REPORT OF GEOTECHNICAL EXPLORATION

Superior Fire Department Station 2
N. 8th Street at John Avenue
Superior, Wisconsin

AET Project No. P-0035882

Date: October 15, 2024

Prepared for:

Superior Fire Department
3326 Tower Avenue
Superior, Wisconsin 54880

Geotechnical • Materials
Forensic • Environmental
Building Technology
Petrography/Chemistry

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AMERICAN
ENGINEERING TESTING

October 15, 2024

Mr. Camron Vollbrecht, Fire Chief
Superior Fire Department
3326 Tower Avenue
Superior, Wisconsin 54880

RE: Report of Geotechnical Exploration
Superior Fire Department Station 2
N. 8th Street at John Avenue
Superior, Wisconsin
AET Project No. P-0035882

Dear Mr. Vollbrecht:

We are pleased to present the results of our subsurface exploration program for your Superior Fire Department Station 2 project in Superior, Wisconsin. These services were performed according to our proposal to you dated July 29, 2024.

We are submitting an electronic (PDF) version of this geotechnical report to you. Unless you request otherwise, we will not submit any hard copies of the report.

We appreciate the opportunity to work with you on this phase of the project. Please contact us if you have questions about this report or require further assistance.

Sincerely,
American Engineering Testing, Inc.

Audrey Norlien

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1.0 INTRODUCTION

The Superior Fire Department is planning the construction of the new (replacement) Station 2 in Superior, Wisconsin. To assist planning and design, the Superior Fire Department authorized American Engineering Testing, Inc. (AET) to conduct a subsurface exploration program at the site and perform a geotechnical engineering review for the project. This report presents the results of the above services and provides our engineering recommendations based on this data.

2.0 SCOPE OF SERVICES

AET's services were performed according to our proposal to the Superior Fire Department dated July 29, 2024. The authorized scope consists of:

- Twelve geotechnical borings to depths of 10 to 25 feet
- Visual/manual classification and limited laboratory testing of the recovered soil samples
- Geotechnical engineering review based on the gained data and preparation of this report

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

3.0 PROJECT INFORMATION

The proposed new Station 2 will be a single-story, slab-on-grade building covering a footprint of about 15,350 square feet; there will be two mezzanine areas providing approximately an additional 1860 square feet. The surface grading of the site will match the current grade. The project will also include paved parking and drive areas, an outdoor training area, and an outdoor public use space. We have not been provided with structural details for the building, but for the purposes of this report we are assuming wall loads of up to 10 kips/foot and column loads of about 100 to 300 kips. The above-stated information represents our understanding of the project and is an integral part of our engineering review. It is important we be contacted if there are changes from that described so we can evaluate if modifications to our recommendations are appropriate.

4.0 SUBSURFACE EXPLORATION AND TESTING

4.1 Field Exploration

Our subsurface exploration program for this project consisted of drilling a total of twelve geotechnical borings on August 28, September 9, and September 12, 2024. We selected the number, depths, and locations of the borings, which are shown on Figure 1 in Appendix A. AET personnel documented the as-drilled boring locations using GPS equipment. The approximate boring coordinates and elevations are shown on Figure 1; the approximate boring elevations are also shown on the boring logs. Our GPS locations have accuracy within the submeter range. The provided location data is intended for reference and informational purposes. To obtain survey grade location data suitable for design, we advise retaining the services of a professional surveyor.

Prior to drilling, we contacted Wisconsin Diggers Hotline to locate public underground utilities at the site. We drilled the borings using hollow-stem augers and mud rotary techniques. Refer to Appendix A for details on the drilling and sampling methods, the classification methods, and the water level measurement details.

The boring logs are found in Appendix A and contain information concerning soil layering, geologic description, moisture condition, and USCS classifications. Relative density or consistency is also noted for the natural soils, which are based on the standard penetration resistance (N-value).

4.2 Laboratory Testing

We performed thirty-two moisture content tests, thirty-one estimates of the unconfined compressive strength (q_p, pocket penetrometer), three Atterberg limits tests, and four sieve analysis tests on the recovered soil samples. The moisture content, unconfined compressive strength, and Atterberg limits test results are shown on the boring logs, adjacent to the sample on which each test was performed. The results of the sieve analysis tests are provided after the boring logs in Appendix A.

5.0 SITE CONDITIONS

5.1 Surface Observations

On the days we drilled, the project area was a vacant lot with a parking lot on the southern area. Some trees were present in the grassy areas surrounding the parking lot. The site was relatively flat, with an elevation difference among our borings of about 2.7 feet.

5.2 Soils

Borings SB-01, SB-02, and SB-11 encountered up to 12 inches of topsoil at the surface. Borings SB-03 through SB-07, SB-09, SB-10, and SB-12 were drilled in paved parking lots and had about 4.0 to 6.75 inches of bituminous pavement at the ground surface.

Below the surficial topsoil or pavement, and starting at the surface of SB-08, we encountered mostly fill and glacio-lacustrine deposits; there was also a layer of swamp deposits in boring SB-07.

The fill extended to depths ranging from 1 to 7 feet. It was highly-variable mixtures of sand, gravel, silt, and clay. Some of the fill had organics. At some borings, the fill was very similar in appearance to the underlying glacio-lacustrine deposits and it is possible these transitions are deeper than shown on the boring logs.

The glacio-lacustrine deposits were mostly soft to hard lean clay and fat clay; some of these clay layers had variable sand, gravel, and organic contents. Some of the deeper glacio-lacustrine deposits were loose to very dense sand with varying silt and clay contents. There was also a layer of medium dense silt in SB-08.

5.3 Groundwater

We measured groundwater at depths of 14.0 and 15.6 feet in borings SB-05 and SB-07, respectively, at the time of drilling. We did not observe a water level in any of the remaining borings; however, it is possible the water levels were obscured by mud rotary drilling methods. The soils we encountered are very slow draining and it could take days or weeks for water to stabilize in open boreholes at this site. Groundwater levels will fluctuate due to varying seasonal and annual rainfall and snow melt amounts, and other factors. Piezometers would be needed to obtain long-term groundwater level measurements, which was beyond our scope of service.

6.0 BUILDING RECOMMENDATIONS

6.1 Approach Discussion

Based on the subsurface conditions found in our borings and our understanding of the project, it is our opinion the proposed building can be supported on a conventional footing foundation after proper site preparation has taken place. Details of our recommendations are presented below.

6.2 Site Preparation

6.2.1 Excavation

To prepare the building area for foundation and floor slab support, we recommend removal of all pavement, underground utilities (if present), vegetation, organic soils, existing fill, and other unsuitable soils that are encountered. Our estimated minimum subcut depths to remove unsuitable materials (at our boring locations) are shown in Table 1 on the following page. However, an experienced soils technician or geotechnical engineer must perform observations during construction to determine actual required subcut depths, which could be more or less than anticipated.

Table 1: Estimated Subcut Depths/Elevations

Boring Location	Surface Elevation (feet)	Estimated Subcut Depth (feet)	Estimated Subcut Elevation (feet)
SB-01	624.6	~2	~622.6
SB-02	624.7	~5	~619.7
SB-03	625.2	~4.5	~620.7
SB-04	625.5	~2	~623.5
SB-05	626.4	~2	~624.4
SB-06	625.1	~2	~623.1
SB-07	625.7	~4.5	~621.2
SB-08	626.1	~7	~619.1

Note: our estimated subcut depths include the possible fill

Where subcutting extends below the proposed foundation grade, the excavation bottom and resultant engineered fill system must be oversized laterally beyond the planned outside edges of the foundation to properly support the loads exerted by that foundation. This 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).

After removing all unsuitable materials, and prior to the placement of new fill or concrete, we recommend that the base soils be surface densified to compact loose zones and to correct zones loosened by the excavating process.

Where clay is exposed at the bottom of any excavation, the contractor must not permit the soil to dry below its natural moisture content before placing new fill or concrete. If these soils are allowed to dry, they will shrink and then swell upon regaining moisture over time after being covered. The swelling pressure can be sufficient to heave footings, slabs, and pavements. We strongly recommend this issue be discussed with the general contractor and the excavator at a pre-construction meeting.

The soils at this site are highly moisture sensitive and have the potential to become easily disturbed by construction activity. Even if the contractor uses appropriate methods, it is possible that wet weather during (or in the months leading up to) construction could make earthwork activities difficult. The project team and contractor must understand this risk and take appropriate precautions.

6.2.2 Fill Placement and Compaction

We do not recommend reusing the on-site clayey soils as fill in the building area. The clayey soils are highly moisture sensitive and will be very difficult to adequately compact. We recommend that new fill below the building consist of non-organic sandy/gravelly soils with a maximum of 15% by weight passing the No. 200 sieve, a maximum of 70% by weight passing the No. 40 sieve, and a maximum particle size of about 1 inch. The existing non-organic sandy/gravelly fill soils at the site would probably be suitable for re-use.

Fill placed to attain grade for foundation support should be compacted in thin lifts, such that the entire lift achieves a minimum compaction level of 98% of its maximum standard Proctor dry density (ASTM D698). We anticipate a lift thickness on the order of 6 to 8 inches may be appropriate, although this should be reviewed in the field at the time of construction.

If there are areas where fill is placed on slopes, we recommend benching the sloped surface (benches cut parallel to the slope contour) prior to placing the fill. Benching is recommended where slopes are steeper than 4H:1V.

6.3 Foundation Design

The proposed building can be supported on a conventional shallow foundation system bearing on competent naturally-occurring soils, or on fill placed and compacted over a suitable subgrade, provided the site has been prepared in accordance with the above recommendations. We recommend perimeter foundations for heated building spaces bear a minimum of 5 feet below exterior grade for protection from frost penetration. Interior footings in heated areas should bear at least 18 inches below the finished floor elevation to provide confinement to the bearing stratum. Footings in unheated areas should be extended to a minimum of 7 feet below surrounding grade. We recommend column footings and continuous wall footings for this project have minimum widths of 3 feet and 2 feet, respectively, even if the contact pressure is less than the allowable bearing pressure.

Based on the subsurface conditions we encountered and provided our recommendations are followed, it is our opinion the foundations for the building can be designed based on a net maximum allowable soil bearing pressure of 3,000 psf. It is our judgment this design pressure will have a factor of safety of at least 3 against the ultimate bearing capacity.

With this design we estimate a maximum total settlement of the building of up to 1 inch, and differential settlements of half this amount over a 30-foot distance for footings of similar size and loading, if the bearing soils are not soft, wet, disturbed, or frozen at the time of construction.

6.4 Floor Slab Design

The floor slab design should include a layer of dense-graded base course below the floor slab; we recommend a minimum thickness of 12 inches in the garage (apparatus) area and a minimum thickness of 6 inches at other locations. Interior backfill in underslab utility trenches and in footing trenches should be held to the same requirements of Section 6.2.2. Provided our site preparation recommendations are followed, the structural engineer can use a modulus of subgrade reaction of 150 pci to design the floor slab thickness and reinforcement.

We recommend the placement of a vapor retarder under the floor slab. The purpose of a vapor retarder is to reduce the potential for the upward migration of water vapor from the soil into and through the concrete slab. Water vapor migrating upward through the slab can damage floor coverings such as the carpeting, wood, or paint/sealers and contribute to excess humidity and microbial growth in the building. Various methods of vapor retarder construction are described in Part 2, Section 302.2R of the American Concrete Institute *Manual of Concrete Practice*. Note that the vapor retarder manufacturer might have specific requirements for the subgrade.

The slab-on-grade should be designed and constructed following the recommendations of the Portland Cement Association and the American Concrete Institute. The slab should have construction joints/control joints at spacings recommended by the Portland Cement Association and the American Concrete Institute to mitigate, but not eliminate, slab curling and cracking. The floor slab should be cast independent of the foundation walls of the building to allow relative movement of the slabs and footings to occur without causing excessive distress to the structure.

6.5 Exterior Slabs and Sidewalks

Where exterior slabs and sidewalks abut the building, they should be designed as structural slabs supported on footings bearing at least 7 feet deep. An air gap of at least 2 inches should be left below the slab, and insulation panels should cover the vertical frost walls to act as a bondbreaker and to prevent adfreezing between the backfilled soils and the frost walls.

As an alternative, silty and clayey soils could be subcut to a depth of 5 feet below bottom of slab/sidewalk and replaced with non-frost susceptible (NFS) granular fill. This NFS fill subbase layer should consist of sand or a sand and gravel mix having less than 5% by weight passing the No. 200 sieve. This fill should be compacted to at least 98% of its maximum standard Proctor dry density. The purpose of constructing the NFS subgrade is to reduce the potential for the characteristic heave (including differential heave) that can occur when silty and clayey soils freeze each winter. This heaving can raise the slabs to jam doors or damage the structures. Drain pipes must be included at the bottom of the NFS subgrade layer to collect and remove water. If the design of the building does not allow for drain pipes beneath the exterior slabs and sidewalks, then the structural slab option described above should be used.

For either option, the design should include transition zones from the frost-protected slabs/sidewalks to unprotected (or less protected) areas. The purpose of this is to reduce the risk of abrupt transitions in frost heave of slabs and pavements.

6.6 Seismic Design Considerations

The Seismic Site Class is determined by the properties of the top 100 feet of the subsurface profile. Based on our borings and geologic conditions at the site, it is our opinion the project site should be classified as Site Class D per Table 1613.5.2 of the IBC.

7.0 PAVEMENT RECOMMENDATIONS

7.1 Approach Discussion

The existing subgrade soils at the site are mostly slow draining and moderately to highly frost susceptible. To reduce these effects, we recommend the project team include a drainage (subbase) layer below the base course; the base course by itself is not considered free draining.

The soils at this site are highly moisture sensitive and have the potential to become easily disturbed by construction activity. Even if the contractor uses appropriate methods, it is possible that wet weather during (or in the months leading up to) construction could make earthwork activities difficult. The project team and contractor must understand this risk and take appropriate precautions.

7.2 Pavement Subgrade Preparation

In areas of new pavement, we recommend complete removal of all existing pavements, vegetation, organic soils, and other unsuitable soils that are found. We anticipate the subcut depths at our pavement boring locations (SB-09 through SB-12) will be 2 feet or less below existing grades. However, an experienced soils technician or geotechnical engineer should perform observations during construction to determine actual subcutting requirements. <u>Further, it is possible or likely some unsuitable soils will be obscured below relatively competent soils; for example, there is sandy/gravelly fill overlying the swamp deposits in SB-07. The project team must be aware of this risk if the existing fill will be left in place. If this risk is not acceptable, all existing fill should be removed from pavement areas.</u>

After excavation to the required depth and removal of all unsuitable soils, the top 12 inches of the exposed subgrade should be surface compacted to a minimum of 98% of its maximum standard Proctor dry density. In addition, each area should be proof rolled (with an appropriate construction vehicle) and observed for signs of poor performance by a geotechnical engineer or experienced soils technician, just prior to placing new fill. All soft areas should be dug out and corrected.

Where new fill (below the drainage layer) is needed in pavement areas, we recommend it consist of non-organic soils similar to the on-site sandy fill or lean clay; fat clay should not be used as fill in pavement areas. Fill placed to attain subgrade elevation in pavement areas should be compacted in thin lifts, such that the entire lift achieves a minimum compaction level of 98% of its maximum standard Proctor dry density. We anticipate a lift thickness on the order of 6 to 8 inches may be appropriate, although this should be reviewed in the field at the time of construction.

Geosynthetic separation fabric (WisDOT 645, Type SAS) should be placed between the prepared subgrade and the overlying drainage layer. The purpose of this fabric is to reduce the risk of migration of the underlying soil into the drainage layer and base course layer.

7.3 Drainage Layer and Base Course

The drainage (subbase) layer should consist of free-draining sand, crushed stone, or breaker run. Free-draining sand, if selected, should have less than 20% by weight passing the No. 100 sieve and less than 5% by weight passing the No. 200 sieve. Crushed stone or breaker run, if selected, should have less than 5% by weight passing the No. 200 sieve. AET should be contacted to review the gradation of the selected drainage layer material. The drainage layer should be extended an additional 2 feet beyond the pavement edge.

The drainage layer must be provided with a means of subsurface drainage to prevent buildup of water. This can be accomplished by placing short segments of drainage lines which are connected to catch basins in low elevation areas (referred to as “finger drains”). Where paved areas are relatively level, and if finger drains are not frequent, longer parallel drainage lines should be placed through the level areas to better remove infiltrating water, including along the perimeter.

The base course should meet the 1-1/4-inch gradation provided in WisDOT 305, and should be compacted to at least 98% of its maximum standard Proctor dry density. After the base course has been placed, compacted, and tested, it is the contractor’s responsibility to maintain the base course in a suitable condition for paving. We recommend each pavement area be proof rolled with a fully-loaded tandem-axle dump truck and observed for signs of poor performance by a geotechnical engineer or experienced soils technician, just prior to placing the pavement. All soft areas should be dug out and corrected.

7.4 Pavement Design Parameters

Table 2 lists our recommended parameters the civil engineer can use to design the site pavements. These recommendations are based on the soil conditions found in our borings and subgrade preparation as described in Sections 7.1 through 7.3. If the subgrade conditions vary from those encountered in our borings, we should be contacted to review our recommendations.

Table 2: Pavement Design Parameters

Parameter	Value
Frost Index	F-4
Wisconsin Design Group Index	17
Soil Support Value (with drainage layer)	4.0
Modulus of Subgrade Reaction	100 pci

7.5 Pavement Fatigue and Maintenance

Regardless of the subgrade preparation and design, the owner should expect that cracks will appear in the bituminous pavement within 1 to 3 years due to thermal expansion and contraction, and due to the loss of volatiles from the bituminous cement. These cracks cannot be avoided; they should be cleaned annually and filled with a hot bituminous sealant. Within three to five years after construction, cracks and depressions may appear in heavily traveled areas, such as drive aisles. Such areas should be cut out and repaired expeditiously to extend the pavement life. Periodically during the pavement life, the engineer responsible for maintenance of the facility should determine the need to apply a seal coat of hot bituminous and rock chips.

8.0 CONSTRUCTION CONSIDERATIONS

8.1 Groundwater

Based on the conditions found in our borings, it is our opinion the contractor will probably not encounter the static groundwater table at this site. However, it is likely perched groundwater will be encountered, particularly within sandy fill overlying clayey soils. If water is encountered in the excavations, it should be promptly pumped out before compacted fill is placed. The contractor should not be allowed to place fill into standing water, or over softened soils in an attempt to displace these materials. This technique can result in trapping softened soils under foundations and floor slabs, resulting in excessive post-construction settlement, even if the softened zone is only a few inches thick.

8.2 Disturbance of Soils

The soils at this site are sensitive to disturbance and will become easily disturbed under construction traffic, especially when wet. If soils become disturbed, they should be subcut to the underlying undisturbed soils, followed by placement of new compacted fill.

8.3 Excavation Slopes

If excavation faces are not retained, the excavations 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.

8.4 Observation and Testing

The recommendations in this report are based on the subsurface conditions found at our test boring locations. Since the soil conditions can be expected to vary away from the soil boring locations, we recommend on-site observation by a geotechnical engineer/technician during construction to evaluate these potential changes. Soil density testing should also be performed on new fill placed in order to document that project specifications for compaction have been met.

9.0 ASTM STANDARDS

When we refer to an ASTM Standard in this report, we mean that our services were performed in general accordance with that standard. Compliance with any other standards referenced within the specified standard is neither inferred nor implied.

10.0 LIMITATIONS

Within the limitations of scope, budget, and schedule, we have endeavored to provide our services according to generally accepted geotechnical engineering practices at this time and location. Other than this, no warranty, 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."

Appendix A

Geotechnical Field Exploration and Testing
Boring Log Notes
Unified Soil Classification System
Figure 1 – Boring Location Map
Subsurface Boring Logs
Gradation Curves

Appendix A
Geotechnical Field Exploration and Testing
Project No. P-0035882

A.1 FIELD EXPLORATION

The subsurface conditions at the site were explored by drilling twelve geotechnical borings. The boring locations are shown on Figure 1.

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. 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. After an initial set of 6 inches, the number of hammer blows to drive the sampler the next 12 inches is known as the standard penetration resistance or N-value.

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 that system. That converted energy provided what is known as an N60 blow count.

Most drill rigs today incorporate an automatic hammer lift and drop system, which has higher energy efficiency and subsequently results in lower N-values than the traditional N60 values. We use a Pile Driving Analyzer (PDA) and an instrumented rod to measure the actual energy generated by the automatic hammer system. The drill rig (AET rig number 85) we used for this project has a measured energy transfer ratio of 64%. The N-values reported on the boring logs and the corresponding relative densities and consistencies are from the field blow counts and have not been adjusted to N60 values.

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 System (USCS). The USCS 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 USCS, 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 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.6 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

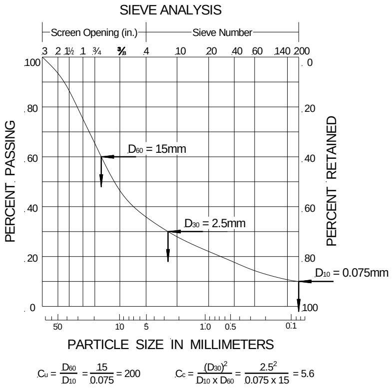
The standard penetration test consists of driving a split-spoon sampler with a drop hammer counting the number of blows applied in each of three 6" increments of penetration. If the sampler is driven less than 18" (usually in highly resistant material), permitted in ASTM: D1586, the blows for each complete 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.

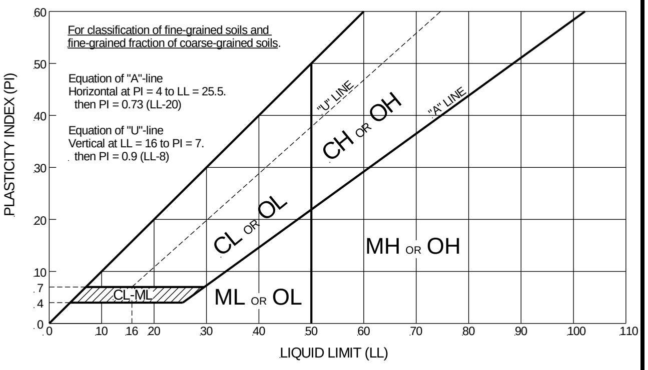
The length of sample recovered, as shown on the "REC" column, may be greater than the distance indicated in the N column. The disparity is because the N-value is recorded below the initial 6" set (unless partial penetration defined in ASTM: D1586 is encountered) whereas the length of sample recovered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





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

[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, soil 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.

Boring ID	Latitude	Longitude	Elevation (ft)
SB-01	46.72975	-92.100687	624.6
SB-02	46.729749	-92.100514	624.7
SB-03	46.729546	-92.100508	625.2
SB-04	46.729528	-92.100259	625.5
SB-05	46.729425	-92.100365	626.4
SB-06	46.729319	-92.100517	625.1
SB-07	46.729332	-92.100248	625.7
SB-08	46.729216	-92.100627	626.1
SB-09	46.72997	-92.100605	623.7
SB-10	46.729964	-92.100317	623.9
SB-11	46.729636	-92.100354	625.2
SB-12	46.72923	-92.100385	625.6

Legend

● 25 foot borings

● 10 foot borings

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Map Reference:
MnGeo 2023

N

0 75 150
Feet

Figure 1

Boring Location Map

Superior Fire Department Station 2
Vacant Lot West of 1505 N 8th St
Superior, WI 54880

Date: 10/15/2024

AET Project No. P-0035882

SUBSURFACE BORING LOG

AET No: **P-0035882** Log of Boring No. **SB-01 (p. 1 of 1)**

Project: **Superior Fire Department Station 2; Superior, Wisconsin**

Surface Elevation **624.6**

DEPTH IN FEET	ELEV. FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
								WC	qp	LL	PL	%-#200
1	623.6	FILL, fat clay with sand and organics, dark brown (OH)	FILL/ TOPSOIL	4	M	SS	10	45				
2	622.6	FILL, fat clay with sand, brown, soft, with trace roots and wood pieces (CH)	GLACIO-LACUSTRINE DEPOSITS									
3		FAT CLAY, reddish brown, firm to stiff (CH) *lens of gray sand at approximately 3 feet*		6	M	SS	16	34	1.8			
4												
5												
6				9	M	SS	20	28	3.3			
7												
8				11	M	SS	24	30	3.5			
9												
10												
11				10	M	SS	24	32	2.8			
12												
13	611.6	FAT CLAY with sand, reddish brown, stiff (CH)		11	M	SS	24	29	1.8			
14	610.1	FAT CLAY, reddish brown (CH)										
15	609.6	CLAYEY SAND, fine grained, brown, moist, dense (SC)										
16				44	M	SS	20					
17	607.6	SAND, fine to medium grained, brown, moist, dense, with lenses of reddish brown clay (SP)										
18				42	M	SS	24					
19	605.1	SAND WITH SILT, fine grained, brown, moist, dense (SP-SM)										
20												
21				36	M	SS	20					10.6
22												
23				41	M	SS	20					
24	600.1	LEAN CLAY, brown and reddish brown, hard, with a lamination of brown sand (CL)										
25				33	M	SS	14	24				
26	598.6	**END OF BORING AT 26.0 FEET**										

DEPTH:	DRILLING METHOD
0-9½'	**4.25" HSA**
9½-24½'	**RD w/DM**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
8/28/24	**1140**	**11.5**	**9.5**	**11.5**	**None**	**None**

BORING COMPLETED: **8/28/24**

DR: **JA** LG: **QS** Rig: **85**

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

AET_CORP W-ELEV P-0035882.GPJ AET+CPT+WELL.GDT 10/15/24

SUBSURFACE BORING LOG

AET No: **P-0035882**   Log of Boring No. **SB-02 (p. 1 of 1)**

Project: **Superior Fire Department Station 2; Superior, Wisconsin**

Surface Elevation **624.7**

DEPTH IN FEET	ELEV. FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	WC	qp	LL	PL	%-#200
1	623.7	FILL, fat clay with sand and organics, dark brown (OH)	FILL/ TOPSOIL	4	M	SS	14					
2	622.7	FILL, fat clay with sand, a little gravel, reddish brown and black, with trace roots (CH)	FILL									
5	619.7	FAT CLAY with sand and organics, black, stiff, possible fill (OH)	GLACIO-LACUSTRINE DEPOSITS	9	M	SS	14	64	2.3			
7	617.7	LEAN CLAY, reddish brown, firm (CL)		7	M	SS	18	37	2.0			
9	615.7	FAT CLAY, reddish brown, stiff (CH)		13	M	SS	24	29	3.5			
15	609.2	LEAN CLAY with sand, reddish brown, soft to stiff (CL)		11	M	SS	18	25	3.0			
				4	M	SS	24	21	2.5	30	17	
22	602.7	SAND, fine to medium grained, brown, moist, dense (SP)				TW	12					
				31	M	SS	22					
				37	M	SS	12					
26	598.7	SAND WITH SILT, fine grained, brown, wet, dense to very dense (SP-SM)		45	W	SS	22					
				62	W	SS	18					
		END OF BORING AT 26.0 FEET										

DEPTH:	DRILLING METHOD
0-9½'	**4.25" HSA**
9½-24½'	**RD w/DM**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
8/28/24	**1424**	**11.5**	**9.5**	**11.5**	**None**	**None**

BORING COMPLETED: **8/28/24**

DR: **JA** LG: **QS** Rig: **85**

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

AET_CORP W-ELEV P-0035882.GPJ AET+CPT+WELL.GDT 10/15/24

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SUBSURFACE BORING LOG

AET No: **P-0035882** Log of Boring No. **SB-03 (p. 1 of 1)**

Project: **Superior Fire Department Station 2; Superior, Wisconsin**

DEPTH IN FEET	ELEV. FEET	Surface Elevation **625.2** MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
								WC	qp	LL	PL	%-#200
	624.8	4.75" Bituminous Pavement	PAVEMENT									
1	624.2	FILL, gravelly clayey sand, fine to coarse grained, dark brown, moist (SC)	FILL	3	M	SS	4					
2		FAT CLAY, reddish brown, firm, possible fill (CH)	GLACIO-LACUSTRINE DEPOSITS									
3		*lens of brown clayey sand at approximately 2.5 feet*		8	M	SS	18	28	3.0			
4	620.7											
5		LEAN CLAY, reddish brown, stiff (CL)										
6				11	M	SS	20	27	4.0			
7	618.2											
8		FAT CLAY, reddish brown, firm to stiff (CH)		10	M	SS	24	28	2.8			
9												
10		*lens of clay with sand at approximately 9.5 feet*										
11				9	M	SS	24	35	2.0			
12												
13				8	M	SS	22	36	2.0			
14												
15												
16				7	M	SS	20	37	1.3			
17												
18	606.7				M	TW	0					
19		CLAYEY SAND, fine grained, reddish brown, wet, dense (SC)										
20												
21				43	W	SS	1					
22	603.2	FAT CLAY, reddish brown, hard (CH)										
23				50/.7	M	SS	4	33	1.3			
24	600.7											
25		SAND WITH SILT, fine grained, brown, moist, very dense, with a lens of clayey sand (SP-SM)		67	M	SS	24					
26	599.2	**END OF BORING AT 26.0 FEET**										

DEPTH:	DRILLING METHOD	DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
0-9½'	**4.25" HSA**							
9½-24½'	**RD w/DM**	**8/28/24**	**1036**	**11.5**	**9.5**	**11.5**	**None**	**None**

WATER LEVEL MEASUREMENTS

BORING COMPLETED: **8/28/24**

DR: **JA** LG: **QS** Rig: **85**

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

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SUBSURFACE BORING LOG

AET No: **P-0035882** Log of Boring No. **SB-04 (p. 1 of 1)**

Project: **Superior Fire Department Station 2; Superior, Wisconsin**

DEPTH IN FEET	ELEV. FEET	Surface Elevation 625.5 MATERIAL DESCRIPTION		GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
									WC	qp	LL	PL	%-#200
	625.1	4.5" Bituminous Pavement	■	PAVEMENT									
1 2	623.5	FILL, fat clay with sand, brown and black and reddish brown (CH)	▩	FILL	7	M	SS	12					
3 4	621.0	FAT CLAY with sand, reddish brown, firm (CH)	▨	GLACIO-LACUSTRINE DEPOSITS	8	M	SS	10	32	2.0			
5 6 7		FAT CLAY, reddish brown with gray laminations, stiff (CH)	▨		14	M	SS	24	26	3.5	61	22	
8 9	616.0				13	M	SS	20	31	2.5			
10 11 12	613.5	LEAN CLAY, reddish brown and gray laminations, firm (CL)	▨		7	M	SS	24	27	3.0			
13 14 15	610.5	FAT CLAY, reddish brown with gray laminations, firm (CH) *lens of clayey sand at approximately 13 feet*	▨		7	M	SS	24	32	1.5			
16 17		FAT CLAY with sand, a little gravel, reddish brown, firm (CH)	▨		5	M	SS	24	31	2.3			
18 19	606.0					M	TW	18					
20 21 22	603.5	FAT CLAY, reddish brown, firm (CH)	▨		5	M	SS	24	28	1.5			
23 24		SAND WITH SILT, fine grained, brown, moist, very dense (SP-SM)	░		57	M	SS	24					
25 26	599.5				72	M	SS	16					
		END OF BORING AT 26.0 FEET											

DEPTH:	DRILLING METHOD
0-9½'	**4.25" HSA**
9½-24½'	**RD w/DM**

BORING COMPLETED: **9/9/24**

DR: **JA** LG: **QS** Rig: **85**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
9/9/24	**1117**	**11.5**	**9.5**	**11.5**	**None**	**None**

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

AET_CORP W-ELEV P-0035882.GPJ AET+CPT+WELL.GDT 10/15/24

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SUBSURFACE BORING LOG

AET No: **P-0035882** Log of Boring No. **SB-05 (p. 1 of 1)**

Project: **Superior Fire Department Station 2; Superior, Wisconsin**

DEPTH IN FEET	ELEV. FEET	Surface Elevation **626.4** MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	WC	qp	LL	PL	%-#200
	625.8	6.75" Bituminous Pavement	PAVEMENT									
1		FILL, gravelly silty sand, fine to coarse grained, brown, moist (SM)	FILL	4	M	SS	1					
2	624.4	FAT CLAY, brown, soft (CH)	GLACIO-LACUSTRINE DEPOSITS									
3				4	M	SS	12	31	1.5			
4	621.9	FAT CLAY with sand, reddish brown, firm (CH)										
5												
6				7	M	SS	16	31	3.0			
7												
8				8	M	SS	24	31	3.3			
9	616.9	FAT CLAY, reddish brown, firm (CH)										
10												
11				8	M	SS	24	37	2.3			
12												
13				7	M	SS	24	31	2.5			
14					▼							
15												
16		*lenses of gray clay at approximately 15.5 feet*		7	W	SS	24	33	2.0			
17												
18				7	W	SS	24	33	1.8			
19		*lens of sandy clay at approximately 19 feet*										
20												
21				8	W	SS	24	38	2.3			
22	604.4	*lenses of sandy clay at approximately 21.5 feet*										
23		SAND, fine grained, brown, moist, medium dense to very dense (SP)		55	W	SS	20					
24												
25				18	W	SS	24					
26	600.4	**END OF BORING AT 26.0 FEET**										

DEPTH: DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
0-24½' 2.25" HSA	DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
	9/9/24	**1602**	**26.0**	**24.5**	**24.4**	**None**	**16.6**	
	9/9/24	**1608**	**26.0**	**24.5**	**24.4**	**None**	**14.0**	
BORING COMPLETED: **9/9/24**								
DR: **JA** LG: **QS** Rig: **85**								

AET_CORP W-ELEV P-0035882.GPJ AET+CPT+WELL.GDT 10/15/24

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SUBSURFACE BORING LOG

AET No: **P-0035882**　　Log of Boring No. **SB-06 (p. 1 of 1)**

Project: **Superior Fire Department Station 2; Superior, Wisconsin**

Surface Elevation **625.1**

DEPTH IN FEET	ELEV. FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	WC	qp	LL	PL	%-#200
	624.8	4" Bituminous Pavement	PAVEMENT									
1		FILL, silty sand with gravel, fine to medium grained, brown, moist (SM)	FILL	3	M	SS	0					
2	623.1											
3		FAT CLAY, a little gravel, reddish brown, soft, with lense of silty sand, possible fill (CH)	GLACIO-LACUSTRINE DEPOSITS	4	M	SS	4	29	2.3			
4												
5												
6				6	M	SS	6	31	2.8			
7	618.1											
8		FAT CLAY, reddish brown, firm (CH)		8	M	SS	20	31	2.5	72	23	
9												
10												
11				7	M	SS	24	32	2.5			
12												
13		*lens of sandy clay at approximately 13 feet*		8	M	SS	24	34	1.5			
14	610.6											
15		FAT CLAY with sand, reddish brown, soft (CH)										
16				4	M	SS	24	43	0.8			
17												
18					M	TW	18					
19	605.6											
20		FAT CLAY, reddish brown, firm to very stiff, with a lens of light gray clay (CH)										
21				8	M	SS	24	30	1.3			
22												
23	602.1			37	M	SS	24	17				
24		SILTY SAND, fine grained, brown, moist, medium dense to dense, with lenses of clay (SM)										
25				26	M	SS	20					
26	599.1											
		END OF BORING AT 26.0 FEET										

DEPTH:	DRILLING METHOD
0-9½'	**4.25" HSA**
9½-24½'	**RD w/DM**

BORING COMPLETED: **9/9/24**

DR: **JA**　LG: **QS**　Rig: **85**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
9/9/24	**1322**	**11.5**	**9.5**	**11.5**	**None**	**None**

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

AET_CORP W-ELEV P-0035882.GPJ AET+CPT+WELL.GDT 10/15/24

SUBSURFACE BORING LOG

AET No: **P-0035882**　　Log of Boring No. **SB-07 (p. 1 of 1)**

Project: **Superior Fire Department Station 2; Superior, Wisconsin**

Surface Elevation **625.7**

DEPTH IN FEET	ELEV. FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	WC	qp	LL	PL	%-#200
	625.4	4.25" Bituminous Pavement	PAVEMENT									
1	623.7	FILL, gravelly clayey sand, fine grained, brown, moist (SC)	FILL	5	M	SS	4					
2 3 4	621.2	Hemic PEAT, black, moist, loose (PT)	SWAMP DEPOSITS	5	M	SS	20	42				
5 6 7	618.7	LEAN CLAY, reddish brown, firm (CL)	GLACIO-LACUSTRINE DEPOSITS	6	M	SS	18	27	2.0			
8 9		FAT CLAY, reddish brown, firm (CH)		5	M	SS	24	33	2.5			
10 11 12				6	M	SS	24	39	2.0			
13 14				8	M	SS	24	39	2.0			
15 16 17	608.7			6	▼M	SS	24	41	1.3			
18 19	606.2	FAT CLAY, reddish brown, firm, with lenses and laminations of silt (CH)		5	W	SS	24	41	1.5			
20 21 22	602.7	LEAN CLAY, reddish brown, firm to hard, with lenses and laminations of silt (CL)		6	W	SS	24	22				
23 24		SILTY SAND, fine grained, brown, wet, loose to dense (SM)		48	W	SS	24					
25 26	599.7			5	W	SS	24					
		END OF BORING AT 26.0 FEET										

DEPTH:	DRILLING METHOD
0-24½'	2.25" HSA

BORING COMPLETED: **9/9/24**

DR: **JA**　LG: **QS**　Rig: **85**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
9/9/24	1420	26.0	24.5	25.1	None	16.4
9/9/24	1433	26.0	24.5	25.1	None	15.6

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

SUBSURFACE BORING LOG

AET No: **P-0035882** Log of Boring No. **SB-08 (p. 1 of 1)**

Project: **Superior Fire Department Station 2; Superior, Wisconsin**

Surface Elevation **626.1**

DEPTH IN FEET	ELEV. FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	WC	qp	LL	PL	%-#200
1		FILL, sand with gravel, fine grained, reddish brown, with trace roots (SP)	FILL	6	M	SS	12					
2	624.1											
3		FILL, sand, a little gravel, fine to medium grained, reddish brown, with a lens of clay (SP)		8	M	SS	16					
4	621.6											
5		FILL, sand with silt, fine to medium grained, a little gravel, reddish brown, moist (SW-SM)		8	M	SS	3					8.2
6												
7	619.1											
8		FAT CLAY, reddish brown, firm to stiff (CH)	GLACIO-LACUSTRINE DEPOSITS	9	M	SS	18	32	2.3			
9												
10				8	M	SS	24	32	2.3			
11												
12												
13				6	M	SS	24	32	2.3			
14												
15				5	M	SS	24	34	1.5			
16												
17	609.1											
18		FAT CLAY, reddish brown, soft (CH)		4	M	SS	24	40	1.5			
19	606.6	*laminations of brown at approximately 19 feet*										
20		LEAN CLAY, reddish brown, firm to stiff (CL)		5	M	SS	20	25				
21												
22												
23	603.1			15	M	SS	24	19				
24		SILT, reddish brown, moist, medium dense (ML)										
25	601.1	LEAN CLAY, reddish brown, very stiff, with lenses and laminations of silt (CL)		24	M	SS	24	17				
26	600.1											
		END OF BORING AT 26.0 FEET										

DEPTH:	DRILLING METHOD
0-24½'	**2.25" HSA**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
9/12/24	**0938**	**26.0**	**24.5**	**24.5**	**None**	**None**
9/12/24	**1003**	**26.0**	**24.5**	**24.5**	**None**	**None**

BORING COMPLETED: **9/12/24**

DR: **JA** LG: **QS** Rig: **85**

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

AMERICAN
ENGINEERING TESTING

SUBSURFACE BORING LOG

AET No: **P-0035882** Log of Boring No. **SB-09 (p. 1 of 1)**

Project: **Superior Fire Department Station 2; Superior, Wisconsin**

DEPTH IN FEET	ELEV. FEET	Surface Elevation **623.7** MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	qp	LL	PL	%-#200
	623.3	4.75" Bituminous Pavement	PAVEMENT									
1		FILL, gravel with sand, fine grained, brown, moist to wet, with concrete pieces (GW)	FILL	13	M	SS	6					
2												
3				19	W	SS	4					4.0
4	619.2											
5		FAT CLAY with sand, trace roots, brown, soft, with wood pieces (CH)	GLACIO-LACUSTRINE DEPOSITS									
6				3	M	SS	6	48	0.3			
7	616.7	FAT CLAY, reddish brown, firm (CH)										
8		*lens of gray sand at approximately 8 feet*		5	M	SS	24	35	2.5			
9												
10												
11	612.2			6	M	SS	24	34	2.5			
		END OF BORING AT 11.5 FEET										

DEPTH:	DRILLING METHOD
0-9½'	**4.25" HSA**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
8/28/24	**0743**	**11.5**	**9.5**	**11.0**	**None**	**None**
8/28/24	**0756**	**11.5**	**10.0**	**10.9**	**None**	**None**

BORING COMPLETED: **8/28/24**

DR: **JA** LG: **QS** Rig: **85**

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

SUBSURFACE BORING LOG

AET No: **P-0035882**   Log of Boring No. **SB-10 (p. 1 of 1)**

Project: **Superior Fire Department Station 2; Superior, Wisconsin**

DEPTH IN FEET	ELEV. FEET	Surface Elevation **623.9** MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
								WC	qp	LL	PL	%-#200
	623.7	4.5 " Bituminous Pavement	PAVEMENT									
1		FILL, gravelly silty sand, fine grained, dark brown, moist, with concrete pieces (SM)	FILL	34	M	SS	10					
2												
3	620.4			8	M	SS	10	52				
4	619.4	LEAN CLAY, dark gray (CL)	GLACIO-LACUSTRINE DEPOSITS									
5		LEAN CLAY, reddish brown, firm (CL)										
6				6	M	SS	4	25	4.5			
7	616.9	*lens of brown clayey sand with gravel at approximately 7 feet*										
8		FAT CLAY, reddish brown, stiff (CH)		10	M	SS	24	30	3.5			
9												
10				9	M	SS		36	2.5			
11	612.4											
		END OF BORING AT 11.5 FEET										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS						
0-9½'	**4.25" HSA**	DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
		8/28/24	**0849**	**11.5**	**9.5**	**12.5**	**None**	**None**

BORING COMPLETED: **8/28/24**

DR: **JA** LG: **QS** Rig: **85**

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

SUBSURFACE BORING LOG

AET No: **P-0035882**   Log of Boring No. **SB-11 (p. 1 of 1)**

Project: **Superior Fire Department Station 2; Superior, Wisconsin**

Surface Elevation **625.2**

DEPTH IN FEET	ELEV. FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	WC	qp	LL	PL	%-#200
1	624.2	FILL, clayey sand with gravel and organics, fine grained, dark brown, moist (SC)	FILL/ TOPSOIL	9	M	SS	10					
2		FILL, clayey sand with gravel, fine grained, brown, moist, trace roots, with bituminous pavement pieces (SC)	FILL									
3	622.2			12	M	SS	14	20				
4		LEAN CLAY, reddish brown, stiff (CL)	GLACIO-LACUSTRINE DEPOSITS									
5												
6				11	M	SS	20	26	3.8			
7	618.2	FAT CLAY, reddish brown, stiff (CH)										
8				12	M	SS	22	28	3.5			
9												
10												
11	613.7			13	M	SS	20	28	3.0			
		END OF BORING AT 11.5 FEET										

DEPTH:	DRILLING METHOD	DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
0-9½'	**4.25" HSA**	**9/9/24**	**0858**	**11.5**	**9.5**	**11.5**	**None**	**None**

BORING COMPLETED: **9/9/24**

DR: **JA** LG: **QS** Rig: **85**

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

SUBSURFACE BORING LOG

AET No: **P-0035882**

Log of Boring No. **SB-12 (p. 1 of 1)**

Project: **Superior Fire Department Station 2; Superior, Wisconsin**

Surface Elevation **625.6**

DEPTH IN FEET	ELEV. FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
								WC	qp	LL	PL	%-#200
	625.2	4.5" Bituminous Pavement	PAVEMENT									
1	624.6	FILL, gravelly silty sand, fine grained, dark brown, moist (SM)	FILL	3	M	SS	10	31				
2	623.6	FILL, sandy fat clay, fine grained, dark brown (CH)	GLACIO-LACUSTRINE DEPOSITS									
3		FAT CLAY, brown, soft (CH)		4	M	SS	12	30	2.0			
4												
5												
6					M	TW	18					
7	618.6	FAT CLAY, reddish brown, firm to stiff (CH)										
8				8	M	SS	24	30	3.0			
9												
10												
11				11	M	SS	24	31	2.3			
	614.1											
		END OF BORING AT 11.5 FEET										

DEPTH:	DRILLING METHOD
0-9½'	**4.25" HSA**

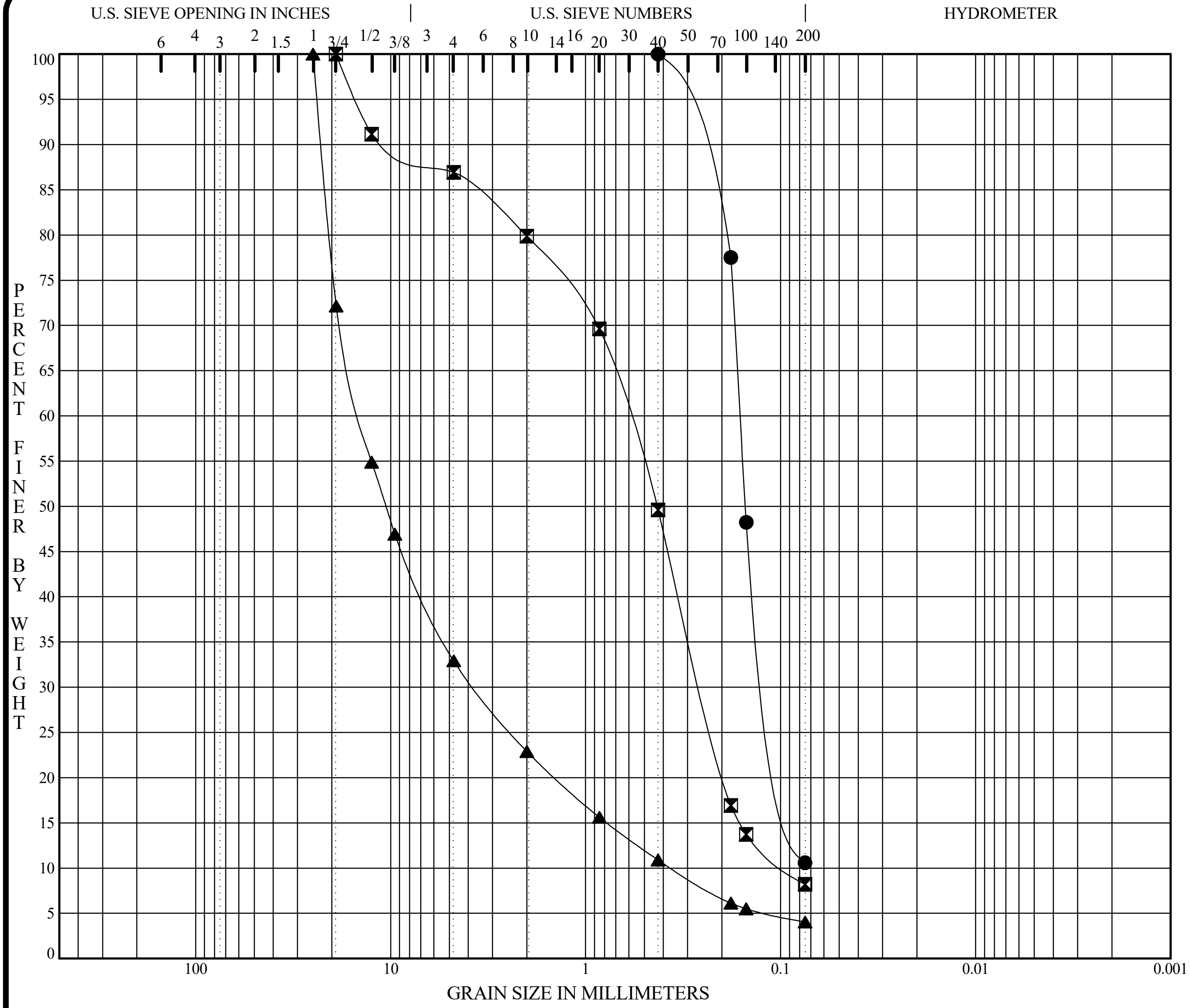
WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
9/9/24	**0907**	**11.5**	**9.5**	**11.5**	**None**	**None**

BORING COMPLETED: **9/9/24**

DR: **JA** LG: **QS** Rig: **85**

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



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	**SB-01**	**20.5'**	**Sand with silt, fine grained (SP-SM)**					**0.96**	**2.2**
☒	**SB-08**	**5.5'**	**Sand with silt, f-m grained, a little gravel (SW-SM)**					**1.13**	**6.5**
▲	**SB-09**	**3.0'**	**Gravel with sand (GW)**					**2.66**	**39.1**

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**SB-01**	**20.5'**	**0.43**	**0.16**	**0.107**		**0.0**	**89.4**	**10.6**	
☒	**SB-08**	**5.5'**	**19.05**	**0.61**	**0.254**	**0.0940**	**13.1**	**78.7**	**8.2**	
▲	**SB-09**	**3.0'**	**25.00**	**14.15**	**3.694**	**0.3620**	**67.1**	**28.9**	**4.0**	

PROJECT **Superior Fire Department Station 2; Superior, Wisconsin**

AET JOB NO. **P-0035882**
DATE **8/28/24**

American Engineering Testing, Inc.
550 Cleveland Avenue North
St. Paul, MN 55114
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GRADATION CURVES

Appendix B

Geotechnical Report Limitations and Guidelines for Use

Appendix B
Geotechnical Report Limitations and Guidelines for Use
Project No. P-0035882

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 GBA[1], of which we are a member firm.

B.2 RISK MANAGEMENT INFORMATION

B.2.1 Understand the Geotechnical Engineering Services Provided for this Report

Geotechnical engineering services typically include the planning, collection, interpretation, and analysis of exploratory data from widely spaced borings and/or test pits. Field data are combined with results from laboratory tests of soil and rock samples obtained from field exploration (if applicable), observations made during site reconnaissance, and historical information to form one or more models of the expected subsurface conditions beneath the site. Local geology and alterations of the site surface and subsurface by previous and proposed construction are also important considerations. Geotechnical engineers apply their engineering training, experience, and judgment to adapt the requirements of the prospective project to the subsurface model(s). Estimates are made of the subsurface conditions that will likely be exposed during construction as well as the expected performance of foundations and other structures being planned and/or affected by construction activities.

The culmination of these geotechnical engineering services is typically a geotechnical engineering report providing the data obtained, a discussion of the subsurface model(s), the engineering and geologic engineering assessments and analyses made, and the recommendations developed to satisfy the given requirements of the project. These reports may be titled investigations, explorations, studies, assessments, or evaluations. Regardless of the title used, the geotechnical engineering report is an engineering interpretation of the subsurface conditions within the context of the project and does not represent a close examination, systematic inquiry, or thorough investigation of all site and subsurface conditions.

B.2.2 Geotechnical Services are Performed for Specific Purposes, Persons, & Projects, & at Specific Times

Geotechnical engineers structure their services to meet the specific needs, goals, and risk management preferences of their clients. A geotechnical engineering study conducted for a given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared solely for the client.

Likewise, geotechnical engineering services are performed for a specific project and purpose. For example, it is unlikely that a geotechnical engineering study for a refrigerated warehouse will be the same as one prepared for a parking garage; and a few borings drilled during a preliminary study to evaluate site feasibility will not be adequate to develop geotechnical design recommendations for the project.

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project or purpose;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, the reliability of a geotechnical-engineering report can be affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. If you are the least bit uncertain about the continued reliability of this report, contact your geotechnical engineer before applying the recommendations in it. A minor amount of additional testing or analysis after the passage of time – if any is required at all – could prevent major problems.

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[1] Geoprofessional Business Association, 15800 Crabbs Branch Way, Suite 300, Rockville, MD 20855
Telephone: 301/565-2733: www.geoprofessional.org

B.2.3 Read the Full Report

Costly problems have occurred because those relying on a geotechnical-engineering report did not read the report in its entirety. Do not rely on an executive summary. Do not read selective elements only. Read and refer to the report in full.

B.2.4 You Need to Inform Your Geotechnical Engineer About Change

Your geotechnical engineer considered unique, project-specific factors when developing the scope of study behind this report and developing the confirmation-dependent recommendations the report conveys. Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the elevation, configuration, location, orientation, function or weight of the proposed structure and the desired performance criteria;
- the composition of the design team; or
- project ownership.

As a general rule, always inform your geotechnical engineer of project or site changes – even minor ones – and request an assessment of their impact. The geotechnical engineer who prepared this report cannot accept responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.

B.2.5 Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface using various sampling and testing procedures. Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing is performed. The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgement to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team through project completion to obtain informed guidance quickly, whenever needed.

B.2.6 This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, they are not final, because the geotechnical engineer who developed them relied heavily on judgement and opinion to do so. Your geotechnical engineer can finalize the recommendations only after observing actual subsurface conditions exposed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.

B.2.7 This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a continuing member of the design team, to:

- confer with other design-team members;
- help develop specifications;
- review pertinent elements of other design professionals' plans and specifications; and
- be available whenever geotechnical engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction-phase observations.

B.2.8 Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical engineering report, along with any attachments or appendices, with your contract documents, but be certain to note conspicuously that you've included the material for information purposes only. To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, only from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and be sure to allow enough time to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

B.2.9 Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. This happens in part because soil and rock on project sites are typically heterogeneous and not manufactured materials with well-defined engineering properties like steel and concrete. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. Read these provisions closely. Ask questions. Your geotechnical engineer should respond fully and frankly.

B.2.10 Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical engineering study. For that reason, a geotechnical engineering report does not usually provide environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. Unanticipated subsurface environmental problems have led to project failures. If you have not obtained your own environmental information about the project site, ask your geotechnical consultant for a recommendation on how to find environmental risk-management guidance.

B.2.11 Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, the engineer's services were not designed, conducted, or intended to prevent migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, proper implementation of the geotechnical engineer's recommendations will not of itself be sufficient to prevent moisture infiltration. Confront the risk of moisture infiltration by including building-envelope or mold specialists on the design team. Geotechnical engineers are not building-envelope or mold specialists.