects of adfreezing should be considered if clayey or silty soils are used as backfill. Adfreezing occurs when backfill adheres to rough surfaced foundation walls and lifts the wall as it freezes and heaves. This occurrence is most common with masonry block walls, unheated or poorly heated building situations and clay backfill. The potential is also increased where backfill soils are poorly compacted and become saturated. The risk of adfreezing can be decreased by placing a low friction separating layer between the wall and backfill.

Adfreezing can occur on exterior piers (such as deck, fence, or other similar pier footings), even if a smooth surface is provided. This is more likely in poor drainage situations where soils become saturated. Additional footing embedment and/or widened footings below the frost zones (which include tensile reinforcement) can be used to resist uplift forces. Specific designs would require individual analysis.

CONSTRUCTION CONSIDERATIONS

Foundations, slabs and other improvements which may be affected by frost movements should be insulated from frost penetration during freezing weather. If filling takes place during freezing weather, all frozen soils, snow and ice should be stripped from areas to be filled prior to new fill placement. The new fill should not be allowed to freeze during transit, placement or compaction. This should be considered in the project scheduling, budgeting and quantity estimating. It is usually beneficial to perform cold weather earthwork operations in small areas where grade can be attained quickly rather than working larger areas where a greater amount of frost stripping may be needed. If slab subgrade areas freeze, we recommend the subgrade be thawed prior to floor slab placement. The frost action may also require reworking and recompaction of the thawed subgrade.

Appendix A

Geotechnical Field Exploration and Testing
Boring Log Notes
Unified Soil Classification System
Figure 1 – Soil Boring Locations
Figure 2 – Project Lay-Out
Subsurface Boring Logs (B-1 to B-4)
Previous Subsurface Boring Log (B11 - from Stadium Project)
Previous STS Consultants Boring Log (B-05)

Appendix A
Geotechnical Field Exploration and Testing
Report No. 01-06424.1

A.1 FIELD EXPLORATION

The subsurface conditions at the site were explored by drilling and sampling 4 standard penetration test borings. Coring of bedrock was conducted at one of these boring locations. The locations of the borings appear on Figure 1, preceding the Subsurface Boring Logs in this appendix.

A.2 SAMPLING METHODS

A.2.1 Split-Spoon Samples (SS) - Calibrated to N_{60} Values

Standard penetration (split-spoon) samples were collected in general accordance with ASTM:D1586 with one primary modification. The ASTM test method consists of driving a 2-inch O.D. split-barrel sampler into the in-situ soil with a 140-pound hammer dropped from a height of 30 inches. The sampler is driven a total of 18 inches into the soil. After an initial set of 6 inches, the number of hammer blows to drive the sampler the final 12 inches is known as the standard penetration resistance or N-value. Our method uses a modified hammer weight, which is determined by measuring the system energy using a Pile Driving Analyzer (PDA) and an instrumented rod.

In the past, standard penetration N-value tests were performed using a rope and cathead for the lift and drop system. The energy transferred to the split-spoon sampler was typically limited to about 60% of it's potential energy due to the friction inherent in this system. This converted energy then provides what is known as an N_{60} blow count.

Most newer drill rigs incorporate an automatic hammer lift and drop system, which has higher energy efficiency and subsequently results in lower N-values than the traditional N_{60} values. By using the PDA energy measurement equipment, we are able to determine actual energy generated by the drop hammer. With the various hammer systems available, we have found highly variable energies ranging from 55% to over 100%. Therefore, the intent of AET's hammer calibrations is to vary the hammer weight such that hammer energies lie within about 60% to 65% of the theoretical energy of a 140-pound weight falling 30 inches. The current ASTM procedure acknowledges the wide variation in N-values, stating that N-values of 100% or more have been observed. Although we have not yet determined the statistical measurement uncertainty of our calibrated method to date, we can state that the accuracy deviation of the N-values using this method is significantly better than the standard ASTM Method.

A.2.2 Disturbed Samples (DS)/Spin-up Samples (SU)

Sample types described as "DS" or "SU" on the boring logs are disturbed samples, which are taken from the flights of the auger. Because the auger disturbs the samples, possible soil layering and contact depths should be considered approximate.

A.2.3 Sampling Limitations

Unless actually observed in a sample, contacts between soil layers are estimated based on the spacing of samples and the action of drilling tools. Cobbles, boulders, and other large objects generally cannot be recovered from test borings, and they may be present in the ground even if they are not noted on the boring logs.

Determining the thickness of "topsoil" layers is usually limited, due to variations in topsoil definition, sample recovery, and other factors. Visual-manual description often relies on color for determination, and transitioning changes can account for significant variation in thickness judgment. Accordingly, the topsoil thickness presented on the logs should not be the sole basis for calculating topsoil stripping depths and volumes. If more accurate information is needed relating to thickness and topsoil quality definition, alternate methods of sample retrieval and testing should be employed.

A.3 CLASSIFICATION METHODS

Soil descriptions shown on the boring logs are based on the Unified Soil Classification (USC) system. The USC system is described in ASTM:D2487 and D2488. Where laboratory classification tests (sieve analysis or Atterberg Limits) have been performed, accurate classifications per ASTM:D2487 are possible. Otherwise, soil descriptions shown on the boring logs are visual-manual judgments. Charts are attached which provide information on the USC system, the descriptive terminology, and the symbols used on the boring logs.

The boring logs include descriptions of apparent geology. The geologic depositional origin of each soil layer is interpreted primarily by observation of the soil samples, which can be limited. Observations of the surrounding topography, vegetation, and development can sometimes aid this judgment.

A.4 WATER LEVEL MEASUREMENTS

The ground water level measurements are shown at the bottom of the boring logs. The following information appears under "Water Level Measurements" on the logs:

- Date and Time of measurement
- Sampled Depth: lowest depth of soil sampling at the time of measurement
- Casing Depth: depth to bottom of casing or hollow-stem auger at time of measurement
- Cave-in Depth: depth at which measuring tape stops in the borehole
- Water Level: depth in the borehole where free water is encountered
- Drilling Fluid Level: same as Water Level, except that the liquid in the borehole is drilling fluid

The true location of the water table at the boring locations may be different than the water levels measured in the boreholes. This is possible because there are several factors that can affect the water level measurements in the borehole. Some of these factors include: permeability of each soil layer in profile, presence of perched water, amount of time between water level readings, presence of drilling fluid, weather conditions, and use of borehole casing.

A.5 LABORATORY TEST METHODS

A.5.1 Water Content Tests

Conducted per AET Procedure 01-LAB-010, which is performed in general accordance with ASTM:D2216 and AASHTO:T265.

A.6 TEST STANDARD LIMITATIONS

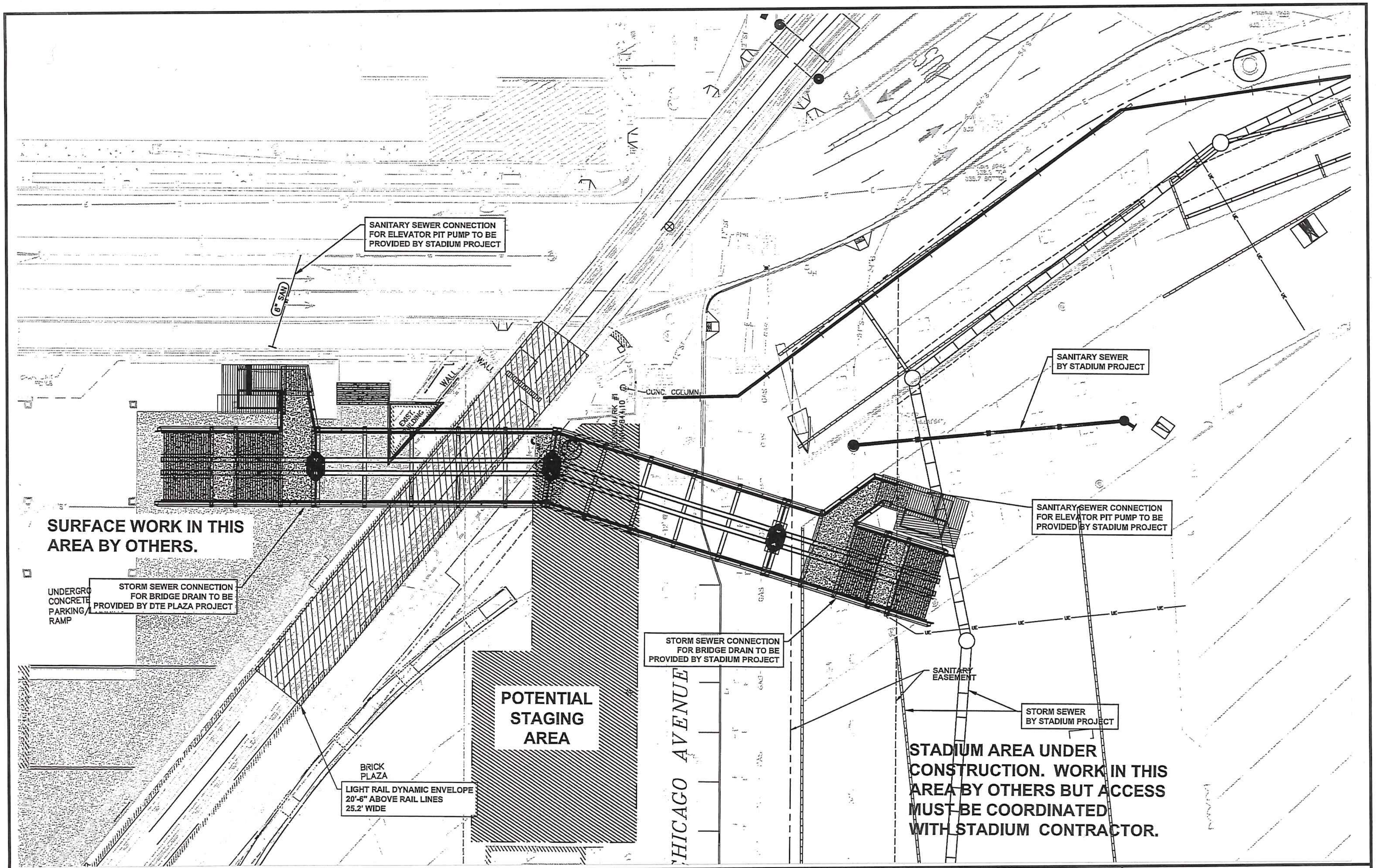
Field and laboratory testing is done in general conformance with the described procedures. Compliance with any other standards referenced within the specified standard is neither inferred nor implied.

A.7 SAMPLE STORAGE

Unless notified to do otherwise, we routinely retain representative samples of the soils recovered from the borings for a period of 30 days.

AMERICAN ENGINEERING TESTING, INC.

Project:	Downtown East Pedestrian Bridge Minneapolis, Minnesota		**AET Proj. No.:** 01-06424
Subject:	Soil Boring Locations		**Date:** 3/10/2015
Scale: Shown	**Drawn By:** MPM	**Checked By:** JKV	**Figure 1**



AMERICAN ENGINEERING TESTING, INC.

Project: Downtown East Pedestrian Bridge
Minneapolis, Minnesota

AET Proj. No.: 01-06424.1

Subject: Project Lay-Out

Date: 4/6/2015

Scale: None

Drawn By: MPM

Checked By: JKV

Figure 2

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET No: **01-06424** Log of Boring No. **B-1 (p. 1 of 3)**

Project: **Downtown East Pedestrian Bridge; Downtown East LRT Station; Kirby Puckett Pl.; Minneapolis, MN**

Surface Elevation **842.7** Hennepin Co. Coordinates: N **167042** E **532107**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	REC %	RQD IN.	RQD %	%-#200
	6.5" Concrete	FILL									
1	17.5" FILL, crushed limestone base, light brown, frozen			F	SU						
2	FILL, mostly silty sand with gravel, trace roots, brown and gray, frozen to 4'			F	SS	12					
3											
4											
5			51	M	SS	3					
6											
7											
8			19	M	SS	12					
9	FILL, mixture of sand with silt and clayey sand, a little gravel, brown										
10			14	M	SS	14	6				
11											
12	SILTY SAND, a little gravel, fine to medium grained, brown, moist, medium dense (SM)	COARSE ALLUVIUM	27	M	SS	14					
13											
14	GRAVELLY SAND WITH SILT, medium to fine grained, brown, moist, dense (SP-SM)										
15			39	M	SS	16					
16											
17											
18											
19											
20			50	M	SS	12					
21											

DEPTH:	DRILLING METHOD
0-49.2'	3.25" HSA
49.2-60.8'	NQ Core

BORING COMPLETED: **2/17/15**

DR: **SG** LG: **SB** Rig: **91C**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
2/17/15	11:40	49.5	49.2	49.2		49.1

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

AET_CORP W-COORDINATES 01-06424.GPJ AET+CPT+WELL.GDT 3/4/15

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET No: **01-06424**   Log of Boring No. **B-1 (p. 2 of 3)**

Project: **Downtown East Pedestrian Bridge; Downtown East LRT Station; Kirby Puckett Pl.; Minneapolis, MN**

Hennepin Co. Coordinates: N **167042** E **532107**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	REC %	RQD IN.	RQD %	%-#200
	GRAVELLY SAND WITH SILT, medium to fine grained, brown, moist, dense (SP-SM) *(continued)*	COARSE ALLUVIUM *(continued)*									
23	SAND WITH SILT, a little gravel, fine to medium grained, brown, moist, very dense to dense (SP-SM)										
24											
25			53	M	SS	16					
26											
27											
28											
29											
30			35	M	SS	16					
31											
32											
33	SAND, medium to fine grained, light brown, moist, medium dense (SP)										
34											
35			29	M	SS	15					
36											
37											
38	SILTY SAND, a little gravel, brown, very dense (SM)	TILL									
39											
40			60	M	SS	18					
41											
42											
43	GRAVELLY SILTY SAND, medium to fine grained, brown, moist, medium dense (SM)	TILL OR COARSE ALLUVIUM									
44											
45			29	M	SS	17					
46											
47											

AET_CORP W-COORDINATES 01-06424.GPJ AET+CPT+WELL.GDT 3/4/15

AMERICAN
ENGINEERING
TESTING, INC.

SUBSURFACE BORING LOG

AET No: **01-06424**

Log of Boring No. **B-1 (p. 3 of 3)**

Project: **Downtown East Pedestrian Bridge; Downtown East LRT Station; Kirby Puckett Pl.; Minneapolis, MN**

Hennepin Co. Coordinates: N **167042** E **532107**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	REC %	RQD IN.	RQD %	%-#20
49	GRAVELLY SILTY SAND, medium to fine grained, brown, moist, medium dense (SM) *(continued)*	TILL OR COARSE*		▼							
	WEATHERED LIMESTONE, gray	**	100/.3		SS	1					
50 51 52 53 54 55 56 57	Limestone, light gray and grayish brown, fossiliferous Weathering: Slightly weathered Fracturing: Very to moderately fractured Stratification: Thickly bedded Hardness: Hard	PLATTEVILLE FORMATION MAGNOLIA MEMBER			NQ NQ	16.5 60		86 100	13 45	68 75	
58 59 60	Limestone, light brown to about 58.2' then gray Weathering: Slightly weathered Fracturing: Intensely fractured to 58.1' then slightly fractured Stratification: Thickly bedded Hardness: Hard	PLATTEVILLE FORMATION HIDDEN FALLS MEMBER			NQ	51		85	41.5	69	
	END OF BORING @ 60.8'	*ALLUVIUM **PLATTEVILLE FORMATION									

AET_CORP W-COORDINATES 01-06424.GPJ AET+CPT+WELL.GDT 3/4/15

AMERICAN
ENGINEERING
TESTING, INC.

SUBSURFACE BORING LOG

AET No: **01-06424**

Log of Boring No. **B-2 (p. 1 of 1)**

Project: **Downtown East Pedestrian Bridge; Downtown East LRT Station; Kirby Puckett Pl.; Minneapolis, MN**

Surface Elevation **842.6**

Hennepin Co. Coordinates: N **167056** E **532116**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
	5.25" Concrete	FILL									
1	12" FILL, crushed limestone base, light brown, frozen			F	SU						
2	FILL, mostly silty sand with gravel, brown, frozen			F	SU						
3	FILL, mostly gravelly silty sand, brown, frozen to 4'			F/M	SU						
4											
5	FILL, mostly silty sand with gravel, pieces of concrete, dark brown and gray		50/.1	M	SS	6					
6	FILL, pieces of concrete or concrete slabs				SU						
	END OF BORING - OBSTRUCTED @ 6.5'										

DEPTH:	DRILLING METHOD
0-6½'	**3.25" HSA**

BORING COMPLETED: **2/18/15**

DR: **SG** LG: **SB** Rig: **91C**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

AET_CORP W-COORDINATES 01-06424.GPJ AET+CPT+WELL.GDT 3/4/15

AMERICAN
ENGINEERING
TESTING, INC.

SUBSURFACE BORING LOG

AET No: **01-06424** Log of Boring No. **B-2A (p. 1 of 2)**

Project: **Downtown East Pedestrian Bridge; Downtown East LRT Station; Kirby Puckett Pl.; Minneapolis, MN**

Surface Elevation **842.7** Hennepin Co. Coordinates: N **167056** E **532116**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	%-#20
1 2 3 4	No samples taken from 0-4.5'										
5 6	FILL, mostly gravelly sand with silt, brown		22	M	SS	4					
7 8	FILL, mostly silty sand with gravel, brown		5	M	SS	10					
9 10 11	SILTY SAND, a little gravel, brown, medium dense (SM) (possible fill)	TILL OR FILL	19	M	SS	15					
12 13			27	M	SS	13					
14 15 16 17	SILTY SAND WITH GRAVEL, fine to medium grained, brown, moist, medium dense (SM)	COARSE ALLUVIUM	24	M	SS	13					
18 19 20 21 22	GRAVELLY SAND WITH SILT, medium to fine grained, brown, moist, very dense (SP-SM)		58	M	SS	8					

DEPTH:	DRILLING METHOD
0-48.7'	**3.25" HSA**

BORING COMPLETED: **2/23/15**

DR: **SG** LG: **SB** Rig: **91C**

WATER LEVEL MEASUREMENTS						
DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
2/23/15	**10:40**	**48.7**	**48.7**	**48.7**		**None**

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

AET_CORP W-COORDINATES 01-06424.GPJ AET+CPT+WELL.GDT 3/4/15

SUBSURFACE BORING LOG

AET No: 01-06424 Log of Boring No. B-2A (p. 2 of 2)

Project: **Downtown East Pedestrian Bridge; Downtown East LRT Station; Kirby Puckett Pl.; Minneapolis, MN**

Hennepin Co. Coordinates: N 167056 E 532116

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	%-#200
	SILTY SAND, a little gravel, fine to medium grained, brown, moist, dense (SM)	COARSE ALLUVIUM *(continued)*									
24											
25			45	M	SS	17					
26											
27											
28	SILTY SAND WITH GRAVEL, fine to medium grained, brown, moist, dense (SM)										
29											
30			49	M	SS	16					
31											
32											
33	SILTY SAND, a little gravel, brown, a little light brown, very dense, laminations of sand (SM)	TILL									
34											
35			55	M	SS	18					
36											
37											
38	SILTY SAND WITH GRAVEL, apparent cobbles, brown, a little gray, very dense (SM)										
39											
40			83	M	SS	16					
41											
42											
43	SILTY SAND, a little gravel, brown, very dense (SM/SC)										
44											
45			99	M	SS	18					
46											
47											
48											
	END OF BORING - OBSTRUCTED SPLIT-SPOON SAMPLER @ 48.75'		100/.05	M	SS	0					

SUBSURFACE BORING LOG

AET No: **01-06424** Log of Boring No. **B-3 (p. 1 of 2)**

Project: **Downtown East Pedestrian Bridge; Downtown East LRT Station; Kirby Puckett Pl.; Minneapolis, MN**

Surface Elevation **842.8** Hennepin Co. Coordinates: N **167024** E **532152**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	%-#200
	2.25" Brick pavers	FILL									
	3.25" Bituminous pavement										
1	3" FILL, crushed limestone base, light brown			F	SU						
2	FILL, mostly silty sand with gravel, pieces of bituminous at 2', dark brown and brown, frozen			F	SS	5					
4	FILL, mixture of silty sand and clayey sand, a little gravel, brown										
5			13	M	SS	12	10				
6	FILL, mostly sand with silt and gravel, a little lean clay, brown										
7.5			19	M	SS	10					
9	FILL, mostly sand, a little gravel and silty sand, light brown										
10			17	M	SS	12					
11	GRAVELLY SAND WITH SILT, possible cobbles, fine to medium grained, brown, moist, very dense (SP-SM)	COARSE ALLUVIUM									
12.5			86	M	SS	5					
15			68	M	SS	16					
18	SILTY SAND, a little gravel, fine grained, brown, moist, medium dense (SM)										
20			23	M	SS	17					
23	SAND, fine grained, light brown, moist, medium dense (SP)										

DEPTH:	DRILLING METHOD
0-49.3'	3.25" HSA

BORING COMPLETED: 2/16/15

DR: SG LG: SB Rig: 91C

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
2/16/15	3:10	49.7	49.3	49.3		48.6
2/16/15	3:20	49.8	49.3	49.3		48.3

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

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SUBSURFACE BORING LOG

AET No: **01-06424** Log of Boring No. **B-3 (p. 1 of 2)**

Project: **Downtown East Pedestrian Bridge; Downtown East LRT Station; Kirby Puckett Pl.; Minneapolis, MN**

Surface Elevation **842.8** Hennepin Co. Coordinates: N **167024** E **532152**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	%-#200
	2.25" Brick pavers	FILL									
	3.25" Bituminous pavement										
1	3" FILL, crushed limestone base, light brown			F	SU						
2	FILL, mostly silty sand with gravel, pieces of bituminous at 2', dark brown and brown, frozen			F	SS	5					
3											
4	FILL, mixture of silty sand and clayey sand, a little gravel, brown										
5			13	M	SS	12	10				
6											
7	FILL, mostly sand with silt and gravel, a little lean clay, brown										
8			19	M	SS	10					
9	FILL, mostly sand, a little gravel and silty sand, light brown										
10			17	M	SS	12					
11	GRAVELLY SAND WITH SILT, possible cobbles, fine to medium grained, brown, moist, very dense (SP-SM)	COARSE ALLUVIUM									
12											
13			86	M	SS	5					
14											
15			68	M	SS	16					
16											
17											
18	SILTY SAND, a little gravel, fine grained, brown, moist, medium dense (SM)										
19											
20			23	M	SS	17					
21											
22											
23	SAND, fine grained, light brown, moist, medium dense (SP)										

DEPTH: DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
0-49.3' 3.25" HSA	DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
	2/16/15	3:10	49.7	49.3	49.3		48.6	
	2/16/15	3:20	49.8	49.3	49.3		48.3	
BORING COMPLETED: 2/16/15								
DR: SG LG: SB Rig: 91C								

AET_CORP W-COORDINATES 01-06424.GPJ AET+CPT+WELL.GDT 3/4/15

SUBSURFACE BORING LOG

AET No: **01-06424**

Log of Boring No. **B-3 (p. 2 of 2)**

Project: **Downtown East Pedestrian Bridge; Downtown East LRT Station; Kirby Puckett Pl.; Minneapolis, MN**

Hennepin Co. Coordinates: N **167024** E **532152**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	%-#200
25	SAND, fine grained, light brown, moist, medium dense (SP) *(continued)*	COARSE ALLUVIUM *(continued)*	30	M	SS	15					
28	LEAN CLAY, brown, a little light brown, hard, laminations of sandy silt (CL)	FINE ALLUVIUM									
30			57	M	SS	18	13				
33	SAND WITH SILT, a little gravel, medium to fine grained, brown, moist, very dense (SP-SM)	COARSE ALLUVIUM									
35			58	M	SS	15					
38	SILTY SAND, a little gravel, apparent cobbles at about 47', brown, very dense (SM)	TILL									
40			69	M	SS	18					
45			51	M	SS	18					
48				▼							
49	WEATHERED LIMESTONE, gray and light brown	PLATTEVILLE FORMATION	100/.4	W	SS	5					
	END OF BORING - OBSTRUCTED SPLIT-SPOON SAMPLER @ 49.7'										

AET_CORP W-COORDINATES 01-06424.GPJ AET+CPT+WELL.GDT 3/4/15

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SUBSURFACE BORING LOG

AET No: **01-06424** Log of Boring No. **B-4 (p. 1 of 2)**

Project: **Downtown East Pedestrian Bridge; Downtown East LRT Station; Kirby Puckett Pl.; Minneapolis, MN**

Surface Elevation **843.2** Hennepin Co. Coordinates: N **167005** E **532141**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	%-#200
	2.25" Brick pavers	FILL									
	3.75" Bituminous pavement										
1	3" FILL, crushed limestone base, light brown, frozen			F	SU						
				F	SU						
2	FILL, mostly silty sand with gravel, dark brown, frozen			F	SS	9	10				
3	FILL, mostly silty sand, a little gravel, brown, frozen										
4											
5	FILL, mostly clayey sand with gravel, a little silty sand, brown, frozen to about 4'		59	M	SS	3	13				
6											
7	SILTY SAND, fine grained, light brown, moist, medium dense (SM)	COARSE ALLUVIUM									
8			17	M	SS	16					
9											
10			23	M	SS	12					
11											
12	SILTY SAND WITH GRAVEL, brown, medium dense (SM)	TILL									
13			20	M	SS	6					
14											
15			20	M	SS	14					
16											
17											
18	CLAYEY SAND, a little gravel, brown, hard, laminations of silty sand and sand (SC)										
19											
20			38	M	SS	16	6				
21											
22											
23											

DEPTH:	DRILLING METHOD
0-49½'	3.25" HSA

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
2/16/15	11:20	49.5	49.5	49.5		49.2
2/16/15	11:30	49.5	49.5	49.5		48.8

BORING COMPLETED: **2/16/15**

DR: **SG** LG: **SB** Rig: **91C**

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

AET_CORP W-COORDINATES 01-06424.GPJ AET+CPT+WELL.GDT 3/4/15

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET No: **01-06424** Log of Boring No. **B-4 (p. 2 of 2)**

Project: **Downtown East Pedestrian Bridge; Downtown East LRT Station; Kirby Puckett Pl.; Minneapolis, MN**

Hennepin Co. Coordinates: N **167005** E **532141**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	%-#200
25	GRAVELLY SAND WITH SILT, apparent cobbles, medium to fine grained, brown, moist, very dense (SP-SM)	COARSE ALLUVIUM	114	M	SS	14					
26											
27											
28	CLAYEY SAND, a little gravel, brown, hard, laminations of silty sand (SC)	TILL									
29											
30			57	M	SS	7	8				
31											
32											
33											
34											
35			59	M	SS	18	7				
36											
37											
38											
39											
40			53	M	SS	18	9				
41											
42											
43	WEATHERED LIMESTONE, gray	PLATTEVILLE FORMATION									
44											
45			40	M	SS	14					
46											
47											
48				▼							
49											
			100/.05	M	SS						
	END OF BORING - OBSTRUCTED @ 49.7'										

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SUBSURFACE BORING LOG

AET No: **01-05723**　Log of Boring No. **B11 (p. 1 of 3)**

Project: **Minnesota Multi-Purpose Stadium; Minneapolis, MN**

Surface Elevation **847.8**　Hennepin Co. Coordinates: N **166950**　E **532196**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	WC	REC %	RQD IN.	RQD %	%-#200
	7" Concrete	FILL									
1	FILL, mostly silty sand with gravel, pieces of brick from 4.5' to 11', pieces of bituminous around 10' and 18'		36	M	SS	3					
2											
3			37	M	SS	12					
4											
5			59	M	SS	14					
6											
7											
8			113	M	SS	12					
9											
10			77	M	SS	14					
11											
12											
13			114	M	SS	10					
14											
15			15	M	SS	12					
16											
17											
18			30	M	SS	14					
19											
20			68	M	SS	12					
21											
22	SAND WITH GRAVEL, fine to medium grained, brown, moist, medium dense (SP)	COARSE ALLUVIUM									
23			69	M	SS	3					
24	CLAYEY SAND WITH GRAVEL, brown, hard (SC/SM)	TILL									
25			58	M	SS	6	9				
26											
27	SAND WITH SILT AND GRAVEL, fine to medium grained, brown, moist, medium dense (SP-SM)	COARSE ALLUVIUM									
28			26	M	SS	3					
29	GRAVELLY SILTY SAND, fine to medium grained, brown, moist, very dense (SM)										
30			66	M	SS	6					
31											

DEPTH:	DRILLING METHOD
0-59.1'	**4.25" HSA**
59.1-59.7'	**RDF w/DM**
59.7-94.1'	**NQ Core**
BORING COMPLETED:	**8/5/13**
DR: **SG**　LG: **TM**	Rig: **85C**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
8/5/13	**2:00**	**54.8**	**54.5**	**54.1**		**53.0**
8/5/13	**2:20**	**54.8**	**54.5**	**54.0**		**52.8**

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

AMERICAN
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SUBSURFACE BORING LOG

AET No: **01-05723**   Log of Boring No. **B11 (p. 2 of 3)**

Project: **Minnesota Multi-Purpose Stadium; Minneapolis, MN**

Hennepin Co. Coordinates: N **166950** E **532196**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	REC %	RQD IN.	RQD %	%-#200
33	GRAVELLY SILTY SAND, fine to medium grained, brown, moist, very dense (SM) *(continued)*		121	M	SS	6					
34	SAND, fine grained, light brown, moist, medium dense (SP)										
35			22	M	SS	12					
36											
37			21	M	SS	12					
38											
39	SAND WITH SILT AND GRAVEL, fine to medium grained, brown, moist, very dense (SP-SM)										
40			100/.4	M	SS	6					
41											
42	SILTY SAND, a little gravel, brown, very dense (SM)	TILL	89	M	SS	12					
43											
44											
45			85	M	SS	18					
46											
47	SAND WITH GRAVEL, fine grained, brown, moist, very dense (SP)	COARSE ALLUVIUM	107	M	SS	14					
48											
49	CLAYEY SAND, a little gravel, brown, hard, lenses and laminations of silty sand (SC)	TILL									
50			49	M	SS	12	9				
51											
52	SILTY SAND WITH GRAVEL, brown, very dense (SM/SC)		87	▼ M	SS	14					
53											
54	GRAVEL WITH SILT AND SAND, brown, waterbearing, very dense (GM)	COARSE ALLUVIUM OR COLLUVIUM	100/.3	W	SS	2					
55	APPARENT LIMESTONE, severely weathered (residual soil) with hard thin layers (based on drill tool action)										
56											
57		APPARENT PLATTEVILLE FORMATION MAGNOLIA MEMBER									
58											
59											
60	LIMESTONE, light gray and gray, a little light brown, fossiliferous Weathering: Slightly weathered Fracturing: Moderately to slightly fractured, very fractured around 61.6' Stratification: Thickly bedded Hardness: Hard	PLATTEVILLE FORMATION MAGNOLIA MEMBER									
61											
62					NQ2	53		100	51	97	
63											
64											
65	LIMESTONE, gray and light gray, a little light brown Weathering: Slightly weathered Fracturing: Very to slightly fractured Stratification: Thickly bedded Hardness: Hard	PLATTEVILLE FORMATION HIDDEN FALLS MEMBER									
66					NQ2	56		93	48	80	
67											
68											
69	LIMESTONE, light gray and gray crinkly										

AET_CORP W-COORDINATES 01-05723.GPJ AET+CPT+WELL.GDT 3/6/15

SUBSURFACE BORING LOG

AET No: **01-05723** Log of Boring No. **B11 (p. 3 of 3)**

Project: **Minnesota Multi-Purpose Stadium; Minneapolis, MN**

Hennepin Co. Coordinates: N **166950** E **532196**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	REC %	RQD IN.	RQD %	%-#200
71	bedded Weathering: Slightly weathered Fracturing: Very to slightly fractured Stratification: Very thinly bedded Hardness: Hard	PLATTEVILLE FORMATION MIFFLIN MEMBER *(continued)*			NQ2	58		97	46	77	
76					NQ2	60		100	57	95	
81					NQ2	58		97	49	82	
83	LIMESTONE, light gray and gray Weathering: Fresh Fracturing: Slightly fractured Stratification: Thinly bedded Hardness: Hard	PLATTEVILLE FORMATION PECATONICA MEMBER									
86	SHALE, gray to about 85.6' then light gray and brown sandy shale to about 86.8' then light brownish gray shaley sandstone	GLENWOOD FORMATION			NQ2	37		62			
88	PROBABLY SANDSTONE (no recovery)	ST. PETER FORMATION									
91					NQ2	0		0			
94	**END OF BORING**										

STS Consultants Ltd.

OWNER
MCDA

PROJECT NAME
Metrodome LRT Station

LOG OF BORING NUMBER **B-05**

ARCHITECT-ENGINEER
Hammel, Green, and Abrahamson, Inc.

SITE LOCATION
Park Ave S & 5th Ave S - Minneapolis, MN

SURFACE ELEVATION 841.1 feet NGVD

○ UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² 1 2 3 4 5

PLASTIC LIMIT % × — WATER CONTENT % ● — LIQUID LIMIT % △ 10 20 30 40 50

⊗ STANDARD PENETRATION BLOWS/FT. 10 20 30 40 50

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³	PHOTO-IONIZATION DETECTOR READING (PPM)	STANDARD PENETRATION BLOWS/FT.
0.5		1	AS			Bituminous pavement			
0.8		1A	AS			Class 5 base course		0	
		1B	AS						
			HS HS						
2.2		2	SS			FILL: Fine to medium sand, little gravel - light brown - damp - loose to medium dense - slight naptha odor - (SP)		0	24
5.0			HS						
6.2		3	SS			FILL: Fine to medium silty sand, trace gravel - dark brown - damp - medium dense - (SM)		0	36
		3A	SS						
			HS						
		4	SS			FILL: Fine to medium sand, with gravel - brown to reddish brown - damp to moist - dense - weathered limestone gravel encountered at 6.1 feet - (SP)			58
10.0			HS						
11.2		5	SS						77
		5A	SS			FILL: Limestone gravel, with sand, light brown to gray - dense to very dense - (GP)		0	
13.3			HS						
15.0			HS			Silty sand, with clay, trace gravel - brown - medium dense - wet - strong petroleum odor encountered In Sample 6 - (SM-SC)			
		6	SS					25	20
20.0			HS						
21.5		7	SS						18
		7A	SS			Fine to coarse sand, trace to some gravel - brown - wet - medium dense to dense - (SW)		0	
25.0			HS						
		8	SS					0	30
30.0			HS						
		9	SS					0	50
35.0			HS						
		10	SS					0	38
40.0			HS						
41.6		11	SS						45
		11A	SS			Gravel, with sand, trace clay - brown - dense - wet - (GP)		0	
44.5			HS						
45.0			HS			Weathered Limestone			
46.5		12	SS					0	70
46.7 47.0			SS			Probably Sound Limestone			

End-of-boring at 46.7 feet
Boring drilled using hollow-stem augers
All samples placed in zip-closure polyethylene bags, and screened with TIP photoionization detector, equipped with a 10.6 eV lamp source and calibrated to a benzene reference.
Borehole grouted with high-solids bentonite

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WL Not Encountered	BORING STARTED 6/13/00	STS OFFICE	Minneapolis Area - 06
WL	BORING COMPLETED 6/13/00	ENTERED BY SSW	SHEET NO. 1 OF 1
WL	RIG/FOREMAN D-50/HH	APP'D BY	STS JOB NO. 97701A

BORING_LOG 97701A.GPJ STS.GDT 7/12/00

Appendix B

Geotechnical Report Limitations and Guidelines for Use

Appendix B
Geotechnical Report Limitations and Guidelines for Use
Report No. 01-06424.1

B.1 REFERENCE

This appendix provides information to help you manage your risks relating to subsurface problems which are caused by construction delays, cost overruns, claims, and disputes. This information was developed and provided by ASFE[1], of which, we are a member firm.

B.2 RISK MANAGEMENT INFORMATION

B.2.1 Geotechnical Services are Performed for Specific Purposes, Persons, and Projects

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

B.2.2 Read the Full Report

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

B.2.3 A Geotechnical Engineering Report is Based on A Unique Set of Project-Specific Factors

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

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

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

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

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

B.2.4 Subsurface Conditions Can Change

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

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[1] ASFE, 8811 Colesville Road/Suite G106, Silver Spring, MD 20910
Telephone: 301/565-2733 : www.asfe.org

B.2.5 Most Geotechnical Findings Are Professional Opinions

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

B.2.6 A Report's Recommendations Are Not Final

Do not overrely on the construction recommendations included in your report. Those recommendations are not final, because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual subsurface conditions revealed during construction. The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.

B.2.7 A Geotechnical Engineering Report Is Subject to Misinterpretation

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

B.2.8 Do Not Redraw the Engineer's Logs

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

B.2.9 Give Contractors a Complete Report and Guidance

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

B.2.10 Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their report. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. Read these provisions closely. Ask questions. Your geotechnical engineer should respond fully and frankly.

B.2.11 Geoenvironmental Concerns Are Not Covered

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

AMERICAN ENGINEERING TESTING, INC.

CONSULTANTS
- ENVIRONMENTAL
- GEOTECHNICAL
- MATERIALS
- FORENSICS

October 20, 2015

Minnesota Sports Facilities Authority
511 11th Avenue South, Suite 401
Minneapolis, MN 55415

Attn: Steve Maki, PE

RE: Geotechnical Exploration and Testing
Vikings Legacy Ship, US Bank Stadium
Minneapolis, Minnesota
AET No. 01-05723

Dear Mr. Maki:

This letter report presents the results of the geotechnical exploration, testing, and review that we performed for the Vikings Legacy Ship planned to be constructed in the southwest corner of the stadium site. This work is being performed per our September 1, 2015 proposal to the MSFA, which was subsequently authorized by Tanya Dreesen of the Vikings on the same date. The scope consisted of three standard penetration test borings, soil index testing, and preparation of this report. As petroleum-type odor was noted from one sample, the samples from that boring were also screened in the laboratory for organic vapors using a photoionization detector (PID).

1.0 Project Information

The Legacy Ship will be located in the southwest corner of the stadium site, in the northeast quadrant of the intersection of 6th Street South and Chicago Avenue. The layout is shown on Figure 1. The borings are located at or near the primary foundations supporting the structure, although there will be smaller foundation elements around the bow foundation. The foundations have reportedly been located to avoid the below grade utilities in the area.

Grade is planned to be raised in the area. At this time, we understand the main on-grade slab to be in the vicinity of elevation 848 feet. This results in grade raises of about 2½ feet to 6½ feet at the test boring locations. The slab subgrade soils will be exposed to freezing temperature conditions.

The mast component represents the most significant foundation, as it will support the "sail" which will be an LED Display Board. This foundation will need to resist the following unfactored loads:

- Moment: 1517 kip-ft
- Lateral force (shear): 37.8 kips
- Axial force (compression): 70.7 kips

We understand the mast foundation is expected to maintain a deflection of less than 1½ inch at the top of the foundation. The preliminary design provided to us consisted of a 6-foot diameter drilled pier, extending 28 feet deep. The pier will be reinforced with #8 reinforcing bars and #4 transverse bars.

We presume the bow and stern foundations will experience considerably lower moment and lateral loads, although axial loads could be similar. These foundations are expected to be shallow spread footings which are buried at least 5 feet for frost protection.

Utilities have been located in the project area in the past. However, we understand these past utilities have been re-routed, and the utilities beneath the ship area have been abandoned. An exception is a fiber optic duct which crosses the area between the bow and mast.

2.0 Subsurface Exploration

The standard penetration test borings were completed in the field on September 21, 2015. The logs of the test borings are attached. The boring designations of M, B, and S correspond to the mast, bow, and stern locations of the ship, respectively. The boring locations appear on Figure 1. We have noted the Hennepin County coordinates as determined by GPS to submeter accuracy on the logs. The surface elevations were referenced to a manhole rim shown on provided plans.

The boring logs contain information concerning soil layering, soil classification, geologic description, and moisture condition. Relative density or consistency is also noted for natural soils, which is based on the standard penetration resistance (N-value). We refer you to the standard sheet entitled "Exploration/Classification Methods" for details on the drilling and sampling methods, the classification methods, and the water level measurement methods. Data sheets concerning the Unified Soils Classification System, the descriptive terminology, and the symbols used on the boring logs are also attached.

3.0 Geotechnical Laboratory Testing

The laboratory test program consisted of two sieve analysis tests. The test results appear on the data sheet following the logs.

4.0 PID Screening

During the field drilling operations, the sample from 17 feet to 18½ feet at Boring M was found to have a relatively strong petroleum-type odor. To document organic vapor presence at this depth, and to document the lack of vapors at the other sample depths at this location, the samples from this boring were screened in the laboratory for organic vapors using a photoionization detector. A photoionization detector (PID) checks for the presence of organic vapors with ionization potentials less than the lamp voltage. The PID is calibrated for direct reading in parts-per-million-volume (PPMv) of a benzene equivalent.

The results of that screening appear on the boring logs. The results do indicate the presence of organic vapors from the 17 to 18½ foot sample, but not at the other samples.

As this report is for geotechnical purposes only, the report does not address handling of the contaminated soils during construction.

5.0 Conditions Encountered

The geologic profile consists of 6½ feet to 11½ feet of fill over water-deposited (alluvial) sands and gravels; although differentiation between the fill and natural soils was not obvious, and the actual depths may vary. The apparent fill mostly consists of silty sand, and is relatively well compacted based on the N-values recorded. The fill thickness may well vary over a short distance in the area, as it may be utility trench backfill.

The underlying alluvial soils are sands (SP), sands with silt (SP-SM), and silty sands (SM), having varying gravel content. Some of the upper sands to sands with silt are loose, based on N-values of 6 to 10, The deeper soils, and the silty sands, are typically medium dense to dense.

6.0 Mast Foundation Review and LPILE Analysis

The critical component of the mast pier foundation design will be the control of deflection due to the moment and lateral loads it will experience. The axial resistance of the mast pier will be relatively high due to the combination of end bearing and skin friction.

Potential deflection of the mast foundation due to the understood loads acting was analyzed using *LPILE v2015* from Ensoft, Inc. Our analysis indicates the preliminarily planned six-foot diameter drilled per will be able to provide proper resistance with about ½ inch of deflection. In our opinion, it should be possible to reduce either the foundation diameter or depth as follows:

- Six-foot diameter pier, 24-foot depth, or
- Five-foot diameter pier, 28-foot depth.

The above cases still result in a deflection of about ½ inch to ⅔ inch, which is within the established criteria. Our analysis indicates the depth to be an important element of the design, as the analysis shows deflections approaching the 1½-inch deflection limit with a pier depth of 20 feet.

7.0 Recommendations

7.1 Grading

We recommend new fill placed to raise grade be Select Granular Borrow per MnDOT Specification 3149.2B.2. In addition, where current grade is within 4 feet of the bottom of the slab and the soil does not meet Select Granular Borrow specifications (silty sand does not), we recommend the soils be subcut and replaced with Select Granular Borrow to provide a more uniform frost heave condition.

Prior to Select Granular Borrow placement or shallow footing placement, we recommend the exposed soils be observed and evaluated by AET geotechnical field personnel. The evaluation should include a series of hand auger borings to explore the quality and uniformity of the soils, particularly in past utility backfill areas and in areas where shallow footings will be placed. If soils are deemed unsuitable, excavation and refilling should be performed as directed by the geotechnical field personnel. Prior to fill and footing placement, the exposed soils should be surface compacted with at least six passes of a vibratory roller compactor.

We are not aware of past utility abandonment procedures. Proper abandonment would involve either complete utility removal, full concrete filling of pipes, or, if the pipe was deemed to have sufficient structural strength, plugging of the ends to prevent soil erosion into the pipe. AET was not involved with this process, nor do we have records of how this was done. If proper abandonment didn't take place, our recommendation would be to have this done. We can state that Boring S was in the area of past utilities, and the N-values recorded do suggest the fill has relatively high compaction.

New fill should be compacted in thin lifts, such that the entire lift achieves a minimum compaction level of 98% of the *standard maximum dry unit weight* per ASTM:D698 (Standard Proctor test). The lift thicknesses should be thin enough such that it can achieve the minimum specified compaction level with the type of compaction equipment being used.

7.2 Mast Foundation Design

We recommend the mast be supported on a drilled pier foundation, with dimensions meeting one of the two cases noted in Section 6.0. During concrete placement, care should be taken to avoid segregation of the aggregates in the concrete caused by concrete striking reinforcing steel or the sides of the casing/excavation. As sands will cave, casing will likely be needed. When casing is used, a positive head of concrete should be maintained above the bottom of the casing during its removal.

7.3 Shallow Spread Foundation Design

Following the recommended grading, the remaining structural elements can be supported on spread footing foundations. We recommend the foundations be placed such that at least 5 feet of soil cover is provided for frost protection purposes. The footings should be deeper if needed to avoid influence on utilities, such as the fiber optic duct which we understand will remain. The footing bottom should be positioned such that it is at least 2H:1V away from the duct bottom.

The foundation design can be based on a maximum allowable soil bearing capacity of up to 3,000 psf. It is our judgment the 3,000 psf design pressure should have a factor of safety of greater than 3 against localized shear or base failure. We judge that total and differential settlements under these loadings will be less than 1 inch and ½ inch, respectively.

8.0 Standard of Care

Within the limitations of scope, budget, and schedule, our services have been conducted according to generally accepted geotechnical engineering practices at this time and location.

Authored By,

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Reviewed By,

Gregory R. Reuter, PE, PG
Principal Engineer

Attachments:

- Figure 1 – Boring Locations
- Subsurface Boring Logs
- Sieve Analysis Test Results
- Exploration/Classification Methods
- Boring Log Notes
- Unified Soil Classification System

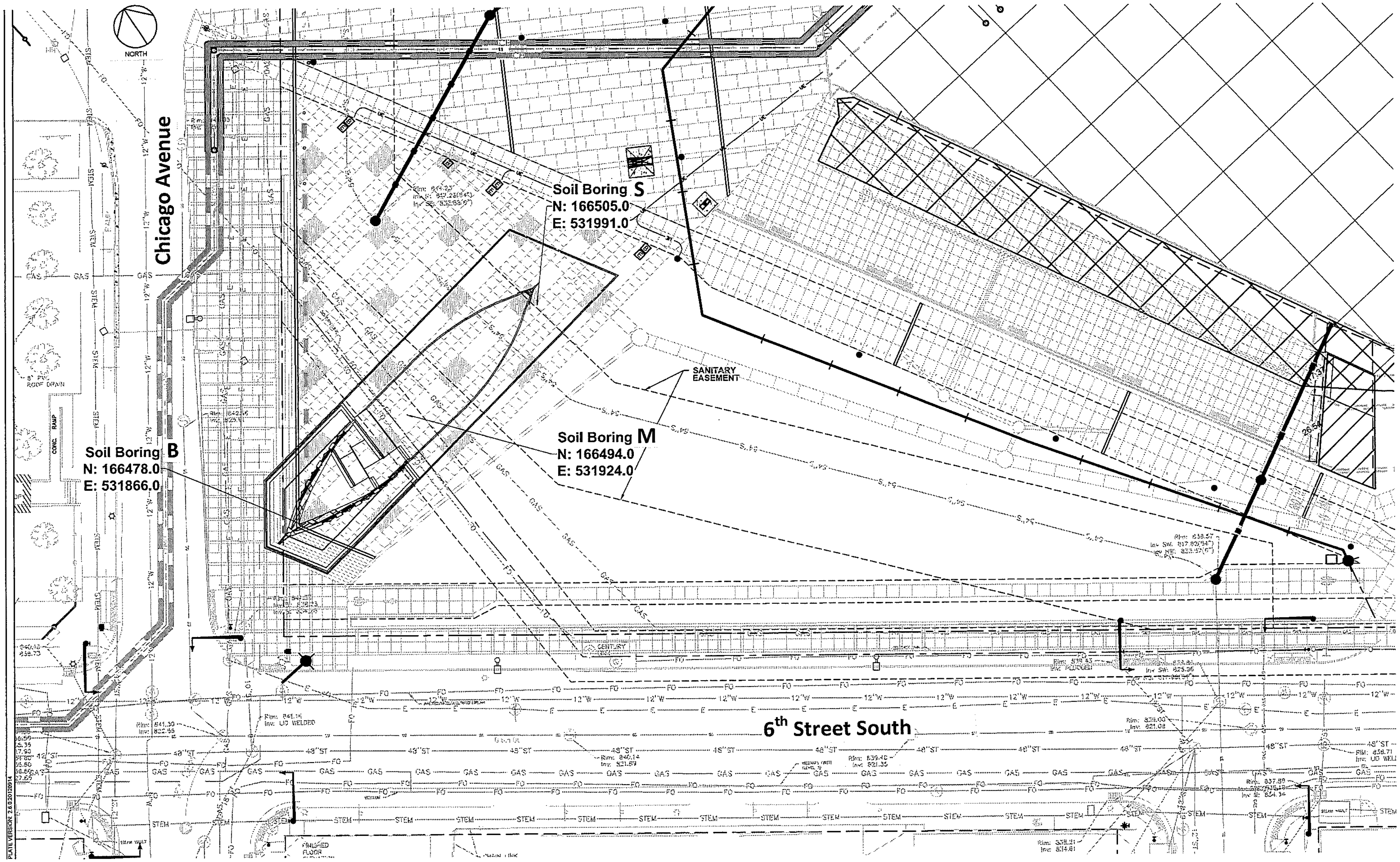

Figure 1 – Boring Locations
Vikings Legacy Ship
AET No. 01-05723

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SUBSURFACE BORING LOG

AET No: **01-05723**

Log of Boring No. **B (p. 1 of 1)**

Project: **Minnesota Multi-Purpose Stadium; Minneapolis, MN**

Surface Elevation **842.5**

Hennepin Co. Coordinates: N **166478** E **531866**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	%-#200
	3" Crushed limestone base, light brown	FILL									
1	FILL, mostly silty sand, dark brown		19	M	SS	14					
2-3			12	M	SS	14					
5			7	M	SS	14	10				18
7-8	SAND WITH SILT, fine to medium grained, brown, moist, loose (SP-SM)	COARSE ALLUVIUM	9	M	SS	12					
10			8	M	SS	14					
12-13	SAND, fine to medium grained, brown, moist, loose (SP)		7	M	SS	14					
14-15	SAND WITH SILT, fine to medium grained, brown, moist, loose (SP-SM)		6	M	SS	12					
17-18	GRAVELLY SAND, medium to fine grained, brown, moist, very dense (SP)		81	M	SS	10					
19-21	SAND WITH SILT AND GRAVEL, fine to medium grained, light brown, a little brown, moist, medium dense, lenses of sandy lean clay (SP-SM)		29	M	SS	12					
22-23	SAND WITH SILT, a little gravel, fine to medium grained, brown, moist, medium dense (SP-SM)		19	M	SS	14					
24-25	SAND WITH SILT, a little gravel, medium to fine grained, brown, a little gray, moist, medium dense, lenses and laminations of sandy lean clay (SP-SM)		18	M	SS	14					
26	**END OF BORING**										

DEPTH:	DRILLING METHOD
0-24½'	3.25" HSA

BORING COMPLETED: 9/21/15

DR: **SG** LG: **TPM** Rig: **91C**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
9/21/15	1:15	26.0	24.5	26.0		None

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

SUBSURFACE BORING LOG

AET No: **01-05723**　　Log of Boring No. **M (p. 1 of 2)**

Project: **Minnesota Multi-Purpose Stadium; Minneapolis, MN**

Surface Elevation **841.7**　　Hennepin Co. Coordinates: N **166494**　E **531924**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	WC	DEN	LL	PL	PID (ppm)
1	FILL, mostly silty sand with gravel, pieces of concrete, brown and gray	FILL	64	M	SS	16					0.6
2	FILL, mostly silty sand, a little gravel, dark brown										
3	FILL, mostly silty sand, a little clayey sand, black to brown		14	M	SS	14					0.2
4											
5			9	M	SS	14					0.2
6											
7	SAND WITH SILT, fine grained, light brown, moist, loose (SP-SM)	COARSE ALLUVIUM									
8			6	M	SS	14					0.3
9	SAND, a little gravel, fine to medium grained, brown, moist, loose (SP)										
10			10	M	SS	10					0.3
11											
12	SAND, fine grained, light brown, moist, medium dense, lenses of silt, laminations of lean clay (SP)										
13			26	M	SS	14					0.2
14	SAND WITH SILT, a little gravel, possible cobble at 15½', fine to medium grained, brown, moist, very dense (SP-SM) *3/.5 + 5/.5 + 100/.2										
15			*	M	SS	12					0.3
16											
17	SILTY SAND, a little gravel, fine to medium grained, brown, moist, medium dense, lenses and laminations of sandy lean clay (SM) (petroleum type odor)										
18			21	M	SS	14					197
19											
20	SILTY SAND, a little gravel, fine grained, brown, moist, medium dense (SM)		23	M	SS	14					0.7
21											
22	SILTY SAND WITH GRAVEL, fine grained, brown, moist, dense (SM)										
23			38	M	SS	12					0.4
24											
25			34	M	SS	10					0.4
26											
27											
28			27	M/W	SS	14					0.4
29	SILTY SAND WITH GRAVEL, fine to medium grained, brown, moist, medium dense (SM)										
30			26	M/W	SS	14					0.5
31											

DEPTH:	DRILLING METHOD
0-39½'	3.25" HSA

BORING COMPLETED: **9/21/15**

DR: **SG**　LG: **TPM** Rig: **91C**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
9/21/15	9:15	41.0	39.5	41.0		None
9/21/15	9:25	41.0	39.5	41.0		None
9/21/15	11:15	41.0	39.5	41.0		None

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

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SUBSURFACE BORING LOG

AET No: **01-05723**

Log of Boring No. **M (p. 2 of 2)**

Project: **Minnesota Multi-Purpose Stadium; Minneapolis, MN**

Hennepin Co. Coordinates: N **166494** E **531924**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	PID (ppm)
33	SAND WITH SILT, fine grained, brown, moist, medium dense, lenses and laminations of sandy lean clay (SP-SM) *(continued)*	COARSE ALLUVIUM *(continued)*	28	M/W	SS	12					0.4
34 35 36	SAND WITH GRAVEL, fine grained, light brown, moist, very dense (SP)		55	M	SS	14					0.4
37 38	SILTY SAND WITH GRAVEL, fine to medium grained, brown, moist, very dense, lenses and laminations of clayey sand (SM)		61	M	SS	14					0.4
39 40	SAND WITH SILT, fine grained, light brown, moist, dense (SP-SM)		49	M	SS	16					0.3
41	**END OF BORING**										

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SUBSURFACE BORING LOG

AET No: **01-05723** Log of Boring No. **S (p. 1 of 1)**

Project: **Minnesota Multi-Purpose Stadium; Minneapolis, MN**

Surface Elevation **845.3** Hennepin Co. Coordinates: N **166505** E **531991**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	WC	DEN	LL	PL	%-#200
1	FILL, mostly silty sand, a little gravel and clayey sand, gray and brown	FILL	18	M	SS	14					
2											
3			71	M	SS	10					
4	FILL, mostly silty sand, a little gravel, brown										
5			15	M	SS	12					
6											
7	FILL, mostly silty sand with gravel, brown										
8			21	M	SS	5	6				14
9											
10			28	M	SS	12					
11											
12	SILTY SAND, a little gravel, fine to medium grained, brown, moist, medium dense, lenses and laminations of clayey sand (SM)	COARSE ALLUVIUM									
13			26	M	SS	10					
14											
15			20	M	SS	14					
16											
17	SILTY SAND WITH GRAVEL, fine to medium grained, brown, moist, medium dense (SM)										
18			21	M	SS	14					
19	SAND, a little gravel, fine to medium grained, light brown, moist, medium dense, lenses and laminations of lean clay and clayey sand (SP)										
20			33	M	SS	10					
21											
22	SILTY SAND WITH GRAVEL, fine to medium grained, brown, moist, dense to medium dense (SM)										
23			32	M	SS	10					
24											
25			24	M	SS	14					
26	**END OF BORING**										

DEPTH:	DRILLING METHOD
0-24½'	**3.25" HSA**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
9/21/15	**9:25**	**26.0**	**26.5**	**26.0**		**None**

BORING COMPLETED: **9/21/15**

DR: **SG** LG: **TPM** Rig: **91C**

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

SIEVE ANALYSIS TEST RESULTS

PROJECT:
Vikings Legacy Ship
US Bank Stadium
Minneapolis, Minnesota

AET NO.: 01-05723

DATE: October 20, 2015

TEST METHOD: General Conformance with ASTM: D6913, Method A

RESULTS:

Boring Number	B	S
Sample Depth	4½'-6'	7'-8½'
Dry Sample Weight (gms)	194.33	160.20
Sieve Size or Number	**Percent Passing by Weight**	
3/4"	100	100
5/8"	100	96
1/2"	100	90
3/8"	100	89
#4	100	80
#10	98	73
#20	90	66
#40	68	52
#100	22	20
#200	18	14

Note: The small sample size limits the accuracy of the test, and the sample may not necessarily be representative of the entire layer shown on the boring log.

SAMPLING METHODS

Split-Spoon Samples (SS) - Calibrated to N_{60} Values

Standard penetration (split-spoon) samples were collected in general accordance with ASTM: D1586 with one primary modification. The ASTM test method consists of driving a 2" O.D. split-barrel sampler into the in-situ soil with a 140-pound hammer dropped from a height of 30". The sampler is driven a total of 18" into the soil. After an initial set of 6", the number of hammer blows to drive the sampler the final 12" is known as the standard penetration resistance or N-value. Our method uses a modified hammer weight, which is determined by measuring the system energy using a Pile Driving Analyzer (PDA) and an instrumented rod.

In the past, standard penetration N-value tests were performed using a rope and cathead for the lift and drop system. The energy transferred to the split-spoon sampler was typically limited to about 60% of its potential energy due to the friction inherent in this system. This converted energy then provides what is known as an N_{60} blow count.

AET's drill rigs incorporate an automatic hammer lift and drop system, which has higher energy efficiency and subsequently results in lower N-values than the traditional N_{60} values. By using the PDA energy measurement equipment, we are able to determine actual energy generated by the drop hammer. With the various hammer systems available, we have found highly variable energies ranging from 55% to over 100%. Therefore, the intent of AET's hammer calibrations is to vary the hammer weight such that hammer energies lie within about 60% to 65% of the theoretical energy of a 140-pound weight falling 30". The current ASTM procedure acknowledges the wide variation in N-values, stating that N-values of 100% or more have been observed. Although we have not yet determined the statistical measurement uncertainty of our calibrated method to date, we can state that the accuracy deviations of the N-values using this method are significantly better than the standard ASTM Method.

Disturbed Samples (DS)/Spin-up Samples (SU)

Sample types described as "DS" or "SU" on the boring logs are disturbed samples, which are taken from the flights of the auger. Because the auger disturbs the samples, possible soil layering and contact depths should be considered approximate.

Sampling Limitations

Unless actually observed in a sample, contacts between soil layers are estimated based on the spacing of samples and the action of drilling tools. Cobbles, boulders, and other large objects generally cannot be recovered from test borings, and they may be present in the ground even if they are not noted on the boring logs.

CLASSIFICATION METHODS

Soil classifications shown on the boring logs are based on the Unified Soil Classification (USC) system. The USC system is described in ASTM: D2487 and D2488. Where laboratory classification tests (sieve analysis or Atterberg Limits) have been performed, accurate classifications per ASTM: D2487 are possible. Otherwise, soil classifications shown on the boring logs are visual-manual judgments. Charts are attached which provide information on the USC system, the descriptive terminology, and the symbols used on the boring logs.

The boring logs include descriptions of apparent geology. The geologic depositional origin of each soil layer is interpreted primarily by observation of the soil samples, which can be limited. Observations of the surrounding topography, vegetation, and development can sometimes aid this judgment.

WATER LEVEL MEASUREMENTS

The ground water level measurements are shown at the bottom of the boring logs. The following information appears under "Water Level Measurements" on the logs:

- Date and Time of measurement
- Sampled Depth: lowest depth of soil sampling at the time of measurement
- Casing Depth: depth to bottom of casing or hollow-stem auger at time of measurement
- Cave-in Depth: depth at which measuring tape stops in the borehole
- Water Level: depth in the borehole where free water is encountered
- Drilling Fluid Level: same as Water Level, except that the liquid in the borehole is drilling fluid

The true location of the water table at the boring locations may be different than the water levels measured in the boreholes. This is possible because there are several factors that can affect the water level measurements in the borehole. Some of these factors include: permeability of each soil layer in profile, presence of perched water, amount of time between water level readings, presence of drilling fluid, weather conditions, and use of borehole casing.

SAMPLE STORAGE

Unless notified to do otherwise, we routinely retain representative samples of the soils recovered from the borings for a period of 30 days.

BORING LOG NOTES

DRILLING AND SAMPLING SYMBOLS

Symbol	Definition
AR:	Sample of material obtained from cuttings blown out the top of the borehole during air rotary procedure.
B, H, N:	Size of flush-joint casing
CAS:	Pipe casing, number indicates nominal diameter in inches
COT:	Clean-out tube
DC:	Drive casing; number indicates diameter in inches
DM:	Drilling mud or bentonite slurry
DR:	Driller (initials)
DS:	Disturbed sample from auger flights
DP:	Direct push drilling; a 2.125 inch OD outer casing with an inner 1½ inch ID plastic tube is driven continuously into the ground.
FA:	Flight auger; number indicates outside diameter in inches
HA:	Hand auger; number indicates outside diameter
HSA:	Hollow stem auger; number indicates inside diameter in inches
LG:	Field logger (initials)
MC:	Column used to describe moisture condition of samples and for the ground water level symbols
N (BPF):	Standard penetration resistance (N-value) in blows per foot (see notes)
NQ:	NQ wireline core barrel
PQ:	PQ wireline core barrel
RDA:	Rotary drilling with compressed air and roller or drag bit.
RDF:	Rotary drilling with drilling fluid and roller or drag bit
REC:	In split-spoon (see notes), direct push and thin-walled tube sampling, the recovered length (in inches) of sample. In rock coring, the length of core recovered (expressed as percent of the total core run). Zero indicates no sample recovered.
SS:	Standard split-spoon sampler (steel; 1.5" is inside diameter; 2" outside diameter); unless indicated otherwise
SU	Spin-up sample from hollow stem auger
TW:	Thin-walled tube; number indicates inside diameter in inches
WASH:	Sample of material obtained by screening returning rotary drilling fluid or by which has collected inside the borehole after "falling" through drilling fluid
WH:	Sampler advanced by static weight of drill rod and hammer
WR:	Sampler advanced by static weight of drill rod
94mm:	94 millimeter wireline core barrel
▼:	Water level directly measured in boring
▽:	Estimated water level based solely on sample appearance

TEST SYMBOLS

Symbol	Definition
CONS:	One-dimensional consolidation test
DEN:	Dry density, pcf
DST:	Direct shear test
E:	Pressuremeter Modulus, tsf
HYD:	Hydrometer analysis
LL:	Liquid Limit, %
LP:	Pressuremeter Limit Pressure, tsf
OC:	Organic Content, %
PERM:	Coefficient of permeability (K) test; F - Field; L - Laboratory
PL:	Plastic Limit, %
q_p:	Pocket Penetrometer strength, tsf (approximate)
q_c:	Static cone bearing pressure, tsf
q_u:	Unconfined compressive strength, psf
R:	Electrical Resistivity, ohm-cms
RQD:	Rock Quality Designation of Rock Core, in percent (aggregate length of core pieces 4" or more in length as a percent of total core run)
SA:	Sieve analysis
TRX:	Triaxial compression test
VSR:	Vane shear strength, remolded (field), psf
VSU:	Vane shear strength, undisturbed (field), psf
WC:	Water content, as percent of dry weight
%-200:	Percent of material finer than #200 sieve

STANDARD PENETRATION TEST NOTES
(Calibrated Hammer Weight)

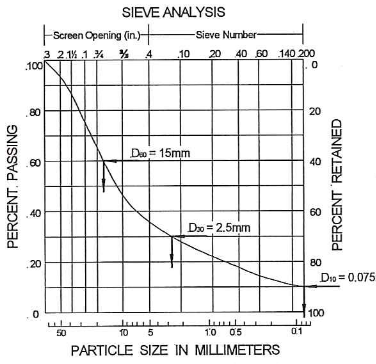
The standard penetration test consists of driving a split-spoon sampler with a drop hammer (calibrated weight varies to provide N_{60} values) and counting the number of blows applied in each of three 6" increments of penetration. If the sampler is driven less than 18" (usually in highly resistant material), permitted in ASTM: D1586, the blows for each complete 6" increment and for each partial increment is on the boring log. For partial increments, the number of blows is shown to the nearest 0.1' below the slash.

The length of sample recovered, as shown on the "REC" column, may be greater than the distance indicated in the N column. The disparity is because the N-value is recorded below the initial 6" set (unless partial penetration defined in ASTM: D1586 is encountered) whereas the length of sample recovered is for the entire sampler drive (which may even extend more than 18").

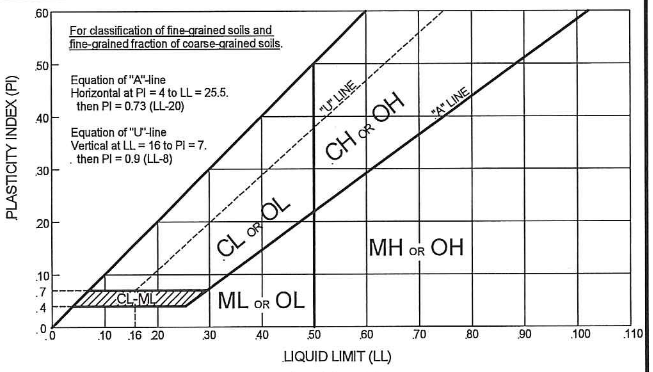
UNIFIED SOIL CLASSIFICATION SYSTEM
ASTM Designations: D 2487, D2488

AMERICAN ENGINEERING TESTING, INC.

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A]				Soil Classification	
				Group Symbol	Group Name[B]
Coarse-Grained Soils More than 50% retained on No. 200 sieve	Gravels More than 50% coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines[C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$[E]	GW	Well graded gravel[F]
			$Cu < 4$ and/or $1 > Cc > 3$[E]	GP	Poorly graded gravel[F]
		Gravels with Fines more than 12% fines [C]	Fines classify as ML or MH	GM	Silty gravel[F.G.H]
			Fines classify as CL or CH	GC	Clayey gravel[F.G.H]
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines[D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$[E]	SW	Well-graded sand[I]
			$Cu < 6$ and/or $1 > Cc > 3$[E]	SP	Poorly-graded sand[I]
		Sands with Fines more than 12% fines [D]	Fines classify as ML or MH	SM	Silty sand[G.H.I]
			Fines classify as CL or CH	SC	Clayey sand[G.H.I]
Fine-Grained Soils 50% or more passes the No. 200 sieve (see Plasticity Chart below)	Silts and Clays Liquid limit less than 50	inorganic	PI>7 and plots on or above "A" line[J]	CL	Lean clay[K.L.M]
			PI<4 or plots below "A" line[J]	ML	Silt[K.L.M]
		organic	$\frac{\text{Liquid limit–oven dried}}{\text{Liquid limit – not dried}} < 0.75$	OL	Organic clay[K.L.M.N] Organic silt[K.L.M.O]
	Silts and Clays Liquid limit 50 or more	inorganic	PI plots on or above "A" line	CH	Fat clay[K.L.M]
			PI plots below "A" line	MH	Elastic silt[K.L.M]
		organic	$\frac{\text{Liquid limit–oven dried}}{\text{Liquid limit – not dried}} < 0.75$	OH	Organic clay[K.L.M.P] Organic silt[K.L.M.Q]
Highly organic soil			Primarily organic matter, dark in color, and organic in odor	PT	Peat[R]



$$C_u = \frac{D_{60}}{D_{10}} = \frac{15}{0.075} = 200 \qquad C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}} = \frac{2.5^2}{0.075 \times 15} = 5.6$$



Plasticity Chart

Notes

[A] Based on the material passing the 3-in (75-mm) sieve.

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols:
- GW-GM well-graded gravel with silt
- GW-GC well-graded gravel with clay
- GP-GM poorly graded gravel with silt
- GP-GC poorly graded gravel with clay

[D] Sands with 5 to 12% fines require dual symbols:
- SW-SM well-graded sand with silt
- SW-SC well-graded sand with clay
- SP-SM poorly graded sand with silt
- SP-SC poorly graded sand with clay

[E] $Cu = D_{60} / D_{10}$, $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot is hatched area, soils is a CL-ML silty clay.

[K] If soil contains 15 to 29% plus No. 200 add "with sand" or "with gravel", whichever is predominant.

[L] If soil contains ≥30% plus No. 200, predominantly sand, add "sandy" to group name.

[M] If soil contains ≥30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI≥4 and plots on or above "A" line.

[O] PI<4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.

[R] Fiber Content description shown below.

ADDITIONAL TERMINOLOGY NOTES USED BY AET FOR SOIL IDENTIFICATION AND DESCRIPTION

Grain Size

Term	Particle Size
Boulders	Over 12"
Cobbles	3" to 12"
Gravel	#4 sieve to 3"
Sand	#200 to #4 sieve
Fines (silt & clay)	Pass #200 sieve

Gravel Percentages

Term	Percent
A Little Gravel	3% - 14%
With Gravel	15% - 29%
Gravelly	30% - 50%

Consistency of Plastic Soils

Term	N-Value, BPF
Very Soft	less than 2
Soft	2 - 4
Firm	5 - 8
Stiff	9 - 15
Very Stiff	16 - 30
Hard	Greater than 30

Relative Density of Non-Plastic Soils

Term	N-Value, BPF
Very Loose	0 - 4
Loose	5 - 10
Medium Dense	11 - 30
Dense	31 - 50
Very Dense	Greater than 50

Moisture/Frost Condition

(MC Column)

D (Dry):	Absence of moisture, dusty, dry to touch.
M (Moist):	Damp, although free water not visible. Soil may still have a high water content (over "optimum").
W (Wet/ Waterbearing):	Free water visible intended to describe non-plastic soils. Waterbearing usually relates to sands and sand with silt.
F (Frozen):	Soil frozen

Layering Notes

Laminations:	Layers less than ½" thick of differing material or color.
Lenses:	Pockets or layers greater than ½" thick of differing material or color.

Peat Description

Term	Fiber Content (Visual Estimate)
Fibric Peat:	Greater than 67%
Hemic Peat:	33 – 67%
Sapric Peat:	Less than 33%

Organic Description (if no lab tests)

Soils are described as *organic*, if soil is not peat and is judged to have sufficient organic fines content to influence the Liquid Limit properties. *Slightly organic* used for borderline cases.

Root Inclusions

With roots:	Judged to have sufficient quantity of roots to influence the soil properties.
Trace roots:	Small roots present, but not judged to be in sufficient quantity to significantly affect soil properties.

HKS

CCD-347

Date: 02.08.2016
To: Ted Mondale
Company: MSFA
Project: 16246.000
Re: Minnesota Multi-Purpose Stadium

From: Kevin A. Taylor, AIA

All items contained herein are an integral part of the Construction Documents and shall be built accordingly.

Summary: DTE West Plaza Construction Document Set Addendum #1

Addendum #1 Information: Geotechnical Reports as supplemental information to the DTE West Plaza CD Set.

- Downtown East Pedestrian Bridge Geotechnical Exploration and Review
- Geotechnical Exploration and Testing Vikings Legacy Ship
- Report of Preliminary Geotechnical Exploration and Review
- Appendix A
- Appendix B

Attachments: CCD-347 Addendum #1

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In accordance with the terms of the Contract Documents and with approval of the owner as required:

1. [X] Addendum #1 via RFP

Ken A. Taylor 02-08-2016

HKS Inc. Date Minnesota Sports Facility Authority Date

Distribution: John Hutchings (HKS), Scott Stenman (Hammes), Jim Cima (Vikings), Brent Leiter (Mortenson), Chad Scheckel (HKS), Anice Stephens (HKS)

Appendix A

Geotechnical Field Exploration and Testing
Boring Log Notes
Unified Soil Classification System
Rock Description Terminology
Figure 1a – Boring Locations, West Side
Figure 1b – Boring Locations, East Side
Subsurface Boring Logs
Triaxial Compression Test Results
Sieve Analysis Test Results

Appendix A
Geotechnical Field Exploration and Testing
Report No. 01-05723.1

A.1 FIELD EXPLORATION

The subsurface conditions were explored by drilling and sampling sixteen standard penetration test (SPT) borings. The test boring locations appear on Figures 1 and 2 preceding the Subsurface Boring Logs in this appendix.

A.2 SOIL BORING SAMPLING METHODS

A.2.1 Split-Spoon Samples (SS) - Calibrated to N_{60} Values

Standard penetration (split-spoon) samples were collected in general accordance with ASTM:D1586 with one primary modification. The ASTM test method consists of driving a 2-inch O.D. split-barrel sampler into the in-situ soil with a 140-pound hammer dropped from a height of 30 inches. The sampler is driven a total of 18 inches into the soil. After an initial set of 6 inches, the number of hammer blows to drive the sampler the final 12 inches is known as the standard penetration resistance or N-value. Our method uses a modified hammer weight, which is determined by measuring the system energy using a Pile Driving Analyzer (PDA) and an instrumented rod.

In the past, standard penetration N-value tests were performed using a rope and cathead for the lift and drop system. The energy transferred to the split-spoon sampler was typically limited to about 60% of its potential energy due to the friction inherent in this system. This converted energy then provides what is known as an N_{60} blow count.

Most newer drill rigs incorporate an automatic hammer lift and drop system, which has higher energy efficiency and subsequently results in lower N-values than the traditional N_{60} values. By using the PDA energy measurement equipment, we are able to determine actual energy generated by the drop hammer. With the various hammer systems available, we have found highly variable energies ranging from 55% to over 100%. Therefore, the intent of AET's hammer calibrations is to vary the hammer weight such that hammer energies lie within about 60% to 65% of the theoretical energy of a 140-pound weight falling 30 inches. The current ASTM procedure acknowledges the wide variation in N-values, stating that N-values of 100% or more have been observed. Although we have not yet determined the statistical measurement uncertainty of our calibrated method to date, we can state that the accuracy deviation of the N-values using this method is significantly better than the standard ASTM Method.

A.2.2 Disturbed Samples (DS)/Spin-up Samples (SU)

Sample types described as "DS" or "SU" on the boring logs are disturbed samples, which are taken from the flights of the auger. Because the auger disturbs the samples, possible soil layering and contact depths should be considered approximate.

A.2.3 Sampling Limitations

Unless actually observed in a sample, contacts between soil layers are estimated based on the spacing of samples and the action of drilling tools. Cobbles, boulders, and other large objects generally cannot be recovered from test borings, and they may be present in the ground even if they are not noted on the boring logs.

A.3 SOIL CLASSIFICATION METHODS

Soil descriptions shown on the boring logs are based on the Unified Soil Classification (USC) system. The USC system is described in ASTM:D2487 and D2488. Where laboratory classification tests (sieve analysis or Atterberg Limits) have been performed, accurate classifications per ASTM:D2487 are possible. Otherwise, soil descriptions shown on the boring logs are visual-manual judgments. Charts are attached which provide information on the USC system, the descriptive terminology, and the symbols used on the boring logs.

The boring logs include descriptions of apparent geology. The geologic depositional origin of each soil layer is interpreted primarily by observation of the soil samples, which can be limited. Observations of the surrounding topography, vegetation, and development can sometimes aid this judgment.

A.4 WATER LEVEL MEASUREMENTS

The ground-water level measurements are shown at the bottom of the boring logs. The following information appears under "Water Level Measurements" on the logs:

- Date and Time of measurement
- Sampled Depth: lowest depth of soil sampling at the time of measurement
- Casing Depth: depth to bottom of casing or hollow-stem auger at time of measurement

- Cave-in Depth: depth at which measuring tape stops in the borehole
- Water Level: depth in the borehole where free water is encountered
- Drilling Fluid Level: same as Water Level, except that the liquid in the borehole is drilling fluid

The true location of the water table at the boring locations may be different than the water levels measured in the boreholes. This is possible because there are several factors that can affect the water level measurements in the borehole. Some of these factors include: permeability of each soil layer in profile, presence of perched water, amount of time between water level readings, presence of drilling fluid, weather conditions, and use of borehole casing.

A.5 ROCK CORING/DESCRIPTION

The rock coring was performed in general accordance with ASTM:D2113, using an NQ size wireline coring system. The Rock Quality Designation (RQD) was evaluated in general accordance with ASTM:D6032.

A.5 LABORATORY TEST METHODS

A.5.1 Water Content Tests

Conducted in general accordance with ASTM:D2216.

A.5.2 Sieve Analysis Tests

Conducted in general accordance with ASTM:D6913, Method A.

A.5.3 Rock Core Compressive Strength Tests

Conducted in general accordance with ASTM:D2938.

A.5.4 Rock Core Triaxial Compression Tests

Conducted in general accordance with ASTM:D7012.

A.6 TEST STANDARD LIMITATIONS

Field and laboratory testing is done in general conformance with the described procedures. Compliance with any other standards referenced within the specified standard is neither inferred nor implied.

A.7 SAMPLE STORAGE

Unless notified to do otherwise, we routinely retain representative samples of the soils recovered from the borings for a period of 30 days.

BORING LOG NOTES

DRILLING AND SAMPLING SYMBOLS

Symbol	Definition
AR:	Sample of material obtained from cuttings blown out the top of the borehole during air rotary procedure.
B, H, N:	Size of flush-joint casing
CAS:	Pipe casing, number indicates nominal diameter in inches
COT:	Clean-out tube
DC:	Drive casing; number indicates diameter in inches
DM:	Drilling mud or bentonite slurry
DR:	Driller (initials)
DS:	Disturbed sample from auger flights
DP:	Direct push drilling; a 2.125 inch OD outer casing with an inner 1½ inch ID plastic tube is driven continuously into the ground.
FA:	Flight auger; number indicates outside diameter in inches
HA:	Hand auger; number indicates outside diameter
HSA:	Hollow stem auger; number indicates inside diameter in inches
LG:	Field logger (initials)
MC:	Column used to describe moisture condition of samples and for the ground water level symbols
N (BPF):	Standard penetration resistance (N-value) in blows per foot (see notes)
NQ:	NQ wireline core barrel
PQ:	PQ wireline core barrel
RDA:	Rotary drilling with compressed air and roller or drag bit.
RDF:	Rotary drilling with drilling fluid and roller or drag bit
REC:	In split-spoon (see notes), direct push and thin-walled tube sampling, the recovered length (in inches) of sample. In rock coring, the length of core recovered (expressed as percent of the total core run). Zero indicates no sample recovered.
SS:	Standard split-spoon sampler (steel; 1.5" is inside diameter; 2" outside diameter); unless indicated otherwise
SU	Spin-up sample from hollow stem auger
TW:	Thin-walled tube; number indicates inside diameter in inches
WASH:	Sample of material obtained by screening returning rotary drilling fluid or by which has collected inside the borehole after "falling" through drilling fluid
WH:	Sampler advanced by static weight of drill rod and hammer
WR:	Sampler advanced by static weight of drill rod
94mm:	94 millimeter wireline core barrel
▼:	Water level directly measured in boring
▽:	Estimated water level based solely on sample appearance

TEST SYMBOLS

Symbol	Definition
CONS:	One-dimensional consolidation test
DEN:	Dry density, pcf
DST:	Direct shear test
E:	Pressuremeter Modulus, tsf
HYD:	Hydrometer analysis
LL:	Liquid Limit, %
LP:	Pressuremeter Limit Pressure, tsf
OC:	Organic Content, %
PERM:	Coefficient of permeability (K) test; F - Field; L - Laboratory
PL:	Plastic Limit, %
q_p:	Pocket Penetrometer strength, tsf (approximate)
q_c:	Static cone bearing pressure, tsf
q_u:	Unconfined compressive strength, psf
R:	Electrical Resistivity, ohm-cms
RQD:	Rock Quality Designation of Rock Core, in percent (aggregate length of core pieces 4" or more in length as a percent of total core run)
SA:	Sieve analysis
TRX:	Triaxial compression test
VSR:	Vane shear strength, remolded (field), psf
VSU:	Vane shear strength, undisturbed (field), psf
WC:	Water content, as percent of dry weight
%-200:	Percent of material finer than #200 sieve

STANDARD PENETRATION TEST NOTES

(Calibrated Hammer Weight)

The standard penetration test consists of driving a split-spoon sampler with a drop hammer (calibrated weight varies to provide N_{60} values) and counting the number of blows applied in each of three 6" increments of penetration. If the sampler is driven less than 18" (usually in highly resistant material), permitted in ASTM: D1586, the blows for each complete 6" increment and for each partial increment is on the boring log. For partial increments, the number of blows is shown to the nearest 0.1' below the slash.

The length of sample recovered, as shown on the "REC" column, may be greater than the distance indicated in the N column. The disparity is because the N-value is recorded below the initial 6" set (unless partial penetration defined in ASTM: D1586 is encountered) whereas the length of sample recovered is for the entire sampler drive (which may even extend more than 18").

UNIFIED SOIL CLASSIFICATION SYSTEM
ASTM Designations: D 2487, D2488

AMERICAN ENGINEERING TESTING, INC.

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A]				Soil Classification	
				Group Symbol	Group Name[B]
Coarse-Grained Soils More than 50% retained on No. 200 sieve	Gravels More than 50% coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines[C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$[E]	GW	Well graded gravel[F]
			$Cu<4$ and/or $1>Cc>3$[E]	GP	Poorly graded gravel[F]
		Gravels with Fines more than 12% fines [C]	Fines classify as ML or MH	GM	Silty gravel[F.G.H]
			Fines classify as CL or CH	GC	Clayey gravel[F.G.H]
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines[D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$[E]	SW	Well-graded sand[I]
			$Cu<6$ and/or $1>Cc>3$[E]	SP	Poorly-graded sand[I]
		Sands with Fines more than 12% fines [D]	Fines classify as ML or MH	SM	Silty sand[G.H.I]
			Fines classify as CL or CH	SC	Clayey sand[G.H.I]
Fine-Grained Soils 50% or more passes the No. 200 sieve (see Plasticity Chart below)	Silts and Clays Liquid limit less than 50	inorganic	$PI>7$ and plots on or above "A" line[J]	CL	Lean clay[K.L.M]
			$PI<4$ or plots below "A" line[J]	ML	Silt[K.L.M]
		organic	$\frac{\text{Liquid limit–oven dried}}{\text{Liquid limit – not dried}} <0.75$	OL	Organic clay[K.L.M.N] Organic silt[K.L.M.O]
	Silts and Clays Liquid limit 50 or more	inorganic	PI plots on or above "A" line	CH	Fat clay[K.L.M]
			PI plots below "A" line	MH	Elastic silt[K.L.M]
		organic	$\frac{\text{Liquid limit–oven dried}}{\text{Liquid limit – not dried}} <0.75$	OH	Organic clay[K.L.M.P] Organic silt[K.L.M.Q]
Highly organic soil			Primarily organic matter, dark in color, and organic in odor	PT	Peat[R]

Notes

[A] Based on the material passing the 3-in (75-mm) sieve.

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols:
- GW-GM well-graded gravel with silt
- GW-GC well-graded gravel with clay
- GP-GM poorly graded gravel with silt
- GP-GC poorly graded gravel with clay

[D] Sands with 5 to 12% fines require dual symbols:
- SW-SM well-graded sand with silt
- SW-SC well-graded sand with clay
- SP-SM poorly graded sand with silt
- SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$, $\quad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains $\geq$15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains $\geq$15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot is hatched area, soils is a CL-ML silty clay.

[K] If soil contains 15 to 29% plus No. 200 add "with sand" or "with gravel", whichever is predominant.

[L] If soil contains $\geq$30% plus No. 200, predominantly sand, add "sandy" to group name.

[M] If soil contains $\geq$30% plus No. 200, predominantly gravel, add "gravelly" to group name.

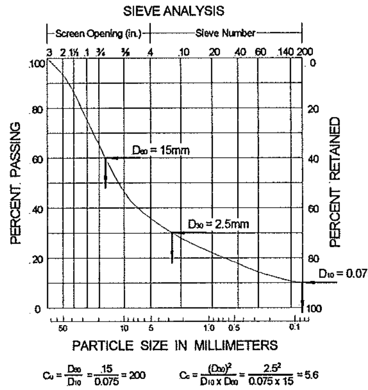
[N] $PI \geq 4$ and plots on or above "A" line.

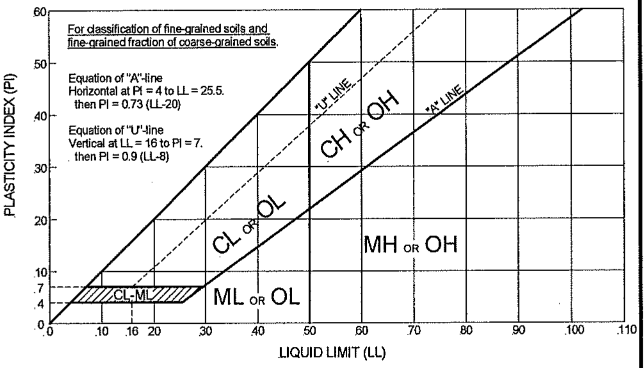
[O] $PI<4$ or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.

[R] Fiber Content description shown below.





Plasticity Chart

ADDITIONAL TERMINOLOGY NOTES USED BY AET FOR SOIL IDENTIFICATION AND DESCRIPTION

Grain Size

Term	Particle Size
Boulders	Over 12"
Cobbles	3" to 12"
Gravel	#4 sieve to 3"
Sand	#200 to #4 sieve
Fines (silt & clay)	Pass #200 sieve

Gravel Percentages

Term	Percent
A Little Gravel	3% - 14%
With Gravel	15% - 29%
Gravelly	30% - 50%

Consistency of Plastic Soils

Term	N-Value, BPF
Very Soft	less than 2
Soft	2 - 4
Firm	5 - 8
Stiff	9 - 15
Very Stiff	16 - 30
Hard	Greater than 30

Relative Density of Non-Plastic Soils

Term	N-Value, BPF
Very Loose	0 - 4
Loose	5 - 10
Medium Dense	11 - 30
Dense	31 - 50
Very Dense	Greater than 50

Moisture/Frost Condition

(MC Column)

D (Dry):	Absence of moisture, dusty, dry to touch.
M (Moist):	Damp, although free water not visible. Soil may still have a high water content (over "optimum").
W (Wet/ Waterbearing):	Free water visible intended to describe non-plastic soils. Waterbearing usually relates to sands and sand with silt.
F (Frozen):	Soil frozen

Layering Notes

Laminations:	Layers less than ½" thick of differing material or color.
Lenses:	Pockets or layers greater than ½" thick of differing material or color.

Peat Description

Term	Fiber Content (Visual Estimate)
Fibric Peat:	Greater than 67%
Hemic Peat:	33 – 67%
Sapric Peat:	Less than 33%

Organic Description (if no lab tests)

Soils are described as *organic*, if soil is not peat and is judged to have sufficient organic fines content to influence the Liquid Limit properties. *Slightly organic* used for borderline cases.

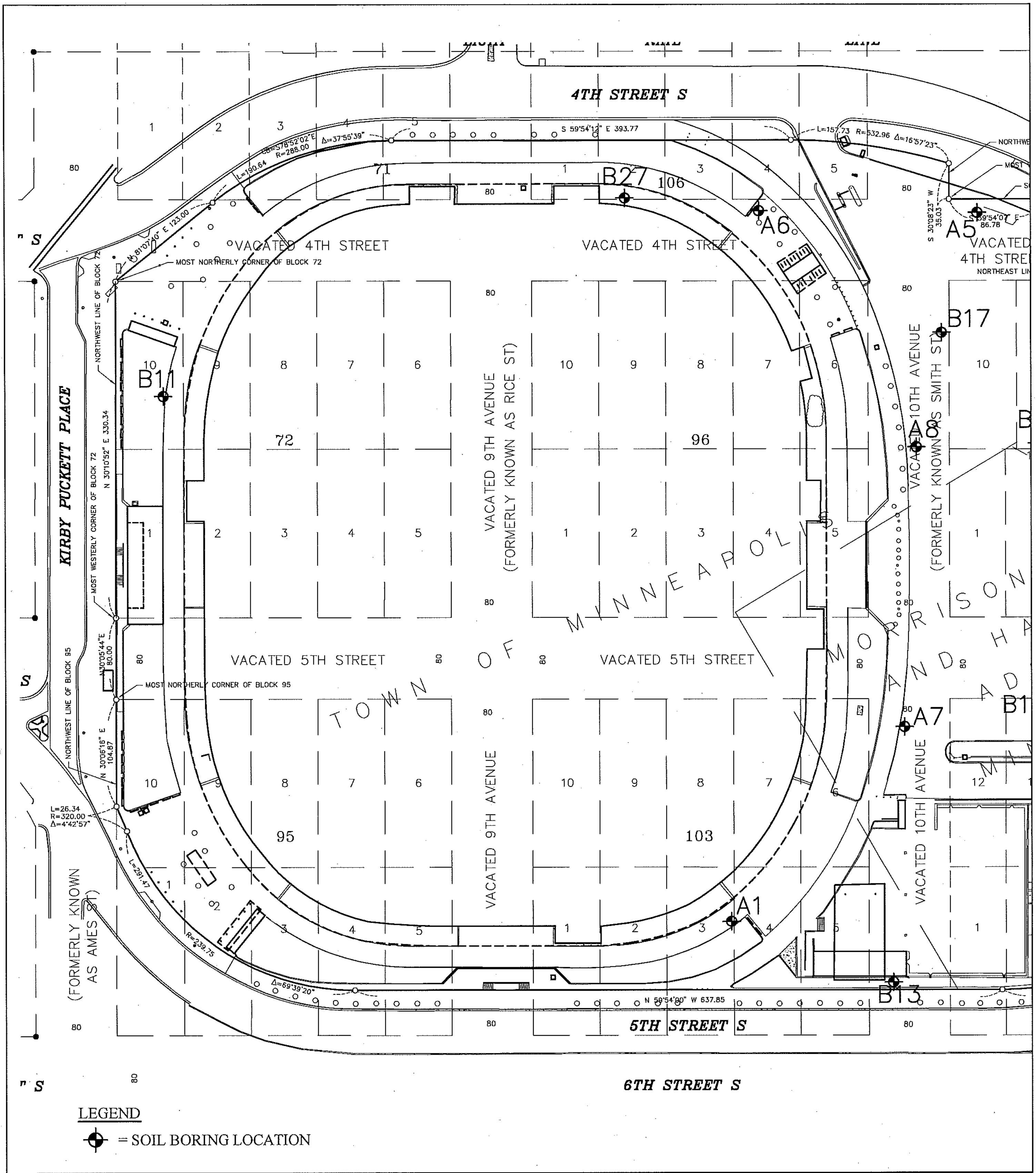
Root Inclusions

With roots:	Judged to have sufficient quantity of roots to influence the soil properties.
Trace roots:	Small roots present, but not judged to be in sufficient quantity to significantly affect soil properties.

ROCK DESCRIPTION TERMINOLOGY

Rock Property	Descriptive Term	Visual or Physical Properties
Weathering	Highly Weathered	Almost complete rock disintegration and decomposition. Soil-like texture with some small inclusions of hard rock.
	Very Weathered	Abundant fractures coated with oxides, carbonates, sulfates, mud, etc., thorough discoloration, rock disintegration, and mineral decomposition.
	Moderately Weathered	Some fracture coating, moderate or localized discoloration, little to no effect on cementation, slight mineral decomposition
	Slightly Weathered	A few stained fractures, slight discoloration, little to no effect on cementation, no mineral decomposition.
	Fresh	Unaffected by weathering agents, no appreciable change with depth.
Fracturing	Intensely Fractured	Less than 1" spacing
	Very Fractured	1" to 6" spacing
	Moderately Fractured	6" to 12" spacing
	Slightly Fractured	12" to 36" spacing
	Solid	36" spacing or greater
Stratification	Thinly Laminated	Less than 1/10"
	Laminated	1/10" to 2"
	Very Thinly Bedded	2" to 2"
	Thinly Bedded	2" to 2'
	Thickly Bedded	More than 2'
Hardness	Soft	Can be dug by hand and crushed by fingers.
	Moderately Hard	Friable can be gouged deeply with knife and will crumble readily under light hammer blows.
	Hard	Knife scratch leaves dust trace, will withstand a few hammer blows before breaking.
	Very Hard	Scratched with knife with difficulty, difficult to break with hammer blows.
RQD*	Very Poor	0 - 25 (%)
	Poor	25 - 50 (%)
	Fair	50 - 75 (%)
	Good	75 - 90 (%)
	Excellent	90 - 100 (%)

**Rock Quality Designation:* *Percent of core run consisting of the summation of hard, sound, and unfractured rock with core segments 4 inches or greater in length. Determination is conducted in general accordance with ASTM:D6032.*



AMERICAN ENGINEERING TESTING, INC.

SCALE

0 FEET 130'

PROJECT Minnesota Multi-Purpose Stadium
Minneapolis, Minnesota

AET NO. 01-05723

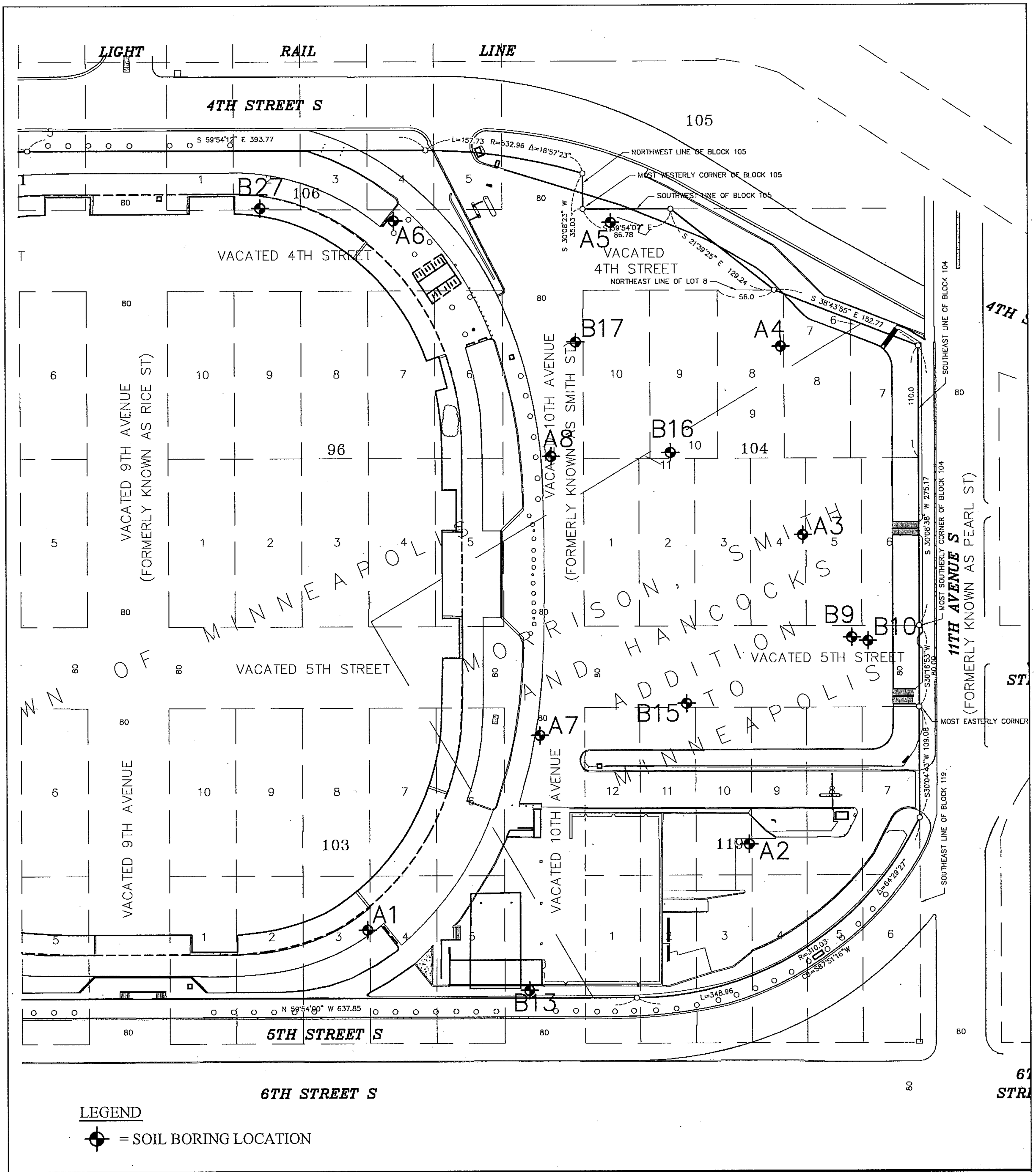
SUBJECT Boring Locations, West Side

DATE September 2013

DRAWN BY VL

CHECKED BY JV

FIGURE 1a



AMERICAN ENGINEERING TESTING, INC.

SCALE

0 FEET 130'

PROJECT Minnesota Multi-Purpose Stadium
Minneapolis, Minnesota

AET NO. 01-05723

SUBJECT Boring Locations, East Side

DATE September 2013

DRAWN BY VL

CHECKED BY JV

FIGURE 1b

AMERICAN
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TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **01-05723** LOG OF BORING NO. **A1 (p. 1 of 2)**

PROJECT: **Minnesota Multi-Purpose Stadium; Minneapolis, MN**

SURFACE ELEVATION: **844.6** Hennepin Co. Coordinates: N **166237** E **532415**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	REC %	RQD IN.	RQD %	%-#200
	6" Concrete pavement	FILL			DS						
				F	DS						
1	FILL, mostly silty sand with gravel, brown, frozen to 2'										
				F	DS						
2											
			28	M	SS	12					
3											
4	FILL, mostly silty sand, a little gravel and clayey sand, pieces of concrete at about 10', dark brown and brown										
5			18	M	SS	6					
6											
7											
			22	M	SS	5					
8											
9											
10			53	M	SS	10					
11											
12											
			30	M	SS	3					
13											
14											
15			27	M	SS	10					
16											
17											
			50	M	SS	18					
18											
19											
20			50	M	SS	16					
21											
22											
			66	M	SS	18					
23											
24											
25			60	M	SS	18					
26											
27											
			70	M	SS	18					
28											
29											
30			48	M	SS	18					
31											

DEPTH:	DRILLING METHOD
0-52.3'	4.25" HSA
52.3-62.3'	NQ Core

BORING COMPLETED: **2/18/13**

DR: **GH** LG: **JMM** Rig: **85C**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
						None

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

AET_CORP W-COORDINATES 01-05723.GPJ AET+CPT+WELL.GDT 5/3/13

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **01-05723**

LOG OF BORING NO. **A1 (p. 2 of 2)**

PROJECT: **Minnesota Multi-Purpose Stadium; Minneapolis, MN**

Hennepin Co. Coordinates: N **166237** E **532415**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	REC %	RQD IN.	RQD %	%-#200
33			65	M	SS	18					
34	FILL, mostly silty sand, a little gravel, pieces of concrete, brown										
35			70	M	SS	18					
36											
37											
38			60	M	SS	18					
39	FILL, mostly silty sand, a little gravel, brown										
40			55	M	SS	18					
41											
42	SILTY SAND, a little gravel, gray, very stiff, laminations of sand (SM)	TILL									
43			16	M/W	SS	18					
44	GRAVEL WITH SAND, apparent cobbles, brown, moist to waterbearing, very dense (GP)	COARSE ALLUVIUM									
45			97	M	SS	8					
46											
47				▽							
48			100	M/W	SS	4					
49	GRAVELLY SAND, apparent cobbles, medium to coarse grained, brown, waterbearing, very dense (SP) *25/0.5 + 55/0.1										
50			*	W	SS	6					
51											
52			50/0	-	SS	0					
53	LIMESTONE, gray Weathering: Slightly weathered Fracturing: Intensely to very fractured Stratification: Very thinly bedded Hardness: Hard	PLATTEVILLE FORMATION MAGNOLIA MEMBER									
54					NQ	36		100	22	61	
55											
56	LIMESTONE, light gray and light brownish gray, fossiliferous Weathering: Slightly weathered Fracturing: Very fractured to slightly fractured Stratification: Thickly bedded Hardness: Hard										
57											
58					NQ	56		93	48	80	
59											
60											
61	LIMESTONE, gray Weathering: Slightly weathered to fresh Fracturing: Intensely to moderately fractured Stratification: Thinly bedded Hardness: Hard	PLATTEVILLE FORMATION HIDDEN**			NQ	20		83	16.5	69	
62											
	END OF BORING	**FALLS MEMBER									

AET_CORP W-COORDINATES 01-05723.GPJ AET+CPT+WELL.GDT 2/25/13

SUBSURFACE BORING LOG

AET JOB NO: **01-05723**

LOG OF BORING NO. **A2 (p. 1 of 2)**

PROJECT: **Minnesota Multi-Purpose Stadium; Minneapolis, MN**

SURFACE ELEVATION: **833.2** Hennepin Co. Coordinates: N **166110** E **532780**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	REC %	RQD IN.	RQD %	%-#200
	5" Bituminous pavement	FILL			SU						
1	FILL, mostly silty sand with gravel, dark brown, frozen			F	SU						
2				F	SU						
3	FILL, mostly sand with silt, a little gravel, light brown			M	SU						
5	FILL, mostly sand, light brown		12	M	SS	14					
7	FILL, mostly sand with silt, a little clayey sand, brown		9	M	SS	14					
9	FILL, mostly sand with silt, a little gravel, brown and gray		10	M	SS	6					
13			9	M	SS	16					
15			9	M	SS	14					
17	FILL, mostly sand, a little gravel, brown		63	M	SS	14					
18	GRAVELLY SAND WITH SILT, possible cobble, fine to medium grained, brown, moist, dense (SP-SM) *43/0.5 + 50/0.4	COARSE ALLUVIUM	*	M	SS	4					
22	SILTY SAND, a little gravel, brown, dense (SM)		36	M	SS	16					
24	GRAVELLY SAND WITH SILT, fine to medium grained, brown, moist, medium dense (SP-SM)		30	M	SS	12					
27	CLAYEY SAND, a little gravel, brownish gray, very stiff (SC)	TILL					17				
28	SILTY SAND, a little gravel, brown, medium dense, lenses and laminations of clayey sand (SM)		19	M	SS	14					
30	CLAYEY SAND, a little gravel, gray, stiff (SC/SM)		13	M	SS	16	12				

DEPTH:	DRILLING METHOD
0-40.9'	4.25" HSA
41.4-51.4'	NQ Core

BORING COMPLETED: **2/16/13**

DR: **DS** LG: **JJ** Rig: **33C**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
2/16/13	10:20	36.0	34.5	35.9		None
2/16/13	10:40	36.0	34.5	35.9		34.7

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

AET_CORP W-COORDINATES 01-05723.GPJ AET+CPT+WELL.GDT 2/25/13

AMERICAN
ENGINEERING
TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **01-05723**

LOG OF BORING NO. **A2 (p. 2 of 2)**

PROJECT: **Minnesota Multi-Purpose Stadium; Minneapolis, MN**

Hennepin Co. Coordinates: N **166110** E **532780**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	REC %	RQD IN.	RQD %	%-#200
33	SAND WITH SILT, fine grained, brown, moist to wet, loose (SP-SM) *(continued)*	COARSE ALLUVIUM *(continued)*	9	M/W	SS	14					
34	SANDY LEAN CLAY, a little gravel, gray, hard, laminations of silt (CL)	TILL		▼							
35			45	M	SS	18	17				
36											
37	GRAVELLY SAND WITH SILT, possible cobbles, coarse to medium grained, gray to brown, waterbearing, very dense (SP-SM)	COLLUVIUM OR COARSE ALLUVIUM									
38			**	W	SS	6					9
39	**9/0.5 + 50/0.3										
40	***46/0.5 + 50/0.3		***	W	SS	8					
41	LIMESTONE, light brownish gray, a little brown around 47.5', a few vuggy zones Weathering: Moderately to slightly weathered Fracturing: Very to moderately fractured Stratification: Thickly bedded Hardness: Hard Rock compressive strength at 42.2' = 12,280 psi	PLATTEVILLE FORMATION MAGNOLIA MEMBER									
42											
43											
44					NQ	42		70	15	25	
45											
46											
47											
48											
49					NQ	60		100	45	75	
50											
51											
	END OF BORING										

AMERICAN
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TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **01-05723**

LOG OF BORING NO. **A3 (p. 1 of 3)**

PROJECT: **Minnesota Multi-Purpose Stadium; Minneapolis, MN**

SURFACE ELEVATION: **843.0**

Hennepin Co. Coordinates: N **166343** E **532983**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	REC %	RQD IN.	RQD %	%-#200
	5.25" Bituminous pavement	FILL			SU						
1	FILL, mostly silty sand with gravel, dark brown, frozen			F	SU						
2	FILL, mixture of silty sand and clayey sand, with gravel, apparent cobbles, brown, frozen to 3.5'										
3				F	SS	16	7				
4											
5			21	M	SS	10	6				
6											
7											
8			6	M	SS	11	10				
9											
10	FILL, mostly silty sand, a little gravel, dark brown		25	M	SS	16					
11											
12	FILL, mostly clayey sand with organic fines, a little gravel, pieces of brick, dark brown										
13			8	M	SS	14	18				
14											
15	FILL, mostly silty sand, a little gravel, pieces of concrete, dark brown		20	M	SS	2					
16											
17	CLAYEY SAND, a little gravel, brown, very stiff (SC)	TILL									
18			19	M	SS	16	12				
19	SILTY SAND WITH GRAVEL, apparent cobbles, brown, very dense (SM)										
20			100/.9	M	SS	6					
21											
22	SILTY SAND, a little gravel, brown, medium dense (SM)										
23			23	M	SS	16					
24	CLAYEY SAND, a little gravel, brown, stiff (SC)										
25			10	M/W	SS	24	15				
26											
27	SAND WITH GRAVEL, apparent cobbles, fine to medium grained, light brown, moist, medium dense (SP)	COARSE ALLUVIUM									
28			29	M	SS	10					
29	SAND, fine to medium grained, light brown, moist, dense (SP)										
30			33	M	SS	14					
31											

DEPTH:	DRILLING METHOD
0-52'	3.25" HSA
52-52.5'	RDF w/DM
52.5-80.8'	NQ Core

BORING COMPLETED: **2/14/13**

DR: **SG** LG: **SB** Rig: **91C**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
2/14/13	11:00	48.5	47.0	47.0		46.7
2/14/13	11:15	48.5	47.0	47.0		46.4

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

AMERICAN
ENGINEERING
TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **01-05723** LOG OF BORING NO. **A3 (p. 2 of 3)**

PROJECT: **Minnesota Multi-Purpose Stadium; Minneapolis, MN**

Hennepin Co. Coordinates: N **166343** E **532983**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	REC %	RQD IN.	RQD %	%-#200
33	SAND WITH GRAVEL, apparent cobbles, fine to medium grained, light brown, moist, very dense (SP) *(continued)*		71/.95	M	SS	16					
34 35 36	SILTY SAND WITH GRAVEL, apparent cobble, fine grained, brown, moist, very dense (SM)		*	M	SS	5					
37 38	*54/0.5+100/0.3		50/0.2	M	SS	1					
39 40 41	SAND WITH SILT AND GRAVEL, medium to fine grained, light brown, moist, very dense (SP-SM)		100/.9	M	SS	17					
42 43			100/.9	M	SS	17					
44 45 46	SAND WITH SILT AND GRAVEL, apparent cobbles, fine to medium grained, brown, very dense (SP-SM) **50/0.5 + 65/0.6 + 35/0.2		**	M ▼	SS	14					
47 48 49	GRAVEL WITH SAND AND SILT, apparent cobbles, light brown, waterbearing, very dense (GP-GM)	COARSE ALLUVIUM OR COLLUVIUM	63	W	SS	16					
50 51	***22/0.5 + 40/0.5 + 60/0.2		***	W	SS	11					8
52 53	LIMESTONE SLAB OVER GRAVEL, light gray to brownish gray	COLLUVIUM	50/0	W	SS NQ	0 2.5		104			
54 55 56 57	LIMESTONE, light brownish gray to about 57.5' then light gray and gray, fossiliferous above 57.6' Weathering: Slightly weathered Fracturing: Very to moderately fractured Stratification: Thickly bedded Hardness: Hard	PLATTEVILLE FORMATION MAGNOLIA MEMBER			NQ	35		94	25	67	
58 59 60	Rock compressive strength at 53.8' = 10,290 psi Rock compressive strength at 58.7' = 19,550 psi				NQ	57		95	40	67	
61 62 63 64 65	LIMESTONE, gray and light gray to about 61' then gray, 1-inch clay seam at 60.8', lenses of shale at 62.1' and 62.8' Weathering: Slightly weathered Fracturing: Very to moderately fractured Stratification: Thickly bedded Hardness: Hard Rock compressive strength at 63.5' = 11,120 psi Rock compressive strength at 65.3' = 14,470 psi	PLATTEVILLE FORMATION HIDDEN FALLS MEMBER			NQ	52		87	30	50	
66 67 68 69	LIMESTONE, light gray and gray, crinkly bedded Weathering: Slightly weathered to fresh Fracturing: Very fractured to slightly fractured Stratification: Very thinly bedded	PLATTEVILLE FORMATION MIFFLIN MEMBER			NQ	58		97	53	88	

AET_CORP W-COORDINATES 01-05723.GPJ AET+CPT+WELL.GDT 2/25/13

AMERICAN
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SUBSURFACE BORING LOG

AET JOB NO: **01-05723**

LOG OF BORING NO. **A3 (p. 3 of 3)**

PROJECT: **Minnesota Multi-Purpose Stadium; Minneapolis, MN**

Hennepin Co. Coordinates: N **166343** E **532983**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	REC %	RQD IN.	RQD %	%-#200
71 72 73 74 75 76 77 78	Hardness: Hard Rock compressive strength at 69.5' = 7,570 psi Rock compressive strength at 74.1' = 10,140 psi	PLATTEVILLE FORMATION MIFFLIN MEMBER *(continued)*			NQ	60		100	57	95	
79 80	LIMESTONE, gray, vuggy Weathering: Slightly weathered Fracturing: Very fractured Stratification: Thinly bedded Hardness: Moderately hard (recovery ends around 79.7')	PLATTEVILLE FORMATION PECATONICA MEMBER			NQ	35		58	30	50	

END OF BORING

AMERICAN
ENGINEERING
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SUBSURFACE BORING LOG

AET JOB NO: **01-05723**

LOG OF BORING NO. **A4 (p. 1 of 2)**

PROJECT: **Minnesota Multi-Purpose Stadium; Minneapolis, MN**

SURFACE ELEVATION: **842.4** Hennepin Co. Coordinates: N **166510** E **533058**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	REC %	RQD IN.	RQD %	%-#200
	4.5" Bituminous pavement	FILL									
1	6" FILL, mostly gravelly silty sand, pieces of concrete, dark brown, frozen			F	SS	6	9				
2	FILL, mixture of silty sand and clayey sand, with gravel, pieces of brick, brown, frozen										
3				F	SS	16					
4	FILL, mostly silty sand with gravel, dark brown, frozen to 4'										
5			20	M	SS	12					
6											
7	FILL, mostly silty sand, a little gravel, pieces of concrete, glass and wood, dark brown										
8			22	M	SS	10					
9											
10			14	M	SS	14					
11											
12											
13	FILL, mostly clayey sand, a little gravel, brown		8	M	SS	12	10				
14	SAND WITH SILT, a little gravel, medium to fine grained, brown, moist, medium dense (SP-SM) (possible fill)	COARSE ALLUVIUM OR FILL									
15			13	M	SS	10					
16											
17	SAND, fine to medium grained, light brown, moist, loose (SP)	COARSE ALLUVIUM									
18			10	M	SS	10					
19	SAND WITH SILT, a little gravel, apparent cobbles, fine to medium grained, dark brown, moist, very dense (SP-SM)										
20			69/0.8	M	SS	14					
21	SAND, a little gravel, fine to medium grained, brown to light brown, moist, very dense to medium dense (SP)										
22											
23			17	M	SS	10					
24											
25			21	M	SS	14					
26											
27	SAND, a little gravel, medium to fine grained, grayish brown, moist, medium dense (SP)										
28			19	M	SS	16					
29											
30			25	M	SS	14					
31											

DEPTH:	DRILLING METHOD
0-49.9'	**3.25" HSA**
49.9-59.6'	**NQ Core**

BORING COMPLETED: **2/15/13**

DR: **SS** LG: **TK** Rig: **85C**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
2/14/13	**12:55**	**48.7**	**47.0**	**46.3**		**46.1**
2/14/13	**1:00**	**48.7**	**47.0**	**46.3**		**46.1**

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

AET_CORP W-COORDINATES 01-05723.GPJ AET+CPT+WELL.GDT 2/25/13

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **01-05723**

LOG OF BORING NO. **A4 (p. 2 of 2)**

PROJECT: **Minnesota Multi-Purpose Stadium; Minneapolis, MN**

Hennepin Co. Coordinates: N **166510** E **533058**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	WC	REC %	RQD IN.	RQD %	%-#200
33	SAND, fine grained, light brown, moist, dense to very dense (SP) *(continued)*		43	M	SS	14					
34											
35			59	M	SS	12					
36											
37											
38			60	M	SS	2					
39											
40			43	M	SS	14					
41											
42	SAND WITH SILT AND GRAVEL, fine to medium grained, brown, moist, dense (SP-SM)										
43			45	M	SS	12					
44											
45	*27/0.5 + 50/0.3		*	M	SS	8					
46	GRAVEL WITH SAND, light grayish brown, moist, very dense (GP)	COARSE ALLUVIUM OR COLLUVIUM		▼							
47	GRAVELLY CLAYEY SAND, brown, hard, lenses and laminations of silty sand (SC)										
48		COLLUVIUM	79	M/W	SS	12	9				
49			100/0	M	SS	1					
50	LIMESTONE SLAB, gray and light gray										
51	LIMESTONE, light brownish gray to about 57.8' then gray and light gray, fossiliferous above 57.8' Weathering: Moderately to slightly weathered Fracturing: Intensely to slightly fractured Stratification: Thickly bedded Hardness: Moderately hard to hard	PLATTEVILLE FORMATION MAGNOLIA MEMBER									
52					NQ	56		99	13	23	
53											
54											
55											
56											
57					NQ	42		70	29	48	
58											
59											
	END OF BORING										

AET_CORP W-COORDINATES 01-05723.GPJ AET+CPT+WELL.GDT 2/25/13

AMERICAN
ENGINEERING
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SUBSURFACE BORING LOG

AET JOB NO: **01-05723** LOG OF BORING NO. **A5 (p. 1 of 2)**

PROJECT: **Minnesota Multi-Purpose Stadium; Minneapolis, MN**

SURFACE ELEVATION: **839.8** Hennepin Co. Coordinates: N **166704** E **532979**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	WC	REC %	RQD IN.	RQD %	%-#200
							FIELD & LABORATORY TESTS				
0	5.75" Bituminous pavement	FILL									
1	6" FILL, mostly gravelly silty sand, dark brown, frozen			F							
1.5				F							
2–3	FILL, mostly silty sand with gravel, a little clayey sand, pieces of concrete around 5', dark brown, frozen to 4'			F	SS	12					
5	*13/0.5 + 60/0.2		60/.2	M	SS	6					
8			24	M	SS	10					
10			35	M	SS	12					
11.5–13	FILL, mixture of sandy lean clay and sand with silt, a little gravel, brownish gray and brown		23	M	SS	10	9				
14–15	FILL, mostly gravel, brown		50/.2	M	SS	1					
16–18	GRAVELLY SAND WITH SILT, fine to medium grained, brown, moist, very dense (SP-SM)	COARSE ALLUVIUM	54	M	SS	10					
20			98	M	SS	8					
21.5–23	SILTY SAND, a little gravel, brown, very dense (SM)	TILL	98	M	SS	14					
25			85	M	SS	16					
28			61	M	SS	14					
29–30	SAND WITH GRAVEL, fine to medium grained, brown, dense to very dense (SP)	COARSE ALLUVIUM	43	M	SS	12					
31											

DEPTH:	DRILLING METHOD
0-49.8'	3.25" HSA
49.8-55.6'	NQ Core

BORING COMPLETED: **2/18/13**

DR: **SS** LG: **TK** Rig: **85C**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
2/15/13	3:00	35.6	34.5	35.3		35.0
2/15/13	4:55	47.1	46.8	46.7		44.7
2/16/13	8:30	47.1	46.8	46.7		43.6
2/16/13	1:30	49.7	49.5	48.1		46.2

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

AET_CORP W-COORDINATES 01-05723.GPJ AET+CPT+WELL.GDT 5/3/13

SUBSURFACE BORING LOG

AET JOB NO: **01-05723**

LOG OF BORING NO. **A5 (p. 2 of 2)**

PROJECT: **Minnesota Multi-Purpose Stadium; Minneapolis, MN**

Hennepin Co. Coordinates: N **166704** E **532979**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	REC %	RQD IN.	RQD %	%-#200
33	SAND WITH GRAVEL, fine to medium grained, brown, dense to very dense (SP) *(continued)*	COARSE ALLUVIUM *(continued)*	68	M	SS	12					
34 35	SAND WITH SILT AND GRAVEL, fine to medium grained, brown, waterbearing, very dense (SP-SM)		**	▼ W/M	SS	12					
36 37	GRAVEL WITH CLAY AND SAND, brown, moist, dense (GC)										
38	SAND, fine to medium grained, light brown, moist, very dense (SP)		55	M	SS	16					
39 40 41	SILTY SAND WITH GRAVEL, fine to medium grained, brown, moist, very dense (SM)		96	M	SS	10					
42	GRAVEL WITH SAND, brown, moist, very dense (GP)	TILL	73	M	SS	14					
43 44	SILTY SAND WITH GRAVEL, dark brown, a little brown, very dense, lenses of clayey sand (SM)						13				
45 46	SANDY LEAN CLAY, a little gravel, gray, hard (CL)	COARSE ALLUVIUM	57	M/W	SS	14					
47	GRAVELLY SILTY SAND, fine to medium grained, gray, wet, very dense (SM)	HIGHLY FRACTURED PLATTEVILLE FORMATION OR COLLUVIUM	100/.3	W	SS	1					
48 49	WEATHERED LIMESTONE, brown to light gray		100/.15	W	SS	1					
50 51 52	LIMESTONE, light brownish gray to gray, fossiliferous Weathering: Moderately to slightly weathered Fracturing: Very fractured Stratification: Thickly bedded Hardness: Hard	PLATTEVILLE FORMATION MAGNOLIA MEMBER			NQ	8		83	7	73	
53 54 55					NQ	45		75	13	22	

END OF BORING

**14/0.5 + 31/0.5 + 50/0.1

Note: Core barrel became wedged and broke off. Barrel and most of core were retrieved, although bottom 0.9' remained in ground. Drillers reported coring was continuously solid with no obvious voids.

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **01-05723** LOG OF BORING NO. **A6 (p. 1 of 2)**

PROJECT: **Minnesota Multi-Purpose Stadium; Minneapolis, MN**

SURFACE ELEVATION: **842.6** Hennepin Co. Coordinates: N **166819** E **532796**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	WC	REC %	RQD IN.	RQD %	%-#200
	5.5" Concrete pavement	FILL			SU						
1	FILL, mostly silty sand with gravel, dark brown, frozen			F	SU						
3	FILL, mostly silty sand, a little gravel and clayey sand, dark brown, frozen to 3.5'			F	SS	16					
5			7	M	SS	10					
8	FILL, mostly silty sand with gravel, pieces of concrete, dark brown *6/0.5 + 17/0.5 + 50/0.2		*	M	SS	12					
10	FILL, mostly clayey sand, a little gravel, dark brown		5	M	SS	12	16				
13	FILL, mostly sand with silt, brown		18	M	SS	13					
15	FILL, mostly sand with silt, a little gravel, apparent cobble at 18', dark brown		11	M	SS	12					
18			20	M	SS	14					
20	FILL, mostly silty sand with gravel, apparent cobbles, brown		42	M	SS	5					
23	SAND, a little gravel, fine to medium grained, light brown, moist, medium dense (SP)	COARSE ALLUVIUM	17	M	SS	14					
25	SAND, a little gravel, possible cobble, medium to fine grained, light brown, moist, dense (SP)		32	M	SS	15					
28	GRAVELLY SAND, apparent cobbles, medium to fine grained, light brown, moist, very dense (SP)		59	M	SS	6					
30	GRAVEL WITH SAND, apparent cobbles, brown, moist, very dense (GP)		55	M	SS	12					

DEPTH:	DRILLING METHOD
0-47.6'	**3.25" HSA**
47.6-60.5'	**NQ Core**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
2/18/13		**47.2**	**47.5**			**None****
						****Wet**

BORING COMPLETED: **2/18/13**

DR: **SG** LG: **SB** Rig: **91C**

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

AET_CORP W-COORDINATES 01-05723.GPJ AET+CPT+WELL.GDT 5/3/13

AMERICAN
ENGINEERING
TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **01-05723**

LOG OF BORING NO. **A6 (p. 2 of 2)**

PROJECT: **Minnesota Multi-Purpose Stadium; Minneapolis, MN**

Hennepin Co. Coordinates: N **166819** E **532796**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	REC %	RQD IN.	RQD %	%-#200
33	SILTY SAND, a little gravel, apparent cobbles, brown, very dense (SM) *(continued)*	TILL *(continued)*	**	M	SS	14					
35	**36/0.5 + 69/0.5 + 31/0.2 ***35/0.5 + 68/0.5 + 32/0.1		***	M	SS						
38			74	M	SS						
40	SAND WITH GRAVEL, medium to fine grained, brown, moist, dense, laminations of clayey sand (SP)	COARSE ALLUVIUM	47	M	SS	15					
43	SAND WITH SILT AND GRAVEL, medium to fine grained, brown, moist, dense (SP-SM)		58	M	SS	18					
45	GRAVELLY SAND WITH SILT, medium to fine grained, brown, moist to waterbearing, very dense (SP-SM)	COARSE ALLUVIUM OR COLLUVIUM	64	M/W	SS	12					
47	SANDY LEAN CLAY, a little gravel, gray, hard (CL)	TILL	50/.2	M	SS	2	16				
49	LIMESTONE, light gray and gray to about 49' then light brownish gray, fractured and weathered zones from 48' to 48.3' and 48.7' to 48.8', vertical fracture from 52.5' to 52.9', fossiliferous, a few vuggy zones Weathering: Moderately to slightly weathered Fracturing: Very to moderately fractured Stratification: Thickly bedded Hardness: Hard	PLATTEVILLE FORMATION MAGNOLIA MEMBER			NQ	25		72	17	49	
53					NQ	56		93	28	47	
58	LIMESTONE, gray, vertical fractures at 57.9' and 59' Weathering: Slightly weathered Fracturing: Very to moderately fractured Stratification: Thickly bedded Hardness: Hard				NQ	50		83	24	40	
	END OF BORING										

AET_CORP W-COORDINATES 01-05723.GPJ AET+CPT+WELL.GDT 8/22/13

AMERICAN
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SUBSURFACE BORING LOG

AET JOB NO: **01-05723**

LOG OF BORING NO. **A7 (p. 1 of 2)**

PROJECT: **Minnesota Multi-Purpose Stadium; Minneapolis, MN**

SURFACE ELEVATION: **842.6** Hennepin Co. Coordinates: N **166300** E **532654**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	REC %	RQD IN.	RQD %	%-#200
	6" Bituminous pavement	FILL			SU						
1	FILL, mostly silty sand with gravel, apparent cobbles, dark brown to brown, frozen to 4'			F	SU						
2				F	SS	3					
3											
4											
5			33	M	SS	15					
6											
7	FILL, mostly sand, a little gravel, brown										
8			20	M	SS	12					
9	FILL, mostly sand, light brown										
10			18	M	SS	12					
11											
12	FILL, mostly gravelly sand with silt, apparent cobbles, brown										
13			110	M	SS	10					
14	FILL, mixture of clayey sand and silty sand, a little gravel, brown and gray										
15			26	M	SS	16	11				
16											
17	GRAVELLY SILTY SAND, brown, dense (SM)	TILL									
18			39	M	SS	3					
19	CLAYEY SAND, a little gravel, apparent cobbles, brown, hard to very stiff, laminations of silty sand (SC/SM)										
20			88	M	SS	5	12				
21											
22			16	M	SS	16	12				
23	SAND WITH SILT, fine grained, light brown, moist, medium dense (SP-SM)	COARSE ALLUVIUM									
24											
25			13	M	SS	14					
26											
27	SILTY SAND WITH GRAVEL, fine to medium grained, brown, moist, dense (SM)										
28			36	M	SS	12					
29	GRAVEL WITH SAND, brown, moist, very dense to dense (GP)										
30			61	M	SS	13					
31											

DEPTH:	DRILLING METHOD
0-49½'	**3.25" HSA**
49½-49.8'	**RD w/DM**
49.8-54.5'	**NQ Core**

BORING COMPLETED: **2/21/13**

DR: **SG** LG: **SB** Rig: **91C**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
2/20/13		**49.5**	**49.5**			**None**

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

AMERICAN
ENGINEERING
TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **01-05723** LOG OF BORING NO. **A7 (p. 2 of 2)**

PROJECT: **Minnesota Multi-Purpose Stadium; Minneapolis, MN**

Hennepin Co. Coordinates: N **166300** E **532654**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	REC %	RQD IN.	RQD %	%-#200
33	GRAVEL WITH SAND, brown, moist, very dense to dense (GP) *(continued)*		28	M	SS	10					
34											
35			99	M	SS	13					
36											
37	SILTY SAND WITH GRAVEL, apparent cobbles, dark brown, very dense (SM)	TILL									
38			*	M	SS	15					
39	**22/0.5 + 58/0.5 + 42/0.3										
40			50/0.3	M	SS	3					
41											
42			50/0.2	M	SS	2					
43											
44			50/0.1	M	SS	1					
45											
46	SILTY SAND WITH GRAVEL, possible cobbles, brown, very dense, laminations of clayey sand (SM)	COLLUVIUM									
47			83/0.5	M	SS	5					
48											
49	LIMESTONE SLAB, gray		50/.05	M	SS	½					
50	LIMESTONE SLABS AND GRAVEL, gray and dark brown										
51											
52	LIMESTONE, light brownish gray, fossiliferous, a few vuggy zones, clay seam at 52.8' Weathering: Slightly weathered Fracturing: Intensely to moderately fractured Stratification: Thickly bedded Hardness: Hard	PLATTEVILLE FORMATION MAGNOLIA MEMBER			NQ	38		67	16	28	
53											
54											

END OF BORING

Note RQD = 54% in Magnolia Member (lower 2.5')

AET_CORP W-COORDINATES 01-05723.GPJ AET+CPT+WELL.GDT 2/25/13

AMERICAN
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SUBSURFACE BORING LOG

AET JOB NO: **01-05723**　　LOG OF BORING NO. **A8 (p. 1 of 2)**

PROJECT: **Minnesota Multi-Purpose Stadium; Minneapolis, MN**

SURFACE ELEVATION: **842.1**　　Hennepin Co. Coordinates: N **166533**　E **532812**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	REC %	RQD IN.	RQD %	%-#200
	4" Bituminous pavement	FILL		F	SU						
1	FILL, mostly silty sand with gravel, pieces of concrete around 2', dark brown, frozen			F	SU						
2					SU						
3				F	SS	12					
4	FILL, mostly silty sand, a little gravel, pieces of brick, apparent cobbles, dark brown										
5			25	M	SS	14					
6											
7											
8			18	M	SS	12					
9	FILL, mostly gravel and silty sand, apparent cobbles, brown										
10			48	M	SS	10					
11											
12	FILL, mostly sand with silt, brown										
13			10	M	SS	16					
14	FILL, mostly silty sand, a little gravel, apparent cobbles, brown and grayish brown										
15			19	M	SS	6					
16											
17	FILL, mostly sand, light brown										
18			15	M	SS	13					
19	FILL, mostly sand with silt, a little gravel, brown										
20			7	M	SS	10					
21											
22	FILL, mostly gravelly silty sand, apparent cobbles, dark brownish gray (petroleum-type odor)		50/.2	M	SS	2					
23											
24	SANDY LEAN CLAY, a little gravel, gray, very stiff (CL) (petroleum-type odor)	TILL									
25			16	M	SS	18	12				
26											
27							16				
28	SILTY SAND, a little gravel, apparent cobble, gray, dense (SM)		36	M	SS	16					
29											
30	SANDY LEAN CLAY WITH GRAVEL, apparent cobbles, gray, a little brownish gray, hard, a lens of silty sand around 30' (CL)		68	M	SS	15	4				
31											

DEPTH:	DRILLING METHOD
0-51.2'	**3.25" HSA**
51.2-60.2'	**NQ Core**

BORING COMPLETED: **2/16/13**

DR: **SG**　LG: **SB**　Rig: **91C**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
2/14/13	**2:40**	**48.5**	**47.0**	**47.0**		**46.3**
2/14/13	**2:50**	**48.5**	**47.0**	**47.0**		**46.4**

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

AMERICAN
ENGINEERING
TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **01-05723**

LOG OF BORING NO. **A8 (p. 2 of 2)**

PROJECT: **Minnesota Multi-Purpose Stadium; Minneapolis, MN**

Hennepin Co. Coordinates: N **166533** E **532812**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	REC %	RQD IN.	RQD %	%-#200
33	SILTY SAND, a little gravel, gray, medium dense (SM) *(continued)*		18	M	SS	13					
34											
35			19	M	SS	16					
36											
37											
38			10	M	SS	8					
39	CLAYEY SAND, a little gravel, gray, very stiff (SC)										
40			20	M	SS	17	14				
41	SAND, fine grained, light brown, moist, medium dense (SP)										
42											
43			73	M	SS	5					
44											
45	SAND WITH SILT AND GRAVEL, apparent cobbles, fine to medium grained, brown, moist, very dense (SP-SM)	COARSE ALLUVIUM	80/.5	M	SS	1					
46				▼							
47	GRAVELLY SAND WITH SILT, medium to coarse grained, brown, very dense (SM)	COLLUVIUM OR TILL									
48			51	W	SS	8					
49	SAND, a little gravel, apparent cobbles, fine to medium grained, brown, waterbearing, very dense (SP)	COARSE ALLUVIUM									
50			50/.4	W	SS	9	12				
51	GRAVELLY CLAYEY SAND, gray, hard (SC)	TILL									
52	LIMESTONE, light brownish gray, a few vuggy zones, fossiliferous Weathering: Slightly weathered Fracturing: Very fractured Stratification: Thickly bedded Hardness: Hard	PLATTEVILLE FORMATION MAGNOLIA MEMBER									
53					NQ	48		100	20	42	
54											
55											
56											
57	LIMESTONE, gray Weathering: Weathered Fracturing: Very fractured Stratification: Thickly bedded Hardness: Hard										
58					NQ	26		43	*	*	
59											
60											

END OF BORING

**Lower 2½' of core could not be retrieved. Portion retrieved likely disturbed by retrieval attempts.*

AMERICAN
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SUBSURFACE BORING LOG

AET JOB NO: **01-05723**

LOG OF BORING NO. **B9 (p. 1 of 3)**

PROJECT: **Minnesota Multi-Purpose Stadium; Minneapolis, MN**

SURFACE ELEVATION: **843.0** Hennepin Co. Coordinates: N **166230** E **532980**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	REC %	RQD IN.	RQD %	%-#200
	5.5" Bituminous pavement	FILL									
1	5" FILL, mostly silty sand, a little gravel and clayey sand, brown and dark brown		19	M	SS	12					
2	FILL, mostly silty sand, a little gravel, a piece of glass at 15', dark brown										
3			21	M	SS	14					
4											
5			18	M	SS	16					
6											
7											
8			10	M	SS	12					
9											
10			13	M	SS	14					
11											
12											
13			4	M	SS	12					
14											
15			9	M	SS	10					
16											
17											
18			4	M	SS	10					
19	SAND, a little gravel, medium to fine grained, light brown, moist, medium dense (SP)	COARSE ALLUVIUM									
20			12	M	SS	8					
21											
22	SAND, fine to medium grained, light brown, moist, loose (SP)										
23			9	M	SS	12					
24	SAND WITH SILT AND GRAVEL, fine to medium grained, brown, moist, medium dense (SP-SM)										
25			17	M	SS	8					
26											
27	SANDY LEAN CLAY, a little gravel, grayish brown, stiff (CL/SC)	TILL									
28			11	M	SS	16	14				
29	CLAYEY SAND WITH GRAVEL, brown, hard, laminations of silty sand (SC) *12/0.5 + 50/0.5 + 50/0.1			▼							
30			*	M	SS	8	11				
31											

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS						
0-32'	4.25" HSA	DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
32-44.3'	RDF w/DM	7/22/13	10:35	31.0	29.5	29.5		None
44.3'-84.7'	NQ Core	7/22/13	11:10	32.1	32.0	30.5		29.8
BORING COMPLETED:	7/22/13	7/22/13	11:25	32.1	32.0	20.7		29.9
DR: JM/SS LG: TM	Rig: 85C	7/25/13	8:11	44.2	44.0	44.0		43.8

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

AET_CORP W-COORDINATES 01-05723.GPJ AET+CPT+WELL.GDT 8/21/13

SUBSURFACE BORING LOG

AET JOB NO: **01-05723**

LOG OF BORING NO. **B9 (p. 2 of 3)**

PROJECT: **Minnesota Multi-Purpose Stadium; Minneapolis, MN**

Hennepin Co. Coordinates: N **166230** E **532980**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	REC %	RQD IN.	RQD %	%-#200
	APPARENT BOULDERS AND/OR SLABS (limestone chips retrieved), gray *(continued)*	TILL OR COLLUVIUM *(continued)*	50/.05		SS						
33											
34											
35			8	-	SS						
36											
37	GRAVEL WITH SILT AND SAND, apparent cobbles, brown, waterbearing, very dense (GP-GM)										
38			73	W	SS	6					
39	GRAVEL WITH SAND, apparent cobbles, brown, waterbearing, very dense (GP)		50/.4	W	SS	8					
40											
41	COBBLES AND/OR BOULDERS (granite pieces retrieved, limestone chips retrieved from cuttings below 44'), dark gray, a little white (limited samples)										
42			50/.1	W	SS	2					
43											
44			100/.2	M	SS	0					
45	BOULDERS AND/OR SLABS, gray				NQ	17		79			
46											
47											
48					NQ	13		33			
49											
50											
51					NQ	18		65			
52	LIMESTONE, gray and light brown, fossiliferous Weathering: Moderately to slightly weathered Fracturing: Intensely to slightly fractured Stratification: Thickly bedded Hardness: Hard	PLATTEVILLE FORMATION MAGNOLIA MEMBER									
53					NQ	32		99	23	71	
54											
55											
56											
57					NQ	55		92	46	77	
58											
59											
60	LIMESTONE, gray and light gray Weathering: Moderately to slightly weathered Fracturing: Intensely to slightly fractured Stratification: Thickly bedded Hardness: Hard Rock compressive strength at 61.8'=12,760 psi Rock compressive strength at 63.0'=5,860 psi	PLATTEVILLE FORMATION HIDDEN FALLS MEMBER									
61											
62					NQ	54		90	44	73	
63											
64											
65											
66	LIMESTONE, light gray and gray, crinkly bedded Weathering: Slightly weathered to fresh Fracturing: Very to slightly fractured Stratification: Very thinly bedded	PLATTEVILLE FORMATION MIFFLIN MEMBER									
67					NQ	60		100	59	98	
68											
69											

AMERICAN
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SUBSURFACE BORING LOG

AET JOB NO: **01-05723**

LOG OF BORING NO. **B9 (p. 3 of 3)**

PROJECT: **Minnesota Multi-Purpose Stadium; Minneapolis, MN**

Hennepin Co. Coordinates: N **166230** E **532980**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	REC %	RQD IN.	RQD %	%-#200
	Hardness: Very hard	PLATTEVILLE FORMATION MIFFLIN MEMBER *(continued)*									
71											
72					NQ	59		98	51	85	
73											
74											
75											
76											
77					NQ	58		97	42	70	
78											
79											
80	LIMESTONE, gray Weathering: Fresh Fracturing: Slightly fractured Stratification: Thinly bedded Hardness: Hard	PLATTEVILLE FORMATION PECATONICA MEMBER									
81											
82		GLENWOOD FORMATION			NQ	57		95	9	15	
83	SHALE, gray to about 83.3' then brown sandy shale to about 84' then light brown shaley sandstone										
84											
	END OF BORING										

AMERICAN
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SUBSURFACE BORING LOG

AET JOB NO: **01-05723**

LOG OF BORING NO. **B10 (p. 1 of 2)**

PROJECT: **Minnesota Multi-Purpose Stadium; Minneapolis, MN**

SURFACE ELEVATION: **842.9** Hennepin Co. Coordinates: N **166219** E **532992**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	REC %	RQD IN.	RQD %	%-#200
	4" Bituminous pavement	FILL									
1	5" FILL, mostly gravelly silty sand, dark brown		26	M	SS	17					
2 3	FILL, mostly silty sand, a little gravel, possible cobbles, dark brown		22	M	SS	9					
4 5	FILL, mostly silty sand with gravel, apparent cobbles, brown and dark brown		39	M	SS	4					
6 7 8			14	M	SS	3					
9 10			14	M	SS	4					
11 12 13			7	M	SS	5					
14 15 16	FILL, mostly silty sand, a little gravel, dark brown		19	M	SS	12					
17 18 19	SAND WITH SILT, a little gravel, possible cobbles, fine to medium grained, light brown, moist, medium dense, laminations of clayey sand (SP-SM)	COARSE ALLUVIUM	14	M	SS	5					
20 21	SAND WITH SILT AND GRAVEL, possible cobbles, medium to fine grained, brown, moist, medium dense (SP-SM)		14	M	SS	4					
22 23	SILTY SAND, a little gravel, possible cobbles, fine to medium grained, dark brown, moist, medium dense (SM)		25	M	SS	4					
24 25 26	CLAYEY SAND, a little gravel, possible cobbles, brown, hard (SC)	TILL	50/.4	M	SS	3	15				
27 28	SILTY SAND, a little gravel, possible cobbles, fine grained, brown, moist, medium dense (SM)	COARSE ALLUVIUM	26	M	SS	7					
29 30 31	CLAYEY SAND, a little gravel, gray, firm (SC)	TILL	8	M	SS	16	12				
32 33	SILTY SAND, a little gravel, brown, medium dense (SM/SC)		21	M	SS	16					

DEPTH:	DRILLING METHOD
0-50.2'	3.25" HSA
53.1-69'	NQ Core

BORING COMPLETED: 7/30/13

DR: SS/SG LG: TM Rig: 85C

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
7/26/13	2:05	46.0	44.5	45.3		45.2
7/26/13	2:15	46.0	44.5	45.3		45.2
7/29/13	8:30	46.0	46.2	46.2		45.3

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

AET_CORP W-COORDINATES 01-05723.GPJ AET+CPT+WELL.GDT 8/6/13

AMERICAN
ENGINEERING
TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **01-05723**

LOG OF BORING NO. **B10 (p. 2 of 2)**

PROJECT: **Minnesota Multi-Purpose Stadium; Minneapolis, MN**

Hennepin Co. Coordinates: N **166219** E **532992**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	REC %	RQD IN.	RQD %	%-#200
35	SAND WITH SILT, fine grained, brown to light brown, moist, medium dense (SP-SM) *(continued)*	COARSE ALLUVIUM *(continued)*	18	M	SS	13					
36											
37	SAND, fine grained, light brown, moist, dense to medium dense (SP)										
38			35	M	SS	15					
39											
40			27	M	SS	15					
41											
42	SILTY SAND WITH GRAVEL, apparent cobbles, brown, very dense (SM)	COARSE ALLUVIUM OR TILL	50/.2	M	SS	1					
43											
44	GRAVELLY SAND WITH SILT, apparent cobbles, medium to fine grained, brown, moist, very dense (SP-SM)	COARSE ALLUVIUM									
45			101	▼ M/W	SS	13					
46											
47	GRAVEL WITH SILT AND SAND, apparent boulder around 50' to 52', brown, waterbearing, very dense (GP-GM)	COLLUVIUM OR COARSE ALLUVIUM	100/.2	W	SS	2					
48											
49											
50			100/.3	M/W	SS	2					
51											
52	LIMESTONE, weathered, gray	PLATTEVILLE FORMATION MAGNOLIA MEMBER	100/.1	W	SS	1					
53	LIMESTONE, gray and light brown to about 57.7' then light gray and gray, fossiliferous Weathering: Moderately to slightly weathered Fracturing: Intensely to slightly fractured Stratification: Thickly bedded Hardness: Hard				NQ2	11		102	0	0	
54											
55											
56					NQ2	58		97	41	68	
57											
58											
59											
60											
61	LIMESTONE, gray and light gray Weathering: Slightly weathered Fracturing: Intensely to slightly fractured Stratification: Thickly bedded Hardness: Hard Rock compressive strength at 61.7'=14,125 psi Rock compressive strength at 65.3'=6,580 psi	PLATTEVILLE FORMATION HIDDEN FALLS MEMBER			NQ2	48		80	25	42	
62											
63											
64											
65											
66											
67	LIMESTONE, light gray and gray, crinkly bedded Weathering: Slightly weathered Fracturing: Very to moderately fractured Stratification: very thinly bedded Hardness: Hard	PLATTEVILLE FORMATION MIFFLIN MEMBER			NQ2	60		100	56	93	
68											
69	**END OF BORING**										

AMERICAN
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SUBSURFACE BORING LOG

AET JOB NO: **01-05723** LOG OF BORING NO. **B11 (p. 1 of 3)**

PROJECT: **Minnesota Multi-Purpose Stadium; Minneapolis, MN**

SURFACE ELEVATION: **847.8** Hennepin Co. Coordinates: N **166950** E **532196**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	REC %	RQD IN.	RQD %	%-#200
	7" Concrete	FILL									
1	FILL, mostly silty sand with gravel, pieces of brick from 4.5' to 11', pieces of bituminous around 10' and 18'		36	M	SS	3					
2–3			37	M	SS	12					
5			59	M	SS	14					
8			113	M	SS	12					
10			77	M	SS	14					
13			114	M	SS	10					
15			15	M	SS	12					
18			30	M	SS	14					
20			68	M	SS	12					
22–23	SAND WITH GRAVEL, fine to medium grained, brown, moist, medium dense (SP)	COARSE ALLUVIUM	69	M	SS	3					
25	CLAYEY SAND WITH GRAVEL, brown, hard (SC/SM)	TILL	58	M	SS	6	9				
27–28	SAND WITH SILT AND GRAVEL, fine to medium grained, brown, moist, medium dense (SP-SM)	COARSE ALLUVIUM	26	M	SS	3					
30	GRAVELLY SILTY SAND, fine to medium grained, brown, moist, very dense (SM)		66	M	SS	6					

DEPTH:	DRILLING METHOD
0-59.1'	4.25" HSA
59.1-59.7'	RDF w/DM
59.7-94.1'	NQ Core

BORING COMPLETED: **8/5/13**

DR: **SG** LG: **TM** Rig: **85C**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
8/5/13	2:00	54.8	54.5	54.1		53.0
8/5/13	2:20	54.8	54.5	54.0		52.8

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

AET_CORP W-COORDINATES 01-05723.GPJ AET+CPT+WELL.GDT 8/20/13

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **01-05723** LOG OF BORING NO. **B11 (p. 2 of 3)**

PROJECT: **Minnesota Multi-Purpose Stadium; Minneapolis, MN**

Hennepin Co. Coordinates: N **166950** E **532196**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	REC %	RQD IN.	RQD %	%-#200
33	GRAVELLY SILTY SAND, fine to medium grained, brown, moist, very dense (SM) *(continued)*		121	M	SS	6					
34 35 36 37 38	SAND, fine grained, light brown, moist, medium dense (SP)		22 21	M M	SS SS	12 12					
39 40 41	SAND WITH SILT AND GRAVEL, fine to medium grained, brown, moist, very dense (SP-SM)		100/.4	M	SS	6					
42 43 44 45 46	SILTY SAND, a little gravel, brown, very dense (SM)	TILL	89 85	M M	SS SS	12 18					
47 48	SAND WITH GRAVEL, fine grained, brown, moist, very dense (SP)	COARSE ALLUVIUM	107	M	SS	14					
49 50 51	CLAYEY SAND, a little gravel, brown, hard, lenses and laminations of silty sand (SC)	TILL	49	M	SS	12	9				
52 53	SILTY SAND WITH GRAVEL, brown, very dense (SM/SC)		87	▼ M	SS	14					
54 55	GRAVEL WITH SILT AND SAND, brown, waterbearing, very dense (GM)	COARSE ALLUVIUM OR COLLUVIUM	100/.3	W	SS	2					
56 57 58 59	APPARENT LIMESTONE, severely weathered (residual soil) with hard thin layers (based on drill tool action)	APPARENT PLATTEVILLE FORMATION MAGNOLIA MEMBER									
60 61 62 63 64	LIMESTONE, light gray and gray, a little light brown, fossiliferous Weathering: Slightly weathered Fracturing: Moderately to slightly fractured, very fractured around 61.6' Stratification: Thickly bedded Hardness: Hard	PLATTEVILLE FORMATION MAGNOLIA MEMBER			NQ2	53		100	51	97	
65 66 67 68	LIMESTONE, gray and light gray, a little light brown Weathering: Slightly weathered Fracturing: Very to slightly fractured Stratification: Thickly bedded Hardness: Hard	PLATTEVILLE FORMATION HIDDEN FALLS MEMBER			NQ2	56		93	48	80	
69	LIMESTONE, light gray and gray crinkly										

AMERICAN
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SUBSURFACE BORING LOG

AET JOB NO: **01-05723**

LOG OF BORING NO. **B11 (p. 3 of 3)**

PROJECT: **Minnesota Multi-Purpose Stadium; Minneapolis, MN**

Hennepin Co. Coordinates: N **166950** E **532196**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	REC %	RQD IN.	RQD %	%-#200
	bedded	PLATTEVILLE									
71	Weathering: Slightly weathered	FORMATION									
	Fracturing: Very to slightly fractured	MIFFLIN			NQ2	58		97	46	77	
72	Stratification: Very thinly bedded	MEMBER									
73	Hardness: Hard	*(continued)*									
74											
75											
76					NQ2	60		100	57	95	
77											
78											
79											
80											
81					NQ2	58		97	49	82	
82											
83	LIMESTONE, light gray and gray	PLATTEVILLE FORMATION									
84	Weathering: Fresh Fracturing: Slightly fractured	PECATONICA MEMBER									
85	Stratification: Thinly bedded Hardness: Hard	GLENWOOD FORMATION									
86	SHALE, gray to about 85.6' then light gray and brown sandy shale to about 86.8' then light brownish gray shaley sandstone				NQ2	37		62			
87											
88	PROBABLY SANDSTONE (no recovery)	ST. PETER FORMATION									
89											
90											
91					NQ2	0		0			
92											
93											
94	**END OF BORING**										

AET_CORP W-COORDINATES 01-05723.GPJ AET+CPT+WELL.GDT 8/20/13

AMERICAN
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SUBSURFACE BORING LOG

AET JOB NO: **01-05723** LOG OF BORING NO. **B13 (p. 1 of 2)**

PROJECT: **Minnesota Multi-Purpose Stadium; Minneapolis, MN**

SURFACE ELEVATION: **836.2** Hennepin Co. Coordinates: N **160091** E **532529**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	REC %	RQD IN.	RQD %	%-#200
1	FILL, mostly sapric peat with sand, dark brown	FILL	11	M	SS	2	51				
3	FILL, mostly silty sand with gravel, pieces of plastic and geotextile, dark brown		14	M	SS	6					
5	FILL, mostly silty sand, a little gravel, dark brown to brown		16	M	SS	12					
8			16	M	SS	12					
10	*4/.5 + 4/.5 + 50/.2		*	M	SS	6					
13	FILL, mostly sand, light brown		7	M	SS	6					
15	FILL, mostly silty sand, dark brown		10	M	SS	12					
18	FILL, mixture of silty sand and clayey sand, a little gravel, brown		18	M	SS	14	12				
20	FILL, mostly silty sand with gravel, brown		31	M	SS	6					
23	FILL, mixture of silty sand and clayey sand, a little gravel, brown		16	M	SS	12	11				
25	SANDY LEAN CLAY, a little gravel, gray, a little brown, stiff, laminations of sand (CL)	TILL	14	M	SS	12	13				
28	SILTY SAND, a little gravel, apparent cobbles, fine grained, grayish brown, very dense (SM)	COARSE ALLUVIUM	43	M	SS	6					
30	SANDY LEAN CLAY, a little gravel, gray, firm (CL)	TILL	6	M	SS	16	21				

DEPTH:	DRILLING METHOD
0-43½'	3.25-4.25" HSA
43.5-64.1'	NQ Core*
44.1-45.3'	*RDF exception

BORING COMPLETED: **8/15/13**

DR: **SG** LG: **TM** Rig: **85C**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
8/14/13	10:40	41.1	39.5	40.9		40.2
8/14/13	10:55	41.1	39.5	40.9		39.0

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

AET_CORP W-COORDINATES 01-05723.GPJ AET+CPT+WELL.GDT 8/22/13

AMERICAN
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TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **01-05723** LOG OF BORING NO. **B13 (p. 2 of 2)**

PROJECT: **Minnesota Multi-Purpose Stadium; Minneapolis, MN**

Hennepin Co. Coordinates: N **160091** E **532529**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	REC %	RQD IN.	RQD %	%-#200
33	GRAVELLY SILTY SAND, fine to medium grained, brown, moist, very dense (SM/) *(continued)*	COARSE ALLUVIUM OR COLLUVIUM *(continued)*	100/.4	M	SS	2					
35			50/.4	M	SS	6					
36	**90/.5 + 100/.5 + 100/.3		**	M	SS	10					
38				▼							
39	CLAYEY SAND, a little gravel, apparent boulder at 41', brown, hard (SC/SM)	TILL	65	W/M	SS	12	9				
42	WEATHERED LIMESTONE, gray and brown	PLATTEVILLE FORMATION	100/.1	M	SS	1					
44	LIMESTONE, gray and brown Weathering: Moderately weathered Fracturing: Very fractured Stratification: thinly bedded Hardness: Hard	PLATTEVILLE FORMATION CARIMONA MEMBER	100/.1	M	SS NQ	1 7		97	0	0	
47	No sample from 44.1' to 45.3'*	PLATTEVILLE FORMATION MAGNOLIA MEMBER			NQ	38		83	16.5	36	
48	LIMESTONE, light gray and a little light brown, fossiliferous Weathering: Slightly weathered Fracturing: Very to moderately fractured Stratification: Thickly bedded Hardness: Hard										
51					NQ	52		87	36	60	
54	LIMESTONE, gray and light gray Weathering: Slightly weathered Fracturing: Very to slightly fractured Stratification: Thinly bedded Hardness: Hard	PLATTEVILLE FORMATION HIDDEN FALLS MEMBER			NQ	4		83	0	0	
57					NQ	48		87	37	67	
59	LIMESTONE, light gray and gray, crinkly bedded Weathering: Slightly weathered Fracturing: Very to moderately fractured Stratification: Very thinly bedded Hardness: Hard	PLATTEVILLE FORMATION MIFFLIN MEMBER			NQ	59		98	32	53	
64	**END OF BORING** *Needed to redrill with tricone to straighten hole which was inclined due to overlying boulders in order to continue coring.										

AET_CORP W-COORDINATES 01-05723.GPJ AET+CPT+WELL.GDT 8/22/13

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **01-05723** LOG OF BORING NO. **B15 (p. 1 of 2)**

PROJECT: **Minnesota Multi-Purpose Stadium; Minneapolis, MN**

SURFACE ELEVATION: **842.8** Hennepin Co. Coordinates: N **166256** E **532806**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	REC %	RQD IN.	RQD %	%-#200
	5.5" Bituminous pavement	FILL									
1	FILL, mostly silty sand, a little gravel, dark brown		35	M	SS	14					
2											
3	FILL, mostly silty sand with gravel, brown		41	M	SS	6					
4											
5			30	M	SS	3					
6											
7	FILL, mostly silty sand, a little gravel, dark brown										
8			28	M	SS	14					
9											
10			6	M	SS	3					
11											
12	SAND, medium to fine grained, light brown to brown, moist, loose (SP) (possible fill)	COARSE ALLUVIUM OR FILL									
13			9	M	SS	12					
14											
15			8	M	SS	12					
16											
17			171/.5	M	SS	12					
18	APPARENT COBBLE OR BOULDER, light brown, moist, very dense (possible fill)										
19	CLAYEY SAND, al little gravel, brown, very stiff, laminations of silty sand (SC)	TILL									
20			24	M	SS	10	13				
21											
22	SILTY SAND, a little gravel, brown, medium dense (SM)										
23			23	M	SS	12					
24	CLAYEY SAND, a little gravel, brown, very stiff, lenses and laminations of silty and around 28' (SC)										
25			12	M	SS	14	13				
26											
27											
28			21	M	SS	16	8				
29	GRAVELLY SILTY SAND, brown, very dense (SM)										
30			56	M	SS	14					
31											
32											
33	CLAYEY SAND, brown, very stiff, laminations of silty sand (SC)	COARSE	18	M	SS	16	11				

DEPTH:	DRILLING METHOD
0-49.1'	3.25" HSA
49.1-69.6'	NQ Core

BORING COMPLETED: 8/12/13

DR: **SG** LG: **TM** Rig: **85C**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
8/12/13	3:00	49.1	49.0	48.7		47.2
8/12/13	3:15	49.1	49.0	48.6		48.0

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

AET_CORP W-COORDINATES 01-05723.GPJ AET+CPT+WELL.GDT 8/22/13

AMERICAN
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SUBSURFACE BORING LOG

AET JOB NO: **01-05723** LOG OF BORING NO. **B15 (p. 2 of 2)**

PROJECT: **Minnesota Multi-Purpose Stadium; Minneapolis, MN**

Hennepin Co. Coordinates: N **166256** E **532806**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	REC %	RQD IN.	RQD %	%-#20
35	SAND WITH SILT, fine grained, brown, moist, medium dense (SP-SM)	ALLUVIUM TILL	60	M	SS	12	14				
36	SANDY LEAN CLAY, a little gravel, gray, a little brown, hard, laminations of silty sand (CL)	COARSE ALLUVIUM									
37	GRAVEL WITH SAND, brown, moist, very dense (GP)										
38			20	M	SS	10					
39	SAND WITH GRAVEL, fine to medium grained, brown, moist, medium dense (SP)										
40	GRAVELLY SAND WITH SILT, fine to medium grained, brown, moist, very dense (SP-SM)		68	M	SS	8					
41											
42											
43	SAND, a little gravel, fine to medium grained, brown, moist, very dense (SP)		68	M	SS	16					
44	GRAVEL WITH SAND, brown, moist, very dense (GP)										
45			133/.5	M	SS	6					
46											
47	GRAVELLY SILTY SAND, pieces of shale, brown and gray, moist, very dense (SM)	COLLUVIUM	300/.5	▼ ~~M~~	SS	6					
48											
49	APPARENT BOULDERS OR SLABS		200/.1	M	SS NQ	0 6		100	0	0	
50											
51	LIMESTONE, gray and light brown, fossiliferous Weathering: Moderately to slightly weathered Fracturing: Intensely to slightly fractured Stratification: Thickly bedded Hardness: Hard	PLATTEVILLE FORMATION MAGNOLIA MEMBER			NQ	25		72	0	0	
52											
53											
54					NQ	22		87	19	75	
55											
56											
57					NQ	59		98	52	87	
58											
59											
60											
61											
62	LIMESTONE, light gray and gray Weathering: Slightly weathered Fracturing: Intensely to slightly fractured Stratification: Thickly bedded Hardness: Hard	PLATTEVILLE FORMATION HIDDEN FALLS MEMBER			NQ	54		90	39.5	66	
63											
64											
65											
66											
67	LIMESTONE, light gray and gray, crinkly bedded Weathering: Slightly weathered Fracturing: Very to moderately fractured Stratification: Very thinly bedded Hardness: Hard	PLATTEVILLE FORMATION MIFFLIN MEMBER			NQ	60		100	56.5	94	
68											
69											

END OF BORING

AET_CORP W-COORDINATES 01-05723.GPJ AET+CPT+WELL.GDT 8/22/13

AMERICAN
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SUBSURFACE BORING LOG

AET JOB NO: **01-05723**

LOG OF BORING NO. **B16 (p. 1 of 2)**

PROJECT: **Minnesota Multi-Purpose Stadium; Minneapolis, MN**

SURFACE ELEVATION: **843.0** Hennepin Co. Coordinates: N **166477** E **532917**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	REC %	RQD IN.	RQD %	%-#200
	3.5" Bituminous pavement	FILL									
1	FILL, mostly silty sand, a little gravel, pieces of bituminous around 10', dark brown to brown		57	M	SS	12					
2											
3			22	M	SS	14					
4											
5			11	M	SS	6					
6											
7											
8			19	M	SS	6					
9											
10	FILL, mostly silty sand, a little gravel and ash/cinders, dark brown		40	M	SS	12					
11											
12	SAND WITH SILT AND GRAVEL, fine to medium grained, brown, moist, medium dense (SP-SM)	COARSE ALLUVIUM									
13			24	M	SS	6					
14	SAND WITH SILT, a little gravel, fine to medium grained, brown, moist, medium dense (SP-SM)										
15			12	M	SS	6					
16											
17	SILTY SAND, a little gravel, fine to medium grained, brown, moist, very dense (SM)										
18			57	M	SS	4					
19	SILTY SAND, a little gravel, fine grained, brown, a little gray, moist, dense to medium dense, laminations of clayey sand around 23', lens of sandy lean clay around 29' (SM)										
20			42	M	SS	12					
21											
22											
23			25	M	SS	14					
24											
25			19	M	SS	14					
26											
27	SILTY SAND, a little gravel, brown, medium dense (SM/SC)	TILL									
28			26	M	SS	12					
29											
30			30	M	SS	2					
31											
32	CLAYEY SAND, a little gravel, brown, medium dense (SC/SM)		28	M	SS	14	14				

DEPTH:	DRILLING METHOD
0-51'	3.25" HSA
51-52.8'	RDF w/DM
52.8-69.6'	NQ Core

BORING COMPLETED: **8/1/13**

DR: **SG** LG: **TM** Rig: **85C**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
7/31/13	11:00	47.6	47.0	47.1		46.3
7/31/13	12:10	47.6	47.0	47.0		45.8
7/31/13	1:17	51.0	51.0	51.0		49.4

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

AET_CORP W-COORDINATES 01-05723.GPJ AET+CPT+WELL.GDT 8/20/13

AMERICAN
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SUBSURFACE BORING LOG

AET JOB NO: **01-05723**

LOG OF BORING NO. **B16 (p. 2 of 2)**

PROJECT: **Minnesota Multi-Purpose Stadium; Minneapolis, MN**

Hennepin Co. Coordinates: N **166477** E **532917**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	REC %	RQD IN.	RQD %	%-#200
34	SAND WITH SILT, fine grained, brown, moist, medium dense (SP-SM)	COARSE ALLUVIUM									
35	GRAVEL WITH SAND, apparent cobbles and boulders, light grayish brown to brown, moist, very dense (GP)		117	M	SS	6					
36											
37											
38			152	M	SS	3					
39											
40			187	M	SS	1					
41											
42											
43	GRAVELLY SAND WITH SILT, fine to medium grained, brown, moist, very dense (SP-SM)		137	M	SS	12					
44											
45			107	▼	SS	12					
46											
47	GRAVELLY SILTY SAND, fine to medium grained, brown, wet, very dense (SM)		100/.6	W	SS	3					
48											
49											
50			100/.6	W	SS	3					
51			50/0	-	SS	0					
52											
53	LIMESTONE, light brown and gray, fossiliferous Weathering: Slightly weathered Fracturing: Intensely to moderately fractured Stratification: Thickly bedded Hardness: Hard	PLATTEVILLE FORMATION MAGNOLIA MEMBER			NQ	15		69	9	42	
54											
55											
56											
57					NQ	58		97	42.5	71	
58											
59											
60	LIMESTONE, light gray and light brownish gray Weathering: Slightly weathered Fracturing: Very to slightly fractured, intensely fractured joinst at 62' and 63' Stratification: Thickly bedded Hardness: Hard	PLATTEVILLE FORMATION HIDDEN FALLS MEMBER									
61											
62					NQ	55		92	38	63	
63											
64											
65											
66	LIMESTONE, light gray and gray, crinkly bedded Weathering: Slightly weathered Fracturing: Very to slightly fractured Stratification: Very thinly bedded Hardness: Hard	PLATTEVILLE FORMATION MIFFLIN MEMBER									
67					NQ	59		98	46	77	
68											
69											

END OF BORING

AET_CORP W-COORDINATES 01-05723.GPJ AET+CPT+WELL.GDT 8/22/13

AMERICAN
ENGINEERING
TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **01-05723**

LOG OF BORING NO. **B17 (p. 1 of 2)**

PROJECT: **Minnesota Multi-Purpose Stadium; Minneapolis, MN**

SURFACE ELEVATION: **841.4** Hennepin Co. Coordinates: N **166618** E **532891**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	REC %	RQD IN.	RQD %	%-#200
	6" Bituminous pavement	FILL									
1	FILL, mostly silty sand, a little gravel, dark brown to brown		57	M	SS	12					
2											
3			29	M	SS	12					
4											
5			25	M	SS	12					
6											
7	FILL, mostly silty sand, brown										
8			27	M	SS	1					
9											
10			10	M	SS	12					
11											
12	SAND, a little gravel, fine to medium grained, brown, moist, medium dense to loose (SP)	COARSE ALLUVIUM									
13			11	M	SS	12					
14											
15			9	M	SS	6					
16											
17	SAND WITH SILT AND GRAVEL, fine to medium grained, brown, moist, dense (SP-SM)										
18			38	M	SS	6					
19	SILTY SAND, a little gravel, fine grained, brown, moist, dense, lenses and laminations of clayey sand (SM)										
20			47	M	SS	6					
21											
22	CLAYEY SAND, a little gravel, brown, very stiff (SC/SM)	TILL									
23			27	M	SS	12	8				
24	SAND, fine grained, light brown, moist (SP)	COARSE ALLUVIUM									
25			60/.8	M	SS	12					
26	CLAYEY SAND, a little gravel, apparent boulder below 25.3', brown, hard, laminations of silty sand (SC/SM)	TILL					11				
27		COARSE ALLUVIUM	112	M	SS	6					
28	SAND WITH SILT AND GRAVEL, fine to medium grained, gray to brown, moist, very dense (SP-SM)										
29											
30			70/.2	M	SS	2					
31											
32											
			67	M	SS	12					

DEPTH:	DRILLING METHOD
0-54.6'	3.25" HSA
54.6-69.3'	NQ Core

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
8/2/13	8:22	46.0	44.5	45.8		45.1
8/2/13	8:44	46.0	49.5	45.4		44.8

WATER LEVEL MEASUREMENTS

BORING COMPLETED: **8/2/13**

DR: **SG** LG: **TM** Rig: **85C**

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

AET_CORP W-COORDINATES 01-05723.GPJ AET+CPT+WELL.GDT 8/20/13

AMERICAN
ENGINEERING
TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **01-05723** LOG OF BORING NO. **B17 (p. 2 of 2)**

PROJECT: **Minnesota Multi-Purpose Stadium; Minneapolis, MN**

Hennepin Co. Coordinates: N **166618** E **532891**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	REC %	RQD IN.	RQD %	%-#200
34 35 36	SAND WITH SILT AND GRAVEL, fine to medium grained, gray to brown, moist, very dense (SP-SM) *(continued)*	COARSE ALLUVIUM *(continued)*	195/.9	M	SS	6					
37 38	SAND WITH GRAVEL, fine to medium grained, light brown, moist, very dense (SP)		92	M	SS	12					
39 40 41	SAND, fine grained, light brown, moist, very dense (SP)		57	M	SS	12					
42 43	SAND WITH SILT AND GRAVEL, fine to medium grained, brown, very dense (SP-SM)		102	M	SS	12					
44 45 46	GRAVELLY SILTY SAND, medium to fine grained, brown, moist, very dense (SM)	COARSE ALLUVIUM OR COLLUVIUM	75	▼ M	SS	12					
47 48 49	CLAYEY SAND, a little gravel, dark brown, hard (SC)	TILL	100/.1	M	SS	6	13				
50 51 52 53 54	LIMESTONE, highly weathered, brown to gray	PLATTEVILLE FORMATION	100/.1 170/.3	M W	SS SS	1 7					
55 56 57 58 59	LIMESTONE, light brown and gray, fossiliferous Weathering: Slightly weathered Fracturing: Intensely to moderately fractured Stratification: Thickly bedded Hardness: Hard	PLATTEVILLE FORMATION MAGNOLIA MEMBER			NQ2	50.5		90	33	59	
60 61 62 63	LIMESTONE, gray and light gray Weathering: Slightly weathered Fracturing: Very to slightly fractured Stratification: Thickly bedded Hardness: Hard	PLATTEVILLE FORMATION HIDDEN FALLS MEMBER			NQ2	57		95	31	52	
64 65 66 67 68 69	LIMESTONE, light gray and gray crinkly bedded Weathering: Slightly weathered Fracturing: Very to slightly fractured Stratification: Very thinly bedded Hardness: Hard	PLATTEVILLE FORMATION MIFFLIN MEMBER			NQ2	60		100	50	83	
	END OF BORING										

AET_CORP W-COORDINATES 01-05723.GPJ AET+CPT+WELL.GDT 8/20/13

AMERICAN
ENGINEERING
TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **01-05723** LOG OF BORING NO. **B27 (p. 1 of 3)**

PROJECT: **Minnesota Multi-Purpose Stadium; Minneapolis, MN**

SURFACE ELEVATION: **852.8** Hennepin Co. Coordinates: N **166950** E **532196**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	WC	REC %	RQD IN.	RQD %	%-#200
1	FILL, mostly silty sand, a little gravel, trace roots, dark brown	FILL	23	M	SS	6					
3	FILL, mostly silty sand, a little gravel, brown		46	M	SS	12					
5	FILL, mostly silty sand with gravel, a little clayey sand, brown		22	M	SS	12					
8	FILL, mostly silty sand, a little gravel and clayey sand, brown to dark brown		39	M	SS	12					
10			57	M	SS	12					
13			16	M	SS	12					
15	FILL, mostly silty sand, a little gravel and ash/cinders, pieces of brick, dark brown		13	M	SS	6					
18	FILL, mostly silty sand, dark brown		7	M	SS	12					
20	CLAYEY SAND, dark brown, very stiff (SC) (possible fill)	MIXED ALLUVIUM OR FILL	19	M	SS	12	12				
23	SAND WITH SILT, fine grained, brown, moist, medium dense (SP-SM)	COARSE ALLUVIUM	20	M	SS	12					
25			12	M	SS	12					
28	GRAVEL WITH SAND, brown and gray, moist, dense (GP)		35	M	SS	6					
30	SILTY SAND, a little gravel, brown, medium dense, laminations of clayey sand (SM)	TILL	22	M	SS	12					

DEPTH:	DRILLING METHOD
0-59½'	**3.25" HSA**
59½'-75.6'	**NQ Core**

BORING COMPLETED: **8/9/13**

DR: **SG** LG: **TM** Rig: **85C**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
8/8/13	**10:25**	**58.5**	**57.0**	**58.3**		**57.9**
8/8/13	**10:45**	**58.5**	**57.0**	**58.3**		**56.9**

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

AET_CORP W-COORDINATES 01-05723.GPJ AET+CPT+WELL.GDT 8/22/13

AMERICAN
ENGINEERING
TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **01-05723**

LOG OF BORING NO. **B27 (p. 2 of 3)**

PROJECT: **Minnesota Multi-Purpose Stadium; Minneapolis, MN**

Hennepin Co. Coordinates: N **166950** E **532196**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	WC	REC %	RQD IN.	RQD %	%-#200
33	SILTY SAND, a little gravel, brown, medium dense, laminations of clayey sand (SM) *(continued)*	TILL *(continued)*	22	M	SS	14					
34	CLAYEY SAND, a little gravel, grayish brown, very stiff (SC)										
35			23	M/W	SS	12	14				
36											
37	SILTY SAND, a little gravel, brown, very dense (SM)										
38			92	M	SS	14					
39											
40			67/.5	M	SS	12					
41											
42											
43			105	M	SS	14					
44											
45			154	M	SS	14					
46											
47			100/0	-	SS	NR					
48	SAND, a little gravel, fine grained, light brown, moist, very dense (SP)	COARSE ALLUVIUM									
49											
50			112	M	SS	12					
51											
52	SILTY SAND WITH GRAVEL, brown, very dense (SM)	TILL									
53			113	M	SS	14					
54	SILTY SAND WITH GRAVEL, medium to fine grained, brown, wet, very dense (SM)	COARSE ALLUVIUM									
55			75	M/W	SS	14					
56				▼							
57	SHALE, weathered, gray	DECORAH FORMATION									
58			196	W	SS	12					
59	LIMESTONE, weathered, gray	PLATTEVILLE FORMATION CARIMONA MEMBER	200/.1	W	SS	1					
60	LIMESTONE, gray and light gray Weathering: Moderately to slightly weathered Fracturing: Very fractured Stratification: Thinly bedded Hardness: Very hard				NQ	9.5		79	5	42	
61											
62		PLATTEVILLE FORMATION MAGNOLIA MEMBER									
63	LIMESTONE, light gray and gray, a little light brown, fossiliferous, voids at about 63.6' and 64.0' Weathering: Slightly weathered Fracturing: Very to slightly fractured Stratification: Thickly bedded Hardness: Hard				NQ	45		75	23	38	
64											
65											
66											
67											
68					NQ	57		95	45	75	
69											

AMERICAN
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SUBSURFACE BORING LOG

AET JOB NO: **01-05723**

LOG OF BORING NO. **B27 (p. 3 of 3)**

PROJECT: **Minnesota Multi-Purpose Stadium; Minneapolis, MN**

Hennepin Co. Coordinates: N **166950** E **532196**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	REC %	RQD IN.	RQD %	%-#200
71 72 73 74 75	LIMESTONE, gray and light gray Weathering: Slightly weathered Fracturing: Moderately fractured, intensely fractured from 71.4' to 72.0' Stratification: Thickly bedded Hardness: Moderately hard to hard	PLATTEVILLE FORMATION HIDDEN FALLS MEMBER			NQ	55		92	42	70	
	LIMESTONE, gray and gray, crinkly bedded Weathering: Slightly weathered Fracturing: Very fractured Stratification: Very thinly bedded Hardness: Hard	PLATTEVILLE* *FORMATION MIFFLIN MEMBER									
	END OF BORING										

AET_CORP W-COORDINATES 01-05723.GPJ AET+CPT+WELL.GDT 8/22/13

TRIAXIAL COMPRESSION TEST RESULTS

PROJECT:
Minnesota Multi-Purpose Stadium
Minneapolis, Minnesota

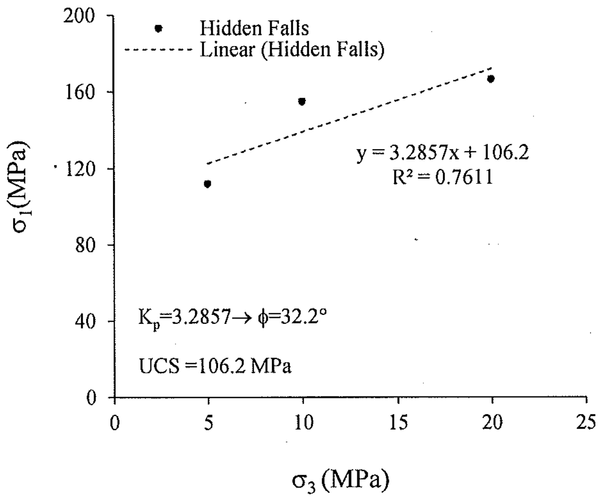
AET JOB NO.: 01-05723

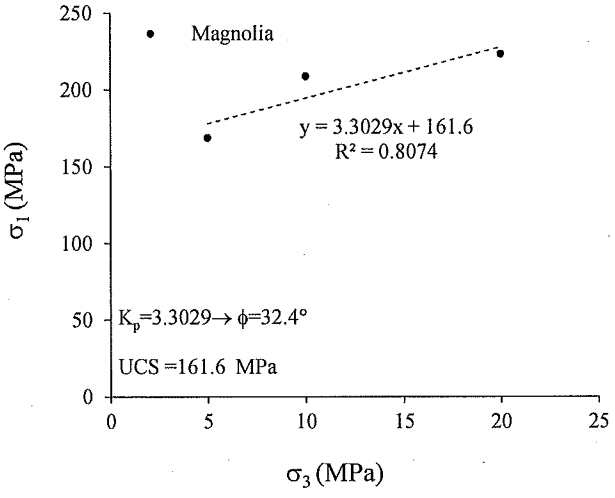
DATE: September 30, 2013

TEST METHOD: General Conformance with ASTM: D7012

RESULTS:

Specimen #	Type	Boring Number	Elevation (ft)	ρ (g/cm^3)	σ_3 (MPa)	σ_1 (MPa)
1	Hidden Falls	B-11	65.5-68.5	2.40	20	138.0
2	Hidden Falls	B-11	65.5-68.5	2.53	10	155.0
3	Hidden Falls	B-11	65.5-68.5	2.41	20	166.6
4	Hidden Falls	B-11	65.5-68.5	2.43	5	112.0
5	Magnolia	B-11	60.2-62.2	2.58	5	168.8
6	Magnolia	B-11	60.2-62.2	2.62	20	223.0
7	Magnolia	B-11	60.2-62.2	2.60	20	203.9
8	Magnolia	B-11	60.2-62.2	2.63	10	208.6
9	Hidden Falls	B-11	65.5-68.5	2.47	0	42.2





SIEVE ANALYSIS TEST RESULTS

PROJECT:
Minnesota Multi-Purpose Stadium
Minneapolis, Minnesota

AET NO.: 01-05723

DATE: February 19, 2013

TEST METHOD: General Conformance with ASTM: D6913, Method A

RESULTS:

Boring Number	A2	A3
Sample Depth	37'-38'	49.5'-50.7'
Dry Sample Weight (gms)	224.70	348.18
Sieve Size or Number	**Percent Passing by Weight**	
1½"	100	100
1"	100	90
3/4"	86	78
5/8"	82	73
1/2"	80	67
3/8"	69	60
#4	51	48
#10	34	37
#20	23	25
#40	18	18
#100	12	11
#200	9.4	8.2

Note: The small sample size limits the accuracy of the test, and the sample may not necessarily be representative of the entire layer shown on the boring log.