AMERICAN ENGINEERING TESTING, Inc.

REPORT OF GEOTECHNCIAL EXPLORATION AND REVIEW

PROPOSED WEST SIDE TREATED WATER PIPELINE
MNI WASTE' WATER PROJECT
EAGLE BUTTE, SOUTH DAKOTA

CONSULTANTS
- GEOTECHNICAL
- MATERIALS
- ENVIRONMENTAL
- FORENSICS

AET No. 17-02769

Date:
November 29, 2016

Prepared for:

Banner Associates, Inc.
2201 Jackson Boulevard, Suite 200
Rapid City, South Dakota 57702

www.amengtest.com

November 29, 2013

Banner Associates
2201 Jackson Boulevard, Suite 200
Rapid City, South Dakota 57702

Attn: Mr. Monte Albert
montea@bannerassociates.com

RE: Geotechnical Study
Proposed West Side Treated Water Pipeline
Mni Waste' Water Project
Eagle Butte, South Dakota
AET Project No. 17-02769

Dear Monte:

American Engineering Testing, Inc. (AET) is pleased to present the results of our subsurface exploration program and geotechnical engineering review for the proposed west side treated water pipeline in Eagle Butte, South Dakota. These services were performed according to our proposal to you dated October 21, 2016. We are submitting one electronic copy of the report to you.

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 expressed or implied, is intended. Important information regarding risk management and proper use of this report is given in the Appendix entitled "Geotechnical Report Limitations and Guidelines for Use".

Please contact me if you have any questions about the report. I can also be contacted for arranging construction observation and testing services during the earthwork phase.

Sincerely,
American Engineering Testing, Inc.

Kristen R. Yates, PE
Geotechnical Project Engineer
Phone: (605) 388-0029
Fax: (605) 388-0064
kyates@amengtest.com
KY/ksp

SIGNATURE PAGE

Prepared for:

Banner Associates, Inc.
2201 Jackson Boulevard, Suite 200
Rapid City, South Dakota 57702

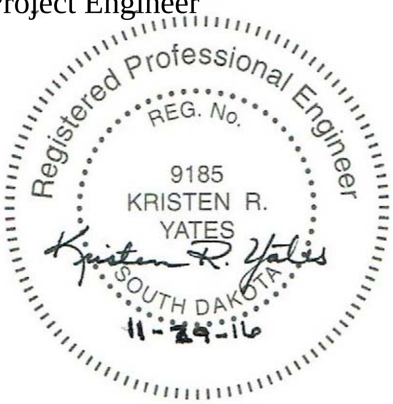
Attn: Mr. Monte Albert

Prepared by:

American Engineering Testing, Inc.
1745 Samco Road
Rapid City, South Dakota 57702
(605) 388-0029

Report Authored By:

Kristen R. Yates, P.E.
Geotechnical Project Engineer



Peer Review Conducted By:

Robert Temme, P.E.
VP Western Region

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1.0 INTRODUCTION

We understand the Mni Waste Water Company plans to construct a section of new water pipeline from the north side, west to Highway 63, and back to the south side of Eagle Butte, South Dakota. Please refer to the Site Location Map in Appendix A for the proposed water pipeline alignment. To assist in planning and design, you have authorized American Engineering Testing, Inc. (AET) to conduct a geotechnical study, including standard penetration test borings at the site, soil laboratory testing, and 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 you dated October 21, 2016. The authorized scope consists of the following:

- Five (5) Standard Penetration Test (SPT) borings to depths of approximately 15 feet below grade.
- Soil laboratory testing.
- Geotechnical engineering analysis based on the gained data and preparation of this report.

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

3.0 PROJECT INFORMATION

As you are aware, AET has provided the geotechnical studies for the raw water transmission line (#18-03565, December 2012); the water treatment plant, the treated water pipeline from treatment plant to Eagle Butte (#17-01817, November 2013); and the elevated water storage tank (#17-02437, January 2016). We understand this section of the project continues with the construction of approximately 5 miles of treated water pipeline around the west side of Eagle Butte.

The alignment of the water line will be from Tower Hill Road west for approximately 2 miles, south for approximately 1 mile across Highway 212 and continuing along Highway 63, and then back to the east along Airport Road for approximately 1.5 miles to the south side of the town of Eagle Butte. We have estimated that the water line will be placed up to 12 feet below grade. We understand the water line will also be bored and jacked below Highway 212.

The previously stated information 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

The subsurface exploration program conducted for this portion of the project consisted of five (5) SPT borings drilled at approximately 1 mile spacings along the alignment of the proposed water pipeline. The borings were drilled on November 1, 2016 to depths of approximately 15 feet below grade. The logs of the borings and details of the methods used appear in Appendix A. The logs contain information concerning soil layering, 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 borings were located in the field by AET personnel at the approximate locations indicated on the Boring Location Map in Appendix A. The ground surface elevations at the bore holes had not yet been surveyed at the time of this report.

4.2 Laboratory Testing

The laboratory test program included natural moisture content, dry density, Atterberg Limits, un confined compression, resistivity, chemistry (pH, Sulfates, Chlorides), moisture-density relationship (modified Proctor), and California tests. The test results are included on the attached boring logs opposite the samples upon which the tests were performed with the exception of the unconfined compression, moisture-density relationship, and CBR test results which are included on separate sheets within Appendix A. The results of the resistivity and chemistry can be found in Sections 6.2 and 6.3.

It should be noted the bulk soil sample represents a mixture of the soils encountered within the top 5 feet of the borehole. As such, the soil classification as presented on the Moisture-Density Relationship data sheet may differ from the classifications of the individual soil layers identified on the respective Subsurface Boring Log.

5.0 SITE CONDITIONS

5.1 Surface Observations

The proposed water line alignment is located west of Tower Hill Road, cross-country north of Highway 212, east of Highway 63, and north of Airport Road. This alignment is primarily within road ditches where it does not travel cross-country. As shown, the alignment will cross County Road 20, Highway 212, and Airport Road. The alignment also crosses several small creeks and unnamed drainage pathways north of Highway 212.

5.2 Subsurface Soils/Geology

In general, the boring logs indicated approximately 6-inches of silty lean clay topsoil over 4 to 13 feet of either fill or alluvium over top of weathered glauconitic sandstone of the Fox Hills Sandstone formation to the final depths drilled in each of the borings to approximately 16.5 feet below grade.

Fill was encountered in Borings B-1 and B-4 below the topsoil to approximately 7 and 4.5 feet below grade, respectively. The fill primarily consisted of light brown to brown silty lean clay with a little sand and gravel in B-1 and shale fragments in B-3. Alluvium was encountered in Borings B-3, B-4, and B-5. The alluvium consisted of light brown to dark brown silty to sandy lean clay.

The weathered glauconitic sandstone of the Fox Hills Sandstone formation consisted of medium dense to very dense brown to gray clayey sand with shale lenses. The weathered glauconitic sandstone was encountered in all five of the borings at various depths below grade, ranging from 0.5 to 13.5 feet below grade, and continued to the final depths sampled.

5.3 Ground Water

At the time of drilling, groundwater was not in any of the five (5) borings. The lack of subsurface water should not be taken as actual subsurface conditions. A long period of time is generally required for groundwater to stabilize in the impermeable soils generally present at this site; this period of time is generally not available during a typical subsurface exploration program.

6.0 RECOMMENDATIONS

6.1 Discussion

The following recommendations are based on the soil conditions observed in the soil borings at the time of our exploration. The soils between the boring locations may differ significantly from those encountered at the boring locations. Further, changes in climatic conditions between the time of exploration and the time of construction may also affect soil conditions, particularly ground water levels and the moisture content of the soils.

6.2 Resistivity Results

Soil electrical resistivity tests were run at each boring location in the laboratory using the Miller soil box method with the following results:

Test #	Depth	Resistivity (ohm-cm)	Corrosion Potential
B-1	10’	509	Severe
B-3	5’	1660	Severe
B-5	5’	1100	Severe

Based on the above data, the site soils should be considered to have a severe potential towards corrosion of iron and other buried metals based on a scale published in the Technical Manual TM 5-811-7. “Electrical Design, Cathodic Protection" by the Department of the Army. If corrosion of buried metal is critical, it should be protected using a non-corrosive backfill, wrapping, coating, sacrificial anodes, or a combination of these methods, as designed by a qualified corrosion engineer.

6.3 Chemistry Results

A soil samples from each of the borings along the water line alignment were submitted to Midcontinent Testing Laboratories for chemical analysis of pH, sulfate, and chloride with the following results:

Boring No.	Depth	pH	Sulfate (SO_4)	Chloride (Cl-)
B-1	10’	8.10	1660	54.3
B-3	5’	8.4	626	3.86
B-5	5’	8.07	148	10.9

The full laboratory analytical report is attached in Appendix A.

6.4 Water Line Construction

The excavation contractor should anticipate that the water line alignment will mostly consist of unconsolidated sandstone and layers of lean clays with variable amounts of sand/gravel. Conventional construction equipment, such as tracked excavators, should be able to make most of the required trench excavations along the proposed alignment. We recommend that all topsoil and organic matter be removed along the alignment of the new water line. The topsoil may be stockpiled for later use over the alignment of the completed line.

While groundwater was not encountered in any of our test borings, encountering localized areas of groundwater should be anticipated along the alignment of the new treated water line. We anticipate such groundwater will be "perched" water and that it can be removed from within the trench excavations using conventional dewatering methods.

Based on the range of current moisture contents determined in our laboratory, the excavated soils for the new utility lines will likely require moisture conditioning to bring the trench spoils close to the optimum moisture content before their reuse as trench backfill. We recommend the moisture content of the compacted trench backfill be within ±3% of the optimum moisture content. We also recommend the trench backfill be compacted to at least 95% of maximum standard Proctor (ASTM D 698) dry density. Additionally, we recommend the top 1-foot of the backfill zone be compacted to at least 98% of the maximum standard Proctor dry density to reduce the potential of future settlement related issues, especially at roadway crossings.

6.5 Trench Excavation

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 side slope erosion or running which could require slope maintenance.

For trench excavations, it is our opinion the clay fill and alluvium can be classified as Type B soils with recommended slope laybacks of 1H:1V. The weathered to unweathered glauconitic sandstone should be classified as Type C soils with recommended slope laybacks of 1½H:1V.

These classifications should be considered preliminary and should be verified in the field on a daily basis by the contractor and/or geotechnical engineer.

Excavations deeper than 20 feet and/or in saturated soils or below the ground water table should be considered on an individual basis. Water levels, due to climatic conditions should be evaluated at the time of construction. If the above trench layback recommendations are not feasible, due to space limitations or other factors, the OSHA rules should be consulted for alternative trench stabilization methods. Trench boxes or shoring in compliance with OSHA rules may be acceptable alternatives.

6.6 Backfill Considerations

It is our opinion that the on-site soils and sandstone may be used as engineered backfill following moisture conditioning. Reconditioning of the soils and weathered shale should be anticipated to obtain moisture contents suitable to achieve the recommended compaction levels.

All recommendations are based on the standard Proctor method (ASTM: D 698). We recommend all backfill be moisture conditioned to within ±3% of optimum moisture content prior to being placed. It is our opinion trench backfill should be placed as follows.

1. All backfill should be free of organics, deleterious/frozen material, and manmade or construction debris and have a maximum nominal size of 3-inches.
2. Cohesionless soils (sands and gravel) should be moisture conditioned to within ±3% of optimum. Clay soils and shale should be moisture conditioned to within -1% to +3% of optimum moisture.
3. All backfill should be placed in loose lift thicknesses of 8-inches or less. If hand-operated compaction equipment is used, the loose lift thickness should be reduced to 4-inches or less.
4. Each lift should be compacted to at least 95% of maximum proctor density. Within areas near future possible structures, roadways, and/or pavements, the top 1-foot lift of backfill should be compacted to at least 98% of maximum proctor density.
5. Compaction density tests should be performed on alternating lifts to ensure the minimum density is maintained.

Should additional fill be required, the proposed import backfill should be submitted to the geotechnical engineer for approval prior to use. The import fill should be free of organics, deleterious material and rock greater than 4 inches.

6.7 Highway 212 Bore

We anticipate the bore pits for the water pipeline will be approximately 10 to 12 feet deep on either side of Highway 212. Based on the boring information, this will place the bottom of the bore pits within the very dense weathered glauconitic sandstone. While groundwater was not encountered in either boring, temporary dewatering within the jacking pit should be anticipated. Depending on the final depth of the jacking pit excavation, placement of a layer of coarse rock may be required to provide a firm and stable base for the boring equipment.

The N values encountered in Boring B-3 indicate very dense weathered glauconitic sandstone at approximately 10 to 12 feet below grade. We anticipate these soils will be the material through which the casing will be bored/jacked below the highways. Boring equipment of sufficient size should be utilized on this project to complete the required bore through these conditions.

If excavation layback slopes in accordance with OSHA Regulations are not possible at the proposed jacking/bore pit locations the use of stacked trench boxes will be required during excavation to provide shoring and personnel safety. We recommend that appropriate connections be made between stacked trench boxes as specified by the manufacturer. Additionally, as a safety measure, it is recommended that all vehicles and soil piles be kept a minimum lateral distance from the crest of the slope equal to no less than the excavation height. The exposed slope/excavation faces should be protected against the elements.

7.0 PAVEMENT DESIGN CONSIDERATIONS

The following pavement sections are designed based on the City of Rapid City Infrastructure Design Criteria, 2012 edition, the City of Rapid City Standard Specifications for Public Works Construction, 2007 edition, and the procedures outlined in the 1993 AASHTO Empirical Equation for Flexible Pavements and Rigid Pavements.

Based on the laboratory test results, a California Bearing Ratio (CBR) value of 3.0 was used in the pavement design analysis utilizing the site clay soils as the subgrade material. We have used a correlation of 1500 x CBR value to estimate the resilient modulus (M_R).

7.1 Traffic Estimates and E-18 Calculations

AET was asked to provide pavement design recommendations; however, no traffic counts were provided at this time of this report. We have assumed a design life of 20 years for the pavement section for a range of equivalent single axle loads (ESALs) for the purpose of our analysis. Please notify us if any of the parameters used in the pavement design do not adequately define the anticipated conditions.

Street Section	Asphalt, in	Concrete, in	Aggregate Base Course, in	Total, in
65,000 ESALs	4	--	6	10
	--	5	5	10
100,000 ESALs	5	--	6	11
	--	5.5	5	10.5
150,000 ESALs	5	--	7	12
	--	6	5	11

7.2 Asphalt Pavement Sections

We recommend the asphalt be obtained from an approved mix design conforming to the South Dakota Department of Transportation (SDDOT) Class E Specifications as defined in Section 321 “Asphalt Concrete” of the Standard Specifications for Road and Bridges, 2015 edition.

Aggregate used in the asphalt and concrete should meet SDDOT specifications under Section 880 “Aggregates for Asphalt Concrete” for quality and gradation. Mix designs should be submitted prior to construction to verify their adequacy. Asphalt material should be placed in maximum 3-inch lifts and should be compacted to the minimum standards outlined in the SDDOT Specifications.

Note that acceptable performance of an asphalt pavement section will be strongly influenced by proper maintenance, periodic maintenance, adequate drainage, and traffic that is consistent with the design traffic discussed in our geotechnical report.

7.3 Concrete Pavement Sections

Where rigid (concrete) pavements are used, the concrete should be obtained from an approved mix design conforming to Section 380 "Portland Cement Concrete Pavement" and Section 460 "Structural Concrete" of the SDDOT Specifications. Longitudinal and transverse joints should be provided as needed in concrete pavements for expansion/contraction and isolation. The location and extent of joints should be based upon the final pavement geometry. Sawed joints should be cut within 24-hours of concrete placement. All joints should be sealed to prevent entry of foreign material and dowelled where necessary for load transfer.

7.4 Aggregate Base Course

Aggregate base course should meet the requirements as outlined in Section 882 "Aggregates for Granular Bases and Surfacing" of the SDDOT specifications. Aggregate base course should be moisture conditioned to within ±3% of optimum prior to use and compacted to a minimum of 98% of the maximum dry density, as determined by ASTM D698 (standard Proctor).

7.5 Subgrade Preparation

The exposed subgrade should be scarified to a depth of 8-inches below design grade, moisture conditioned to within ±2% of optimum moisture content and be compacted to at least 95% of maximum density as determined by the standard Proctor method (ASTM D 698).

We recommend the pavement subgrade areas be thoroughly proofrolled with a loaded water truck or tandem axle dump truck after final grading and recompaction are complete, and prior to paving. Particular attention should be paid to high traffic areas that were rutted and disturbed by construction traffic and to areas where backfilled trenches (if applicable) are located.

If disturbance has occurred or unstable subgrade soils are observed, pavement subgrade areas should be reworked, moisture conditioned, or removed and replaced with properly compacted engineered fill to the recommendations provided herein. All pavement subgrade areas should be moisture conditioned and properly compacted to the recommendations in this report immediately prior to paving.

The proof rolling should be observed by our geotechnical engineer to identify areas of soft subgrade. Once the subgrade has been proof rolled and approved by the geotechnical engineer, the asphalt pavement/gravel surfacing may be placed.

7.6 Pavement Maintenance

Pavements should be sloped to provide rapid drainage of surface water. Water allowed to pond on or adjacent to the pavements could saturate the subgrade and contribute to premature pavement deterioration. In addition, the pavement subgrade should be graded to provide positive drainage within the granular base section.

The pavement sections provided in this report represent minimum recommended thicknesses and, as such, periodic maintenance should be anticipated. Therefore, preventive maintenance should be planned and provided for through an on-going pavement management program.

Preventive maintenance activities are intended to slow the rate of pavement deterioration. Pavement maintenance consists of both localized maintenance (crack and joint sealing and patching) and global maintenance (surface sealing). Preventive maintenance is usually the first priority when implementing a planned pavement maintenance program and provides the highest return on investment for pavements. Prior to implementing any maintenance program, additional engineering input is recommended to determine the type and extent of preventive maintenance appropriate. Even with periodic maintenance, some movements and related cracking may still occur and repairs may be required.

8.0 CONSTRUCTION CONSIDERATIONS

8.1 Potential Difficulties

Depending on the time of year in which construction takes place, soft wet subgrade soils could be along the proposed alignments. If encountered, additional conditioning of the soils may be required to obtain moisture contents which allow for firm and unyielding subgrade and/or compaction. Typically, scarification and drying of the subgrade soils can be accomplished over a relatively short period of time provided the work is completed during warm/hot and dry weather. Localized areas of soft wet subgrades can be remedied with additional excavation to expose firmer soils, placement of coarse rock to provide a solid base on which to place additional fill and/or the use of geotextiles between the soft soils and the overlying fill and/or pavement sections. The appropriate means of subgrade stabilization should be evaluated by the geotechnical engineer at the time of construction.

8.2 Runoff Water in Excavation

Water can be expected to collect in the excavation bottom during times of inclement weather or snow melt. To allow observation of the excavation bottom, to reduce the potential for soil disturbance, and to facilitate filling operations, we recommend water be removed from within the excavation during construction. Based on the soils encountered, we anticipate the ground water can be handled with conventional sump pumping.

8.3 Disturbance of Soils

The on-site soils can become disturbed under construction traffic, especially if the soils are wet. If soils become disturbed, they should be subcut to the underlying undisturbed soils. The subcut soils can then be dried and recompacted back into place, or they should be removed and replaced with drier imported fill.

8.4 Excavation Backsloping

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 side slope erosion or running which could require slope maintenance.

8.5 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 satisfied.

9.0 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 expressed 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".

Standard Data Sheets

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 12% 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

AET Project No. 17-02769

A.1 FIELD EXPLORATION

The subsurface conditions at the site were explored by drilling and sampling standard penetration test borings. 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. 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.

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.

Visual-manual judgment of the AASHTO Soil Group is also noted as a part of the soil description. A chart presenting details of the AASHTO Soil Classification System is also attached.

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.

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)

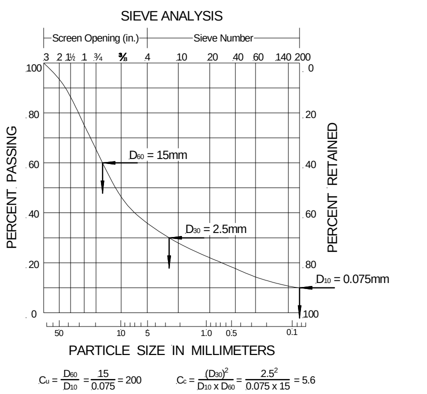
The standard penetration test consists of driving a split-spoon sampler with a drop hammer (calibrated weight varies to provide N_{60} values) and counting the number of blows applied in each of three 6" increments of penetration. If the sampler is driven less than 18" (usually in highly resistant material), 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.

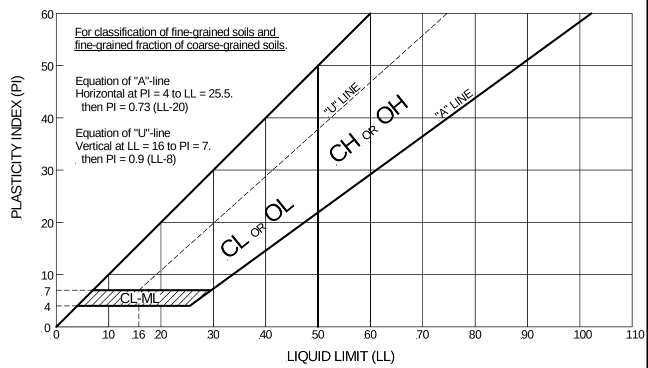
The length of sample recovered, as shown on the “REC” column, may be greater than the distance indicated in the N column. The disparity is because the N-value is recorded below the initial 6" set (unless partial penetration defined in ASTM: D1586 is encountered) whereas the length of sample recovered 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	Soil Classification: 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 $1 > Cc > 3$[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	**Liquid limit–oven dried** **<0.75** Liquid limit – not dried	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	**Liquid limit–oven dried** **<0.75** Liquid limit – not dried	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]$Cu = D_{60} / D_{10}$, $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

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

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

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

[Q]Pl 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):	Absense 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.

Fiber Content of Peat

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

Organic/Roots Description (if no lab tests)

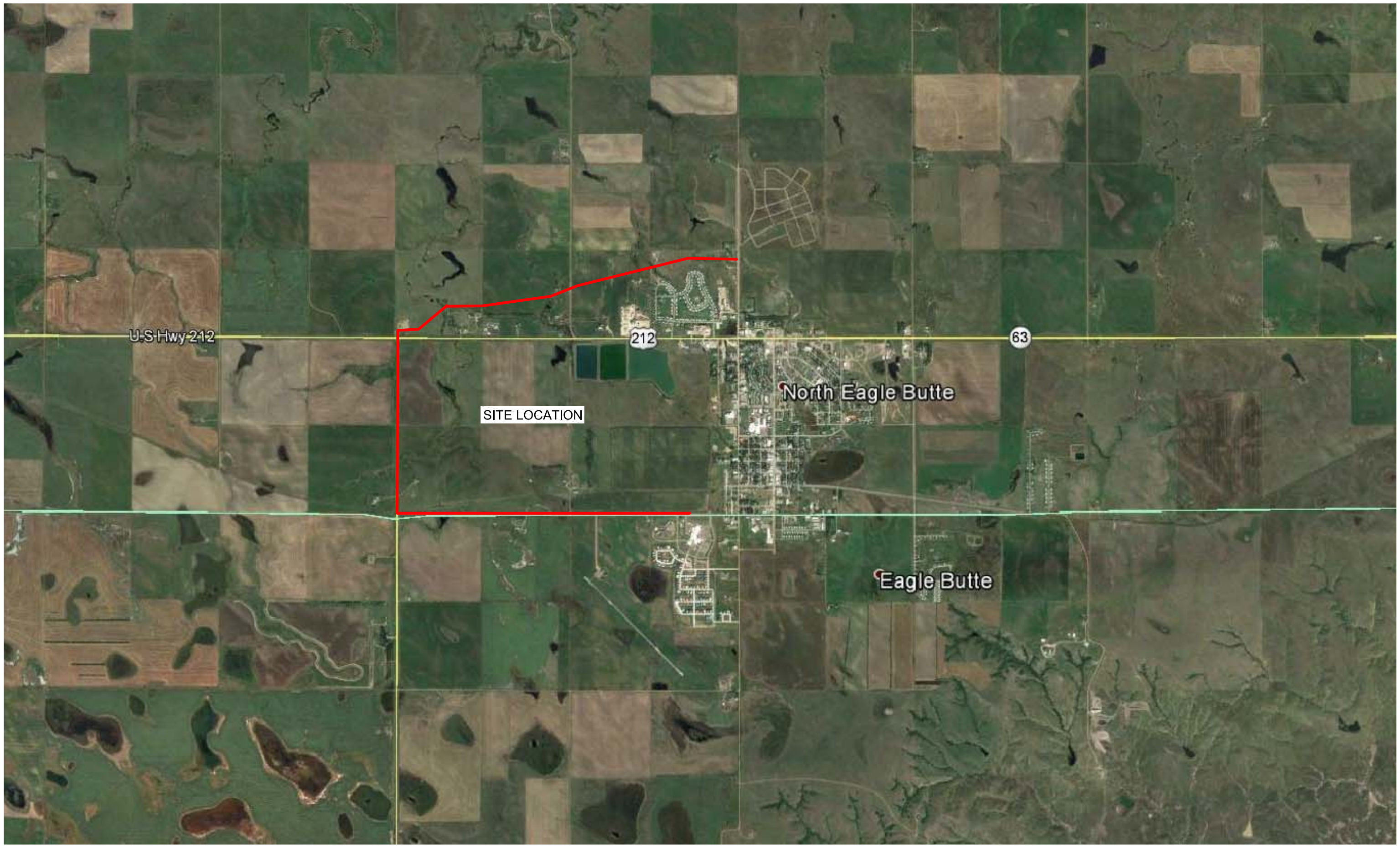
Soils are described as *organic*, if soil is not peat and is judged to have sufficient organic fines content to influence the soil properties. *Slightly organic* used for borderline cases.

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 core segments 4O or greater in length.*



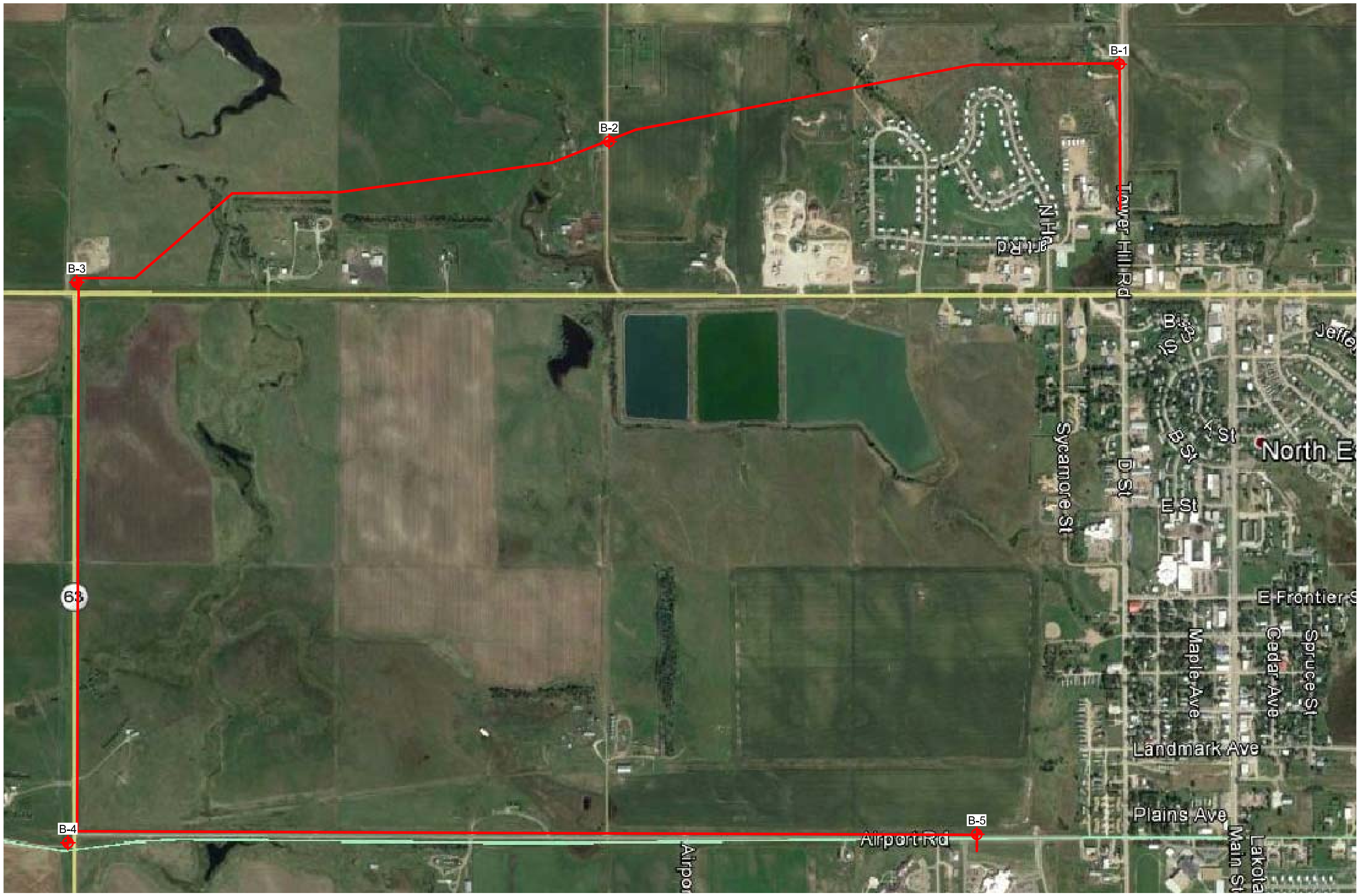
N

SCALE
(MILES)

0 1

AMERICAN ENGINEERING TESTING, INC.

PROJECT: PROPOSED WEST SIDE TREATED WATER LINE EAGLE BUTTE, SOUTH DAKOTA		PROJECT NO. 17–02769
SUBJECT: SITE LOCATION MAP		DATE: NOVEMBER 10, 2016
SCALE: 1 INCH = 1 MILE	DRAWN BY: JR	REVIEWED BY: RT



SCALE (FEET)

0 1600

AMERICAN ENGINEERING TESTING, INC.

PROJECT: PROPOSED WEST SIDE TREATED WATER LINE EAGLE BUTTE, SOUTH DAKOTA	PROJECT NO. 17-02769
SUBJECT: BORING LOCATION MAP	DATE: NOVEMBER 0, 2016
SCALE: 1 INCH = 1600 FEET — DRAWN BY: JR	REVIEWED BY: RT

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-02769** LOG OF BORING NO. **B-1 (p. 1 of 1)**

PROJECT: **Proposed West Side Treated Water Line; Eagle Butte, South Dakota**

SURFACE ELEVATION: **NA**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	WC	DEN	LL	PL	%-#200
0–0.4	**TOPSOIL**, Silty Lean Clay with organics, brown	TOPSOIL									
0.4–7	**FILL**, Silty Lean Clay with a little sand, gravel and trace organics, light brown	FILL									
3			67	M	MC	18	15	94			
5.5			21	M	MC	18					
7–16.5	**WEATHERED GLAUCONITIC SANDSTONE**, Clayey Sand with shale lenses and laminations and iron oxide staining, brown-gray, medium dense (SC)	FOX HILLS SANDSTONE									
8			16	M	MC	18	24	101			
10.5			29	M	MC	18					
13			37	M	MC	18	26	94			
15.5			38	M	MC	18					
	Bottom of Boring										

DEPTH:	DRILLING METHOD
15.0	4" FA

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
11/1/16	14:15	16.5	NA	16.5	NA	None

BORING COMPLETED: **11/1/16**

DR: **ES** LG: **JR** Rig: **RC-1**

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

AET_CORP 17-02769.GPJ AET+CPT+WELL.GDT 11/18/16

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET No: **17-02769** Log of Boring No. **B-2 (p. 1 of 1)**

Project: **Proposed West Side Treated Water Line; Eagle Butte, South Dakota**

Surface Elevation: **NA**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	WC	DEN	LL	PL	%-#200
0–0.8	**TOPSOIL**, Silty Lean Clay with organics, brown	TOPSOIL									
0.8–14.5	**WEATHERED GLAUCONITIC SANDSTONE**, Clayey Sand with shale lenses and laminations and iron oxide staining, brown-gray, very dense to medium dense to dense(SC)	FOX HILLS SANDSTONE									
3			59	M	MC	18					
5.5			97	M	MC	18	23	104	48	24	
8			61	M	MC	18	26	89			
10.5			61	M	MC	18	23	92			
13			55	M	MC	18					
14.5–16.4	**GLAUCONITIC SANDSTONE**, Clayey Sand with shale lenses and laminations and iron oxide staining, brown-gray, very dense (SC)										
15.5			98/.9	M	MC	17					
	Bottom of Boring										

DEPTH:	DRILLING METHOD
15.0	4" FA

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
11/1/16	15:00	16.4	NA	16.4	NA	None

BORING COMPLETED: **11/1/16**

DR: **ES** LG: **JR** Rig: **RC-1**

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

AET_CORP 17-02769.GPJ AET+CPT+WELL.GDT 11/30/16

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-02769** LOG OF BORING NO. **B-3 (p. 1 of 1)**

PROJECT: **Proposed West Side Treated Water Line; Eagle Butte, South Dakota**

SURFACE ELEVATION: **NA**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	WC	DEN	LL	PL	%-#200
0–0.5	**TOPSOIL**, Silty Lean Clay with organics, brown	TOPSOIL									
0.5–4.5	**SANDY LEAN CLAY** with trace organics, light brown, very stiff (CL)	ALLUVIUM									
3			22	M	MC	18	9	95			
4.5–16.5	**WEATHERED GLAUCONITIC SANDSTONE**, Clayey Sand with shale lenses and laminations and iron oxide staining, brown-gray, medium dense to very dense (SC)	FOX HILLS SANDSTONE									
5.5			27	M	MC	18					
8			49	M	MC	18					
10.5			55	M	MC	18					
13			61	M	MC	18	26	100			
15.5			76	M	MC	18					
	Bottom of Boring										

DEPTH:	DRILLING METHOD
15.0	4" FA

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
11/1/16	11:20	16.5	NA	16.5	NA	None

BORING COMPLETED: **11/1/16**

DR: **ES** LG: **JR** Rig: **RC-1**

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

AET_CORP 17-02769.GPJ AET+CPT+WELL.GDT 11/18/16

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-02769** LOG OF BORING NO. **B-4 (p. 1 of 1)**

PROJECT: **Proposed West Side Treated Water Line; Eagle Butte, South Dakota**

SURFACE ELEVATION: **NA**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	WC	DEN	LL	PL	%-#200
0–0.5	**TOPSOIL**, Silty Lean Clay with organics, brown	TOPSOIL									
0.5–4.5	**FILL**, Silty Lean Clay with shale fragments and organics, brown	FILL									
3			37	M	MC	18					
4.5–13.5	**SILTY LEAN CLAY** with trace organics, dark brown, hard to stiff to hard (CL)	ALLUVIUM									
5.5			39	M	MC	18	11				
8			14	M	MC	18					
10.5			25	M	MC	18	19	103			
13	with a little gravel		36	M	MC	18					
13.5–16.5	**WEATHERED GLAUCONITIC SANDSTONE**, Clayey Sand with shale lenses and laminations and iron oxide staining, brown-gray, medium dense (SC)	FOX HILLS SANDSTONE									
16			16	M	MC	18					
	Bottom of Boring										

DEPTH:	DRILLING METHOD	DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
15.0	**4" FA**	**11/1/16**	**12:15**	**16.5**	**NA**	**16.5**	**NA**	**None**

BORING COMPLETED: **11/1/16**

DR: **ES** LG: **JR** Rig: **RC-1**

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

AET_CORP 17-02769.GPJ AET+CPT+WELL.GDT 11/18/16

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-02769**

LOG OF BORING NO. **B-5 (p. 1 of 1)**

PROJECT: **Proposed West Side Treated Water Line; Eagle Butte, South Dakota**

SURFACE ELEVATION: **NA**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	WC	DEN	LL	PL	%-#200
0–0.5	**TOPSOIL**, Silty Lean Clay with organics, brown	TOPSOIL									
0.5–6	**SANDY LEAN CLAY** with trace organics, brown, stiff (CL)	ALLUVIUM									
3			17	M	MC	18	20	106	38	18	
5.5			19	M	MC	18					
6–16.5	**WEATHERED GLAUCONITIC SANDSTONE**, Clayey Sand with shale lenses and laminations and iron oxide staining, brown-gray, dense to very dense (SC)	FOX HILLS SANDSTONE									
8			40	M	MC	18	26	98			
10.5			60	M	MC	18					
13			65	M	MC	18	24	102			
15.5			88	M	MC	18					
	Bottom of Boring										

DEPTH:	DRILLING METHOD	DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
15.0	4" FA	11/1/16	13:15	16.5	NA	16.5	NA	None

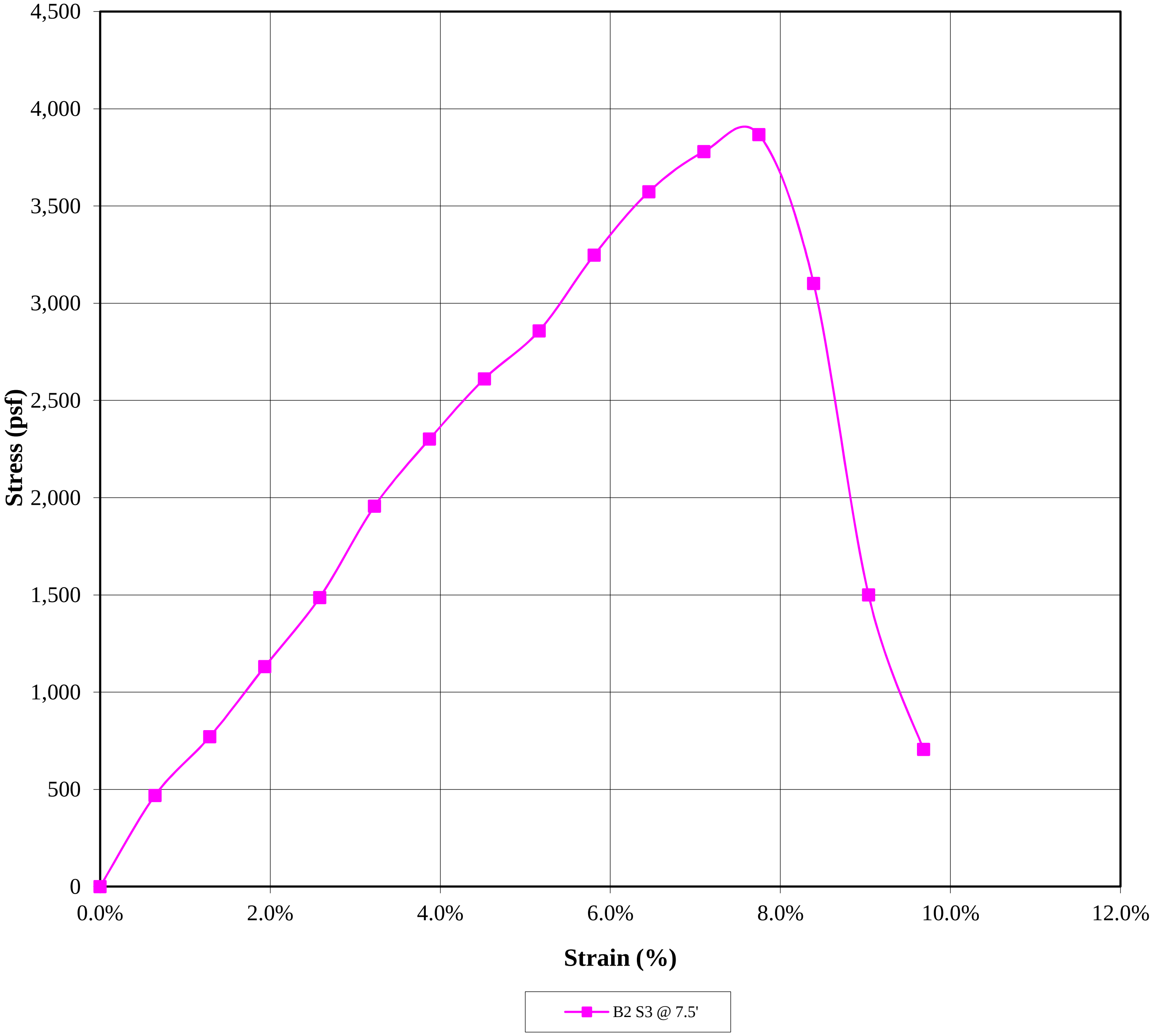
The column headings DATE through WATER LEVEL fall under the printed heading WATER LEVEL MEASUREMENTS.

BORING COMPLETED: **11/1/16**

DR: **ES** LG: **JR** Rig: **RC-1**

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

Stress vs. Strain

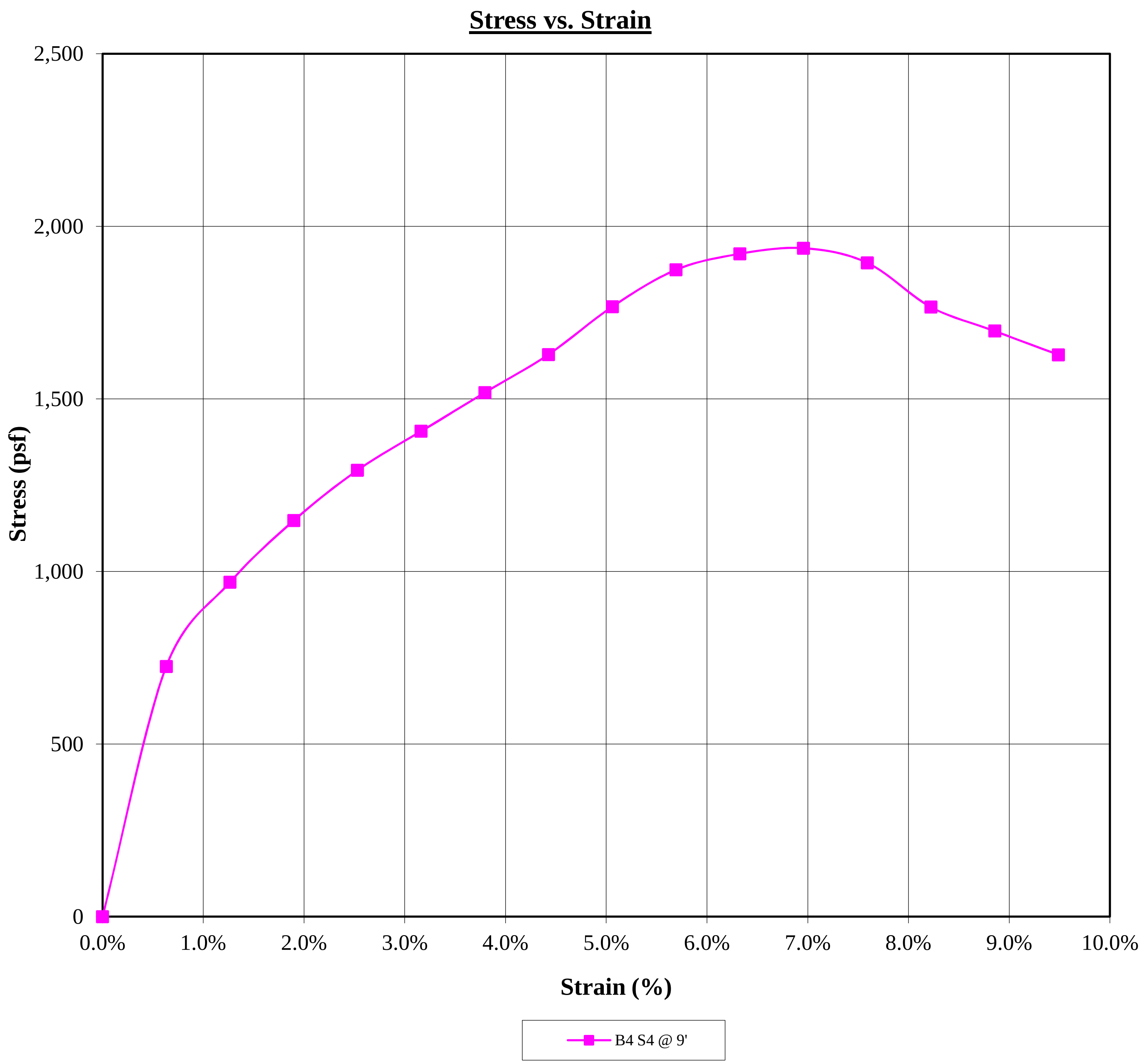


Test Results						
Boring	**Sample**	**Depth**	**Stress at Failure**	**Strain at Failure**	**Dry Density**	**% Moisture**
2	3	7.5'	3880.0 psf	7.7%	88.9 pcf	26.4%

Project Information			
Project:	Proposed West Side Treated Water Line	**Job Number:**	17-02769
Location:	Eagle Butte, South Dakota	**Date:**	11/10/2016

AMERICAN ENGINEERING TESTING, INC.

UNCONFINED COMPRESSION TEST RESULTS



Test Results

Boring	Sample	Depth	Stress at Failure	Strain at Failure	Dry Density	% Moisture
4	4	10	1,936 psf	6.9%	103.3 pcf	19.4%

Project Information

Project:	Proposed West Side Treated Water Line	**Job Number:**	17-02769
Location:	Eagle Butte, South Dakota	**Date:**	11/10/2016

AMERICAN ENGINEERING TESTING, INC.

UNCONFINED COMPRESSION TEST RESULTS

Job No. **17-02769** Date

Project **Proposed West Side Treated Water Line**
Eagle Butte, South Dakota

Source of Material **Bulk B-5 0 - 5.0'**

Description of Material **Sandy Lean Clay, brown (CL)**

Test Method **1557A**

TEST RESULTS

Maximum Dry Density **116.3 PCF**

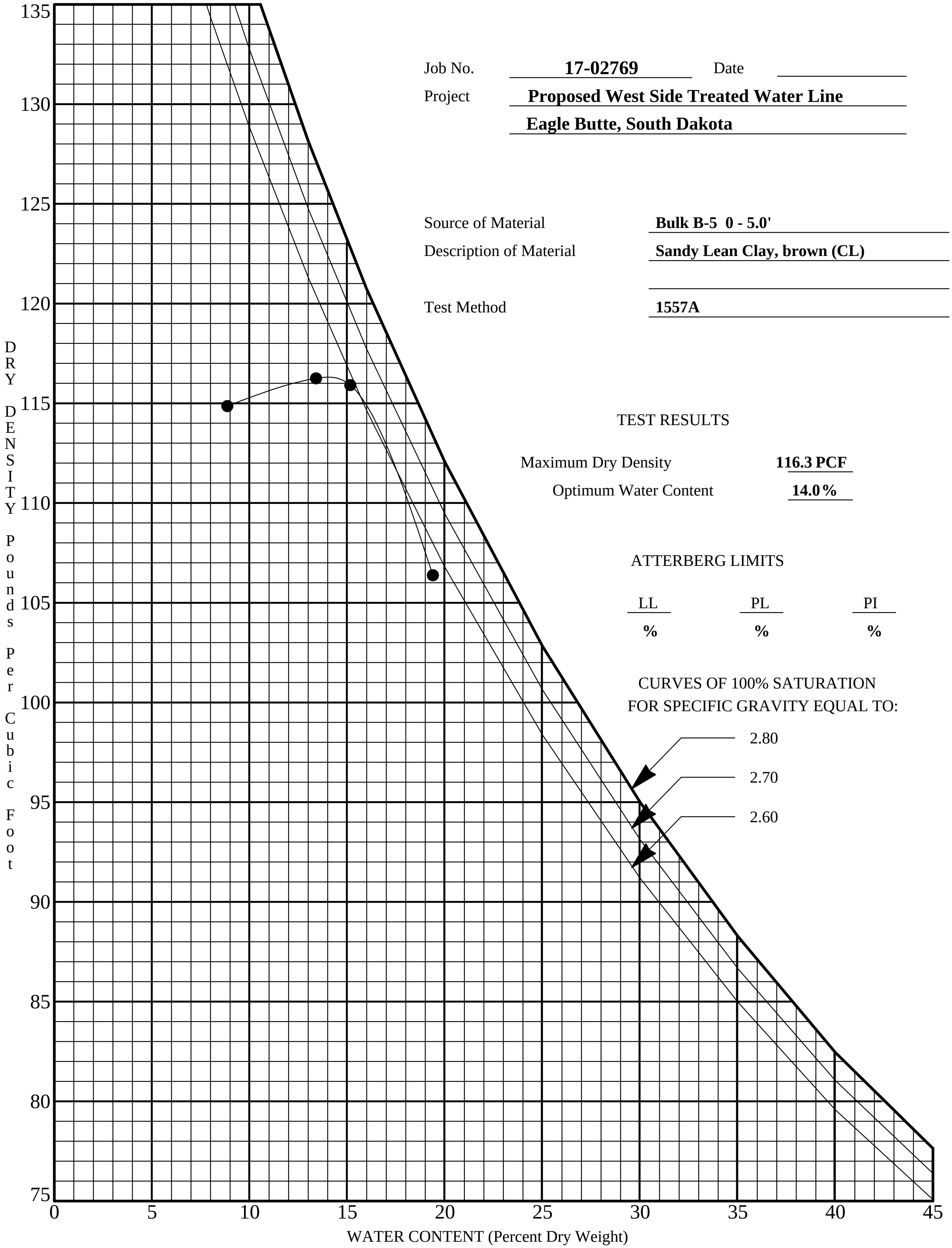
Optimum Water Content **14.0 %**

ATTERBERG LIMITS

LL	PL	PI
%	%	%

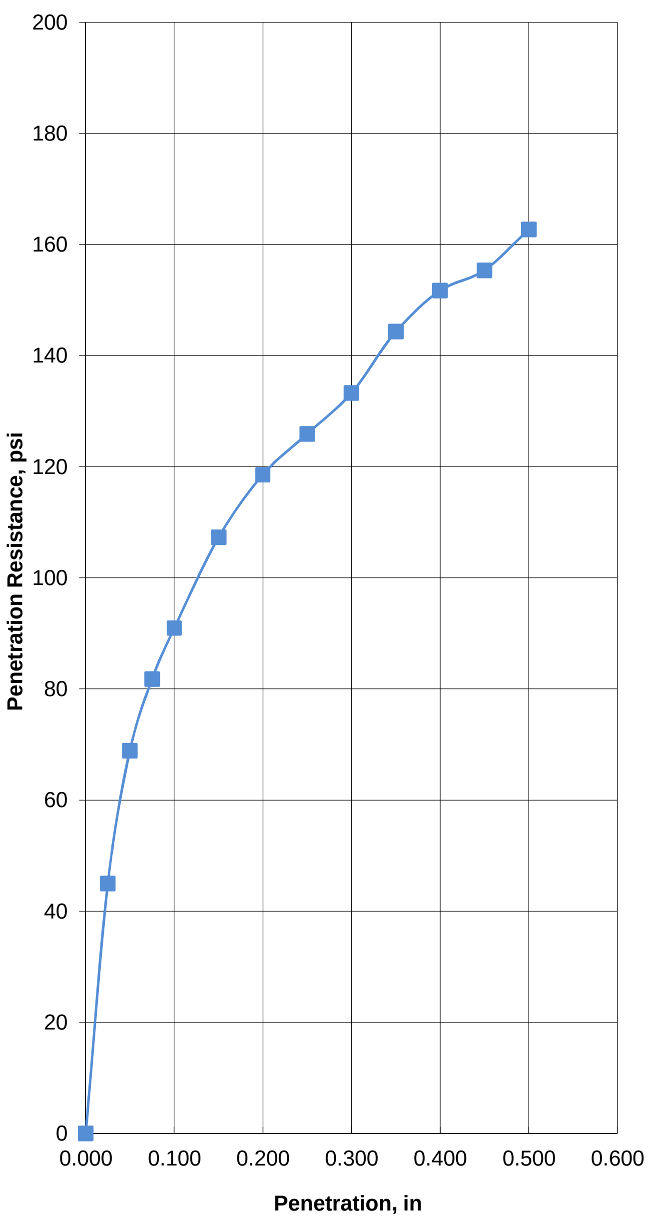
CURVES OF 100% SATURATION
FOR SPECIFIC GRAVITY EQUAL TO:

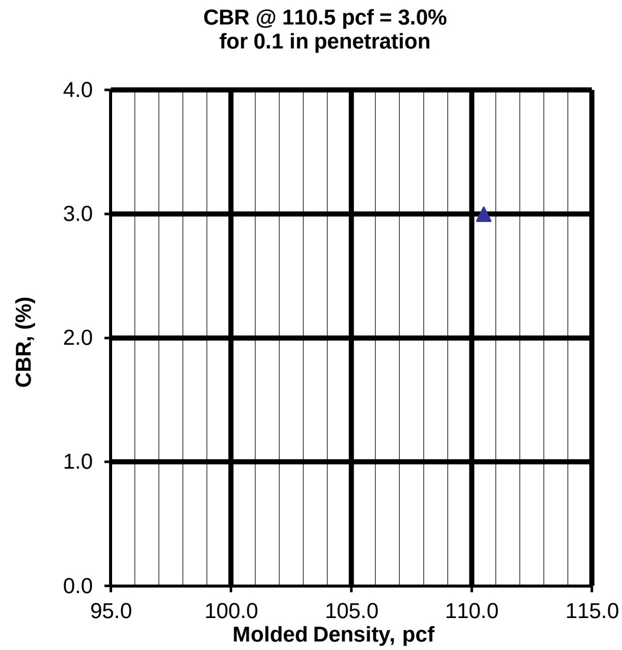
2.80
2.70
2.60

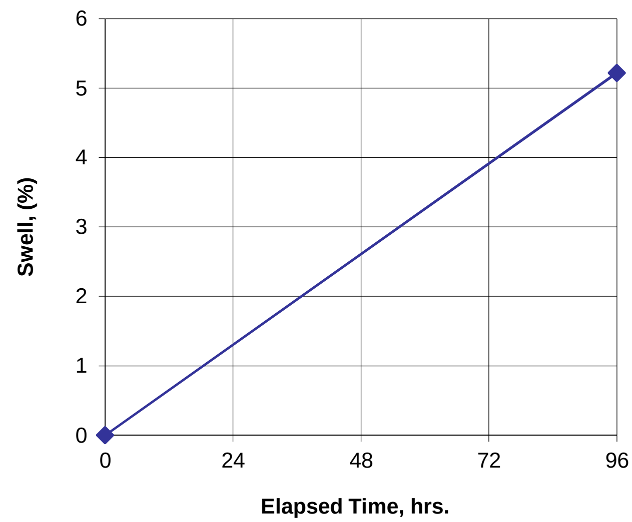


AMERICAN ENGINEERING TESTING, INC.

MOISTURE-DENSITY RELATIONSHIP







Molded			Soaked			CBR, (%)		Pen.	Swell
Dens.	% Max.	% Moisture	Dens.	% Max.	% Moisture	0.1 in	0.2 in	Surcharge	%
110.5	95.0	14.0	105.2	90.4	23.2	3.0	2.6	10lb	5.2
MATERIAL DESCRIPTION					USCS	Max. Dens.	Opt. Mois.	LL	PI
Sandy Lean Clay, brown					CL	116.3	14.0		

Project No: 17-02769 Bulk B-5 0-5'

Project: Proposed West Side Treated Water Line
Eagle Butte, South Dakota

Date: 11/14/2016

Test Descr. / Remarks

CBR: ASTM D 1883

Proctor: ASTM D1557 A

AMERICAN ENGINEERING TESTING, INC.

BEARING RATIO TEST REPORT

Appendix B

Geotechnical Report Limitations and Guidelines for Use

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.

RISK MANAGEMENT INFORMATION

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. No one, not even you, should apply the report for any purpose or project except the one originally contemplated.

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.

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.

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.

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

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.

A Report's Recommendations Are Not Final
Do not over rely 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.

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.

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.

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 to 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.

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.

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.