Geotechnical Reports

1. West Rapid Substation GT Exploration and Review
2. West Rapid City Substation Investigative Borings
3. West Rapid Substation Transmission Line Poles GT Report

AMERICAN ENGINEERING TESTING, Inc.

CONSULTANTS
- GEOTECHNICAL
- MATERIALS
- ENVIRONMENTAL
- FORENSICS

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REPORT OF GEOTECHNICAL EXPLORATION AND REVIEW

WEST RAPID SUBSTATION
RAPID CITY SERVICE CENTER
409 DEADWOOD AVENUE
RAPID CITY, SOUTH DAKOTA

AET No. 17-03356

Date:

May 31, 2018

Prepared for:

Black Hills Energy
7001 Mt. Rushmore Road
Rapid City, South Dakota 57702

AMERICAN ENGINEERING TESTING, INC.

CONSULTANTS
· GEOTECHNICAL
· MATERIALS
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May 31, 2018

Black Hills Energy
7001 Mt. Rushmore Road
Rapid City, South Dakota 57702

Attn: Mr. Ron Williams, PE

RE: Geotechnical Exploration and Review
West Rapid Substation
Rapid City Service Center
409 Deadwood Avenue
Rapid City, South Dakota
Report No.17-03356

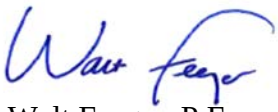
Dear Ron,

American Engineering Testing, Inc. (AET) is pleased to present the results of our subsurface exploration program and geotechnical engineering review for the proposed West Rapid Substation to be constructed at 409 Deadwood Avenue, in Rapid City, South Dakota. These services were performed in general accordance with our proposal dated April 10, 2018 and the signed Statement of Services No. 38863, dated April 25, 2018. We are submitting one (1) electronic copy of the report to you and one (1) additional copy to Ms. Maria Garduna (Black Hills Energy).

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 our office if you have any questions about the report. We can also be contacted to arrange the observation and testing services during construction of the project.

Sincerely,
American Engineering Testing, Inc.



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Rapid City, South Dakota 57701

Attn: Mr. Ron Williams, PE

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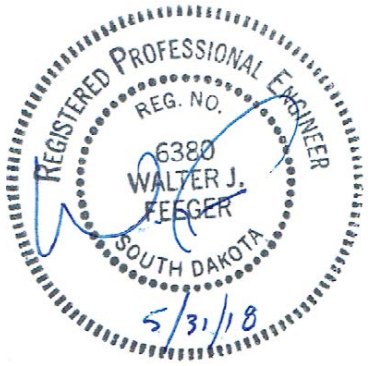

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1.0 INTRODUCTION

We understand the construction of a new substation has been proposed at Black Hills Energy's Rapid City Service Center facility at 409 Deadwood Avenue in Rapid City, South Dakota. Please refer to the Site Location Map included in Appendix A of this report. To assist with the planning and design, American Engineering Testing, Inc. (AET) has been authorized to conduct a subsurface exploration program at the site, conduct soil laboratory testing, and perform a geotechnical engineering review for the project. This report presents the results of the above services, and provides our engineering recommendations based on this data.

2.0 SCOPE OF SERVICES

AET's services were performed in general accordance with our proposal dated April 10, 2018. The authorized scope consists of the following:

- Ten (10) standard penetration test (SPT) borings within the proposed substation area to depths of about 30 feet below existing grade.
- Soil laboratory testing.
- Geotechnical engineering analysis based on the gained data and preparation of this report.

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

3.0 PROJECT INFORMATION

Based on the information provided, we understand the proposed 230/69kV substation will be constructed at Black Hills Energy's Rapid City Service Center facility located at 409 Deadwood Avenue in Rapid City. The substation will consist of a control building as well as deadends, bus/switch supports, transformers, and take-off structures. Furthermore, we understand these types of structures are typically placed on pad/mat foundations or reinforced concrete drilled piers (caissons).

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 the project consisted of ten (10) SPT borings which were drilled on May 8 and 9, 2018. The borings were located in the field by AET personnel at the approximate locations shown on the Boring Location Map within Appendix A. Surface elevations at the boring locations were referenced to a Temporary Benchmark (TBM). The TBM selected for this project was the top of the well cover located northeast of Boring B-3. For purposes of our report, the TBM was given a reference elevation on 100.0 feet.

The logs of the borings and details of the methods used appear in Appendix A. The logs contain information concerning soil layering, soil 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).

4.2 Laboratory Testing

The laboratory test program included water content, dry density, Atterberg Limits, percent passing the #200 sieve, and unconfined compression. The laboratory test results appear in Appendix A on the individual boring logs adjacent to the samples upon which they were performed with the exception of the unconfined compression tests, which can be found on separate sheets within Appendix A of this report.

5.0 SITE CONDITIONS

5.1 Surface Observations

The project site is located within the area of the former Black Hills Power Plant at the Rapid City Service Center, on the west side of Deadwood Avenue in Rapid City. At the time of our field work, the project site consisted of an equipment and vehicle staging area, which was covered with about 9 to 10 inches of crushed limestone aggregate. In general, the site slopes slightly downward to the west, with an elevation difference of about 2½ feet noted between the borings.

5.2 Subsurface Soils/Geology

Underlying approximately 9 to 10 inches of aggregate surfacing, the subsurface soils encountered in the borings consisted of about 1 to 12 feet of fill overlying varying depths of alluvium and/or claystone bedrock and gypsum, associated with the Spearfish Formation. The fill is comprised of residual coal from the former power plant as well as silty/sandy lean clays. The alluvium consists of stiff to hard lean clays. The claystone/gypsum bedrock extended to the total depths explored in each of the borings, with the exception of Boring B-1. Within Boring B-1, the alluvial silty lean clays extended to the total depth explored.

Conditions encountered at each boring location are indicated on the individual boring logs in Appendix A of this report.

5.3 Groundwater

At the time of our field work, measurable groundwater was encountered within Borings B-1, B-2, B-4, B-7, and B-10 at depth varying from approximately 10½ to 15 feet below existing grades. The presence or lack of groundwater noted at the boring locations should not be taken as an accurate representation of the actual groundwater levels. Groundwater level fluctuations occur due to seasonal variations in the amount of precipitation, surface drainage, local irrigation practices, and other factors not evident at the time the borings were performed. Due to the relatively low permeability of the clay soils encountered in the borings, a relatively long period of time may be needed for a groundwater level to develop and/or stabilize in the borings. The possibility of encountering groundwater and associated fluctuations in groundwater levels should be considered when developing the design and construction plans for the project.

5.3 Hydrocarbon Impacted Soils and Groundwater

Potential hydrocarbon impacted soils and groundwater may be encountered during the project excavation activities based on field photoionization detector (PID) screening results of samples obtained from the borings (please refer to the results shown on the Boring Logs). Hydrocarbon impacted soils that are encountered during the excavation activities could be considered solid waste material by the South Dakota Department of Environment and Natural Resources (SD DENR), which would require proper removal and disposal in accordance with SD DENR guidelines.

Regarding hydrocarbon-impacted groundwater that may require dewatering during the project, concentrations of hydrocarbons in groundwater may exceed the surface water quality standards as established by the SD DENR, and therefore, cannot be discharged as surface water. If dewatering of hydrocarbon impacted groundwater is required for the project, the successful bidding contractor for the project would need to coordinate with the City of Rapid City to obtain permission to discharge to the sanitary sewer or discuss other potential disposal options acceptable to the City of Rapid City and/or DENR.

6.0 RECOMMENDATIONS

6.1 Discussion

Our recommendations in the following sections are based on our understanding of the project details at this time. The geotechnical engineer should be allowed to review the final project plans to verify the following recommendations remain applicable for construction.

Based on the field and laboratory data, it is our opinion drilled pier foundations can be used to support the proposed dead-end structures, transmission line poles, and other miscellaneous substation structures. Conventional spread footing or mat foundations can be used for support of the new control building, transformers, capacitor banks, or other miscellaneous support equipment provided the recommendations provided herein are followed.

As designed, spread footing/mat loadings should provide a theoretical safety factor of 3 or more with respect to a general shear or base failure of the footings/mats. For drilled piers, loadings should provide a theoretical safety factor of 2 or more. Total and differential movement should not exceed 1-inch and 1/2-inch, respectively.

Additionally, it should be noted that gypsum is a common geologic feature found in the Spearfish Formation derived soils at this site. Once exposed, gypsum material can degrade which could cause future movement related distress to the structures, especially if water is introduced to the gypsum matrix.

If gypsum is encountered at the base of the excavations for foundations, retaining walls, and concrete slabs-on-grade, the geotechnical engineer should be allowed to observe the excavations and provide additional recommendations. Such recommendations typically involve over-excavation of the gypsum material to a specified depth and replacement with approved engineered fill material or lean concrete flowable fill. Gypsum fragments greater than 2-inches in nominal size should be screened out of all fill material prior to placement. Drilled pier foundations should not terminate (end bear) on gypsum.

6.2 General Site Preparation Recommendations

At this time, a grading plan or design finished structure elevations has not been provided. Based on the elevations obtained at the boring locations, fills on the order of about 3 feet (or less) will be required along the western portion of the proposed substation in order to provide a level building pad. All proposed imported fill material required to reach the design substation grade elevations should consist of lean clay or sand/gravel material. We do not recommend fat clay or shale material be used as fill within the proposed substation. All proposed imported material should be submitted to the geotechnical engineer for approval prior to being hauled and stockpiled on-site.

The existing aggregate surfacing, coal layers associated with the former power plant, and other unsuitable materials should be removed from within the construction limits of the proposed new substation. Any former infrastructure or structural elements associated with the former power plant should also be removed in their entirely if encountered during require site excavations. The existing lean clay material may be left in-place provided it is properly reconditioned as recommended herein prior to placement of structures and/or additional fill material required

Once the required stripping and foundation excavations are complete, we recommend the exposed subgrade soils be moisture conditioned to within ±3% of the optimum moisture content and compacted to at least 92% of maximum modified Proctor dry density (ASTM D 1557). Once completed and approved, applicable engineered fill zones and/or structural elements may be placed.

6.3 Drilled Pier Foundation Recommendations

Based on the results of the borings, laboratory testing, and our analysis, we have developed the following design parameters. We recommend all drilled piers bear at least 5 feet into the very stiff/hard lean clay alluvium or claystone bedrock and have a minimum length of 15 feet.

Soil Type	Allowable Skin Friction (psf)	Allowable End Bearing Pressure (psf)
Frost Zone 0 – 5'	Ignore	Ignore
Lean Clay Fill	300	na
Lean Clay Alluvium	600	6,000
Gypsum	na	na
Claystone Bedrock	1,000	10,000

In designing to resist uplift, ⅔ of the allowable side friction values provided for compressive loading could be used along with the effective weight of the drilled shafts. Straight shaft piers with a minimum diameter of 18-inches are recommended. Proper reinforcing steel should be included in the drilled shaft designs.

Lateral deflections of drilled shafts should be evaluated using an appropriate design procedure, and would be dependent on shaft diameter, length, configuration, stiffness and "fixed head" or "free head" conditions.

Single pier lateral load capacity can be estimated using the following design parameters for the soil profile in a p-y analysis such as conducted using the computer program LPILE:

Design Parameter	Lean Clay Fill	Lean Clay Alluvium	Gypsum	Claystone
Moist Unit Weight (pcf)	115	120	na	125
Undrained Shear Strength (psf)	1,000	2,000	na	4,000
Friction Angle (degrees)	18	18	na	15
Static Soil Modulus Parameter, k (pci)	500	500	na	2,000
Strain, ε_{50} (in/in)	0.005	0.005	na	0.004

Drilling to design depths should be possible with conventional large drilled pier equipment. Difficult drilling should be anticipated where gypsum masses are encountered which may require rock cutting teeth and/or coring in order to advance the drilled pier hole. We highly recommend a separate bid item be provided in the bid documents that addresses drilling through the gypsum.

Care should be taken so that the sides and bottom of the shaft excavations are not disturbed during drilling. The bottom of the shaft excavations should be free of loose material and water when concrete is placed. Concrete should be placed as soon as possible after the foundation excavation is completed to reduce the potential for disturbance of the bearing surface.

Groundwater was encountered at the time of our field work; therefore, the use of temporary casing will likely be required. The need for casing will depend on the conditions encountered at the time the pier excavations are made. A sufficient head of plastic concrete having a minimum slump on the order of 6-8 inches should be maintained inside the casing as it is withdrawn to prevent concrete arching and the influx of soil and water (if encountered) and creation of voids in the pier shaft.

Drilled shaft construction should be constructed in accordance with applicable portions of ACI 336.3R-93 or other similar, approved specification. Concrete mix should be designed utilizing cement to have a minimum 28-day compressive strength of 4,000 psi and a maximum water cement ratio of 0.45. A super plasticizer may be necessary to increase concrete slump/flow temporarily for drilled shaft placement.

Concrete should be on-site and ready for placement as soon as practical after each pier excavation is completed. Concrete placement in pier excavations should occur on the same day as pier excavation is completed.

We do not recommend free-fall concrete placement in piers. The use of a bottom-dump hopper, tremie, or pump, discharging near the bottom of the hole where concrete segregation will be minimized, is recommended.

A representative from AET should observe all drilled shaft excavations to evaluate the suitability of the bearing materials and to verify that conditions in the drilled shaft excavations are consistent with those encountered in the test borings. If unsuitable materials are encountered at planned depths, it may be necessary to deepen the shaft.

6.4 Spread Footing or Mat Foundation Recommendations

As noted, clay soils are present at the site. In order to limit potentially damaging differential and total movements through moisture variations in the clay soils, we recommend the site clays be removed within the proposed structure footprints to allow for the placement of at least two (2) feet of imported granular low/non-frost susceptible engineered fill below the foundations and/or mats.

Where applicable, excavations should be laterally oversized at a 1H:1V ratio as necessary to accommodate the two (2) feet of granular engineered fill material. Once the over excavation is complete, we recommend the exposed subgrade be scarified to a depth of at least 8-inches, the moisture content of the scarified soils adjusted to ±3% of the optimum moisture content and the scarified soils compacted to at least 92% of maximum modified Proctor dry density (ASTM D 1557). The excavated site clays may be stockpiled on-site and used as overlot fill outside of the building limits, where required.

Conventional Spread Footing Foundations – Imported granular engineered fill can then be placed within the over-excavations below the foundations. The granular engineered fill should be pre-approved by the geotechnical engineer prior to use. The granular engineered fill should be a pit run or crushed/screened material with a maximum aggregate size of 3-inches, no more than 15% passing the #200 sieve with a Liquid Limit less than 25. Engineered fill should be placed in 8-inch thick maximum loose lifts; the moisture content conditioned to within ±3% of optimum moisture content and compacted to at least 95% of maximum modified Proctor (ASTM D 1557) dry density.

We recommend exterior footings, interior footings in unheated portions of the building, or footings placed during freezing conditions be placed at least four (4) feet below final grades for frost protection. Interior footings in heated areas may be placed directly below the floor slab (where applicable).

The spread footing foundation system may be designed for an allowable bearing capacity of 2,500 pounds per square foot (psf) bearing on the properly placed imported granular engineered fill. As designed, loadings should provide a theoretical safety factor of three or more with respect to a general shear or base failure of the footings. Total and differential settlement should not exceed 1 inch and 1/2-inch, respectively.

Mat Foundations – In our opinion, the proposed substation structures can also be supported by a slab-on-grade (mat) foundation system bearing on a zone of compacted select (low frost susceptible) granular engineered fill extending to a depth of at least two (2) feet below the base of the mat. The mat foundation system may be designed for an allowable bearing capacity of 2,500 pounds per square foot (psf). As designed, loadings should provide a theoretical safety factor of three or more with respect to a general shear or base failure of the footings. Total and differential settlement should not exceed 1 inch and 1/2-inch, respectively.

Lateral loads transmitted to the mat foundation can be resisted by the soil-concrete friction on the base of the foundation. The friction on the base of the concrete and underlying granular engineered fill may be computed using a friction coefficient of 0.45.

6.5 Backfill Considerations

It is our opinion exterior backfill around the structures, utility trench backfill and overlot fill may consist of the site soils and should be placed as follows. All recommendations are based on the modified Proctor method (ASTM: D 1557).

1. All backfill should be free of deleterious/frozen material and have a maximum aggregate size of 3-inches. Gypsum material, if encountered, should be removed to the extent possible and in no case should fill material contain gypsum fragments greater than 2-inches in nominal size.
2. Fill should be moisture conditioned to within ±3% of optimum moisture content prior to being placed.
3. All fill 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 of backfill should be compacted to at least 92% of maximum proctor density. Compaction should be increased to 95% for the final lift of utility trench backfill placed within areas to receive pavement.

5. Compaction density tests should be performed on alternating lifts to ensure the minimum density is maintained.

7.0 CONSTRUCTION CONSIDERATIONS

7.1 Potential Difficulties

Depending on the time of year in which construction takes place, unstable subgrade soils could be encountered during the site and building grading operations. If encountered, additional conditioning of the soils may be required to obtain moisture contents which allow for firm and unyielding subgrade and/or compaction.

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.

7.2 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, reduce the potential for soil disturbance, and facilitate filling operations, we recommend water be removed from within the excavation during construction. Based on the soils encountered, we anticipate the groundwater can be handled with conventional sump pumping.

7.3 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.

7.4 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 sideslope erosion or running which could require slope maintenance.

7.5 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.

8.0 LIMITATIONS

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

Appendix A

AET Project No. 17-03356

Boring Log Notes
Unified Soil Classification System
Site Location Map
Boring Location Map
Subsurface Boring Logs
Unconfined Compression Test Results

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 the Boring Location Map, preceding the Subsurface Boring Logs in this appendix.

A.2 SAMPLING METHODS

A.2.1 Ring-lined barrel Samples - Calibrated to N_{60} Values

Standard penetration (ring-lined barrel) samples were collected in general accordance with ASTM: D3550. The ASTM test method consists of driving a 2.5-inch O.D. thick-walled, split-barrel sampler lined with brass rings 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.5.2 Atterberg Limits Tests
Conducted per AET Procedure 01-LAB-030, which is performed in general accordance with ASTM: D4318 and AASHTO: T89, T90.

A.5.3 Sieve Analysis of Soils (thru #200 Sieve)
Conducted per AET Procedure 01-LAB-040, which is performed in general conformance with ASTM: D6913, Method A.

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.

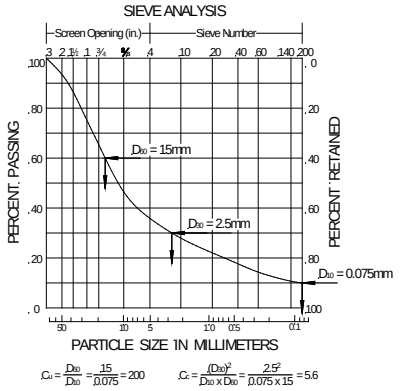
A.7 SAMPLE STORAGE

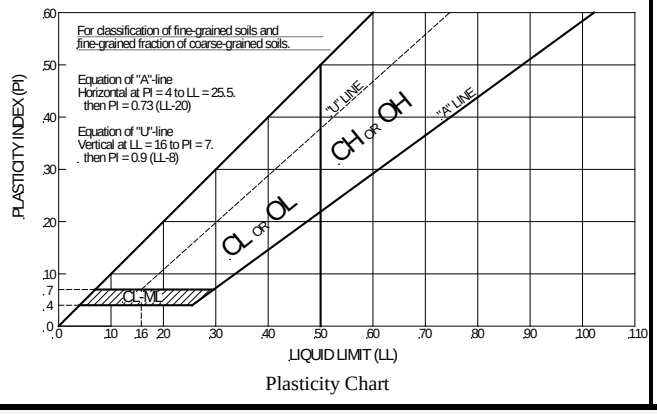
Unless notified to do otherwise, we routinely retain representative samples of the soils recovered from the borings for a period of 30 days.

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≥4 and 1≤Cc≤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≥6 and 1≤Cc≤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]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.

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.

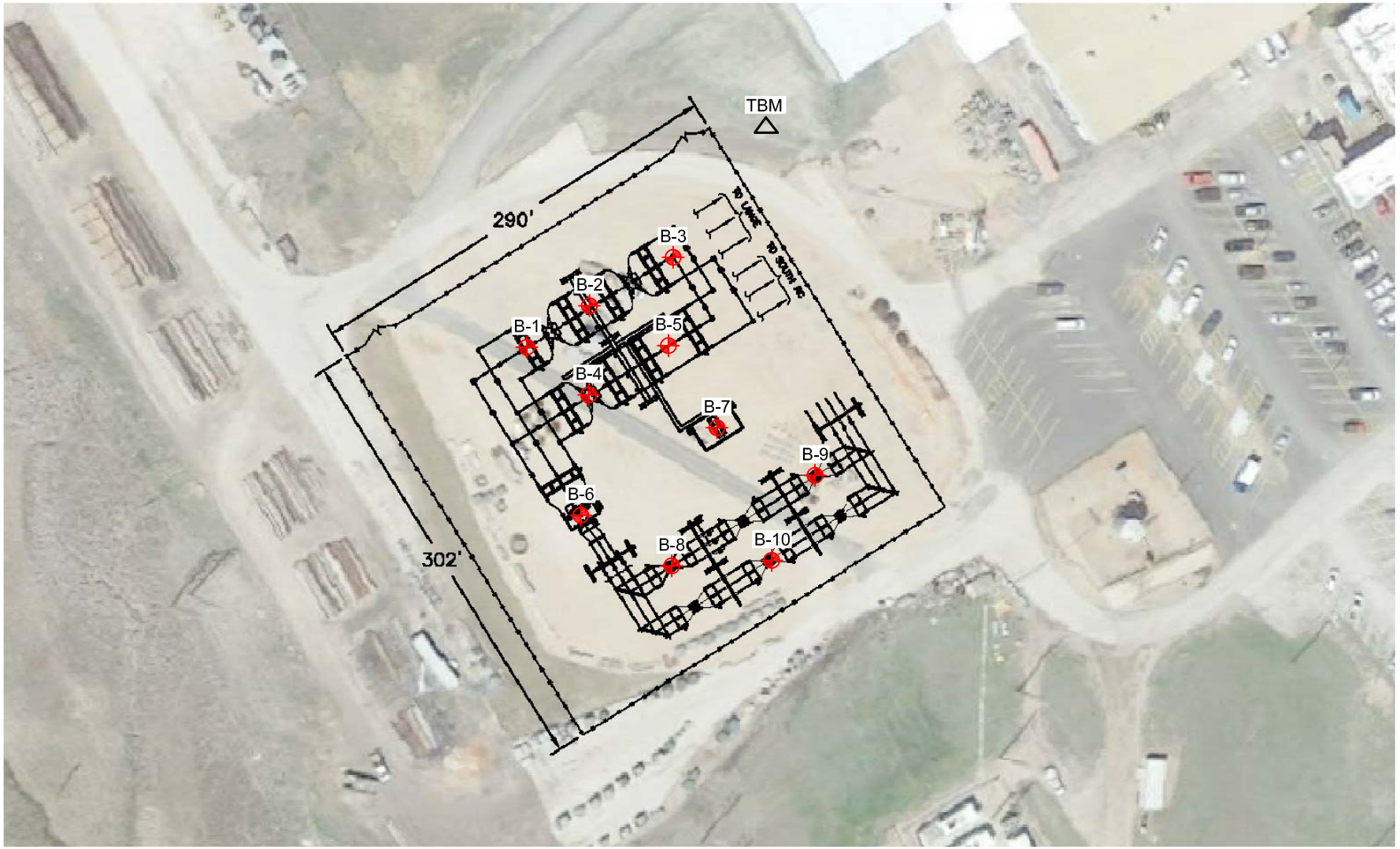
Trace roots: Small roots present, but not judged to be in sufficient quantity to significantly affect soil properties.

SCALE (FEET)

0 800

AMERICAN ENGINEERING TESTING, INC.

PROJECT: WEST RAPID SUBSTATION RAPID CITY, SOUTH DAKOTA		PROJECT NO. 17-03356
SUBJECT: SITE LOCATION MAP		DATE: MAY 23, 2018
SCALE: 1 INCH = 800 FEET	DRAWN BY: JR	REVIEWED BY: WF



SCALE (FEET)

0 100

AMERICAN ENGINEERING TESTING, INC.

PROJECT: WEST RAPID SUBSTATION RAPID CITY, SOUTH DAKOTA		PROJECT NO. 17-03356
SUBJECT: BORING LOCATION MAP		DATE: MAY 24, 2018
SCALE: 1 INCH = 100 FEET	DRAWN BY: JR	REVIEWED BY: WF

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B- 1 (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

SURFACE ELEVATION: **92.6**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	PID (ppm)
1	**LIMESTONE AGGREGATE SURFACING**, 9 inches	SURFACING									
2	**FILL**, Silty Lean Clay with Sand, reddish brown (CL)	FILL									
3			20	M	MC	18					ND
4											
5											
6			14	M	MC	18	26	96	43	19	ND
7											
8			18	M	MC	18	19	110			ND
9											
10											
11			13	M	MC	18	20	114			ND
12											
13	**SILTY LEAN CLAY with SAND**, reddish brown, very stiff to hard, sandstone fragments present (CL)	ALLUVIUM	18	W	MC	18					ND
14											
15											
16			25	M	MC	18					ND
17											
18											
19											
20											
21			31	M	MC	18					ND
22											
23											
24											
25											
26			45	M	MC	18					ND
27											
28											
29											
30											
31			25	M	MC	18					NSR
	Bottom of Boring										

DEPTH:	DRILLING METHOD
30.0	**3.25" HSA**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
5/8/18	**10:20**	**31.5**	**30.0**	**NA**	**NA**	**12.5**

BORING COMPLETED: **5/8/18**

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

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

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 5/30/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B- 2 (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

SURFACE ELEVATION: **94.0**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	PID (ppm)
1	**LIMESTONE AGGREGATE SURFACING**, 10 inches	SURFACING									
2	**FILL**, Silty Lean Clay Sand, reddish brown (CL)	FILL									
3			38	M	MC	18					ND
4											
5											
6	**GYPSUM**, white, hard	SPEARFISH FORMATION	50/.3	M	MC	10					ND
7											
8			34	M	MC	18	8				ND
9	**CLAYSTONE**, Silty Lean Clay, red, very stiff to hard, gypsum lenses present (CL)										
10											
11			20	M	MC	18					ND
12											
13			50/.4	W	MC	17	13				ND
14											
15											
16			NSR	M	MC	0					ND
17											
18											
19											
20											
21			50/.4	M	MC	11					ND
22											
23											
24											
25											
26			50/.4	M	MC	11					ND
27											
28											
29											
30			50/.4	M	MC	11					NSR
	Bottom of Boring										

DEPTH:	DRILLING METHOD
30.0	**3.25" HSA**

BORING COMPLETED: **5/8/18**

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

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
5/8/18	**17:00**	**30.9**	**30.0**	**NA**	**NA**	**13.0**

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

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 5/30/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B- 3 (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

SURFACE ELEVATION: **95.2**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	PID (ppm)
1	**LIMESTONE AGGREGATE SURFACING**, 9 inches	SURFACING									
2	**FILL**, Coal, black	FILL									
3			50/.5	M	MC	12					ND
4	**GYPSUM**, white, hard, siltstone lenses present	SPEARFISH FORMATION									
5											
6			50/.5	M	MC	12					ND
7											
8			50/.5	M	MC	6					ND
9											
10											
11			50/.5	M	MC	6					ND
12											
13			50/.3	M	MC	4					ND
14											
15											
16			NSR	M	MC	0					ND
17											
18											
19											
20											
21	**CLAYSTONE**, Silty Lean Clay, red, hard, gypsum lenses present (CL)		78/.8	M	MC	16					ND
22											
23											
24											
25											
26			50/.2	M	MC	9					ND
27											
28											
29											
30			50/.3	M	MC	10					NSR
	Bottom of Boring										

DEPTH:	DRILLING METHOD
30.0	**3.25" HSA**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
5/9/18	**8:30**	**30.8**	**30.0**	**NA**	**NA**	**None**

BORING COMPLETED: **5/9/18**

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

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

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 5/30/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B- 4 (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

SURFACE ELEVATION: **93.5**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	PID (ppm)
1	**LIMESTONE AGGREGATE SURFACING**, 10 inches	SURFACING									
2	**FILL**, Silty Lean Clay with Sand, reddish brown (CL)	FILL									
3			45	M	MC	18					ND
4											
5	**CLAYSTONE**, Silty Lean Clay, red, hard (CL)	SPEARFISH FORMATION									
6			55	M	MC	18	8				ND
7											
8			50/.5	M	MC	12	7				ND
9											
10											
11			85/.8	M	MC	16					15
12				▽							
13			90	W	MC	18	9	119			55
14											
15											
16			75/.9	M	MC	17					<1
17											
18											
19											
20											
21			50	M	MC	18	11				ND
22											
23											
24											
25	with gypsum lenses										
26			NSR	M	MC	0					<1
27											
28											
29											
30			50/.3	M	MC	4					NSR
	Sampler Refusal at 30.3'										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS						
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
30.0	**3.25" HSA**	**5/9/18**	**9:50**	**30.3**	**30.0**	**NA**	**NA**	**12.0**
BORING COMPLETED: **5/9/18**								
DR: **ES** LG: **JH** Rig: **RC-1**								

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

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 5/30/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B- 5 (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

SURFACE ELEVATION: **95.0**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	PID (ppm)
1	**LIMESTONE AGGREGATE SURFACING**, 10 inches	SURFACIING									
2	**FILL**, Coal, black	FILL									
3	**SILTY LEAN CLAY with SAND**, reddish brown, very stiff to hard, claystone fragments present (CL)	ALLUVIUM	42	M	MC	18	26	99			ND
6			35	M	MC	18	19				ND
8			35	M	MC	18					179
10	with gypsum fragments		46	M	MC	18					146
13			17	M	MC	18	18	112			82
16			78	M	MC	18	9	126			ND
21	**CLAYSTONE**, Silty Lean Clay, red, hard, gypsum lenses present (CL)	SPEARFISH FORMATION	50/.2	M	MC	9					ND
26			NSR	M	MC	0					ND
30	Sampler Refusal at 30.0'		NSR	M	MC	0					NSR

DEPTH:	DRILLING METHOD
30.0	**3.25" HSA**

BORING COMPLETED: **5/9/18**

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

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
5/9/18	**12:00**	**30.0**	**30.0**	**NA**	**NA**	**None**

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

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 5/30/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B- 6 (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

SURFACE ELEVATION: **92.5**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	PID (ppm)
1	**LIMESTONE AGGREGATE SURFACING**, 10 inches	SURFACING									
2	**FILL**, Coal, black	FILL									
3	**SILTY LEAN CLAY with SAND**, reddish brown, hard, claystone and gypsum fragments present (CL)	ALLUVIUM	55	M	MC	18					105
6			50/.5	M	MC	12	12				173
8			40	M	MC	18	12	119			164
11			66	M	MC	18					33
13			50/.5	M	MC	6	11				13
16	**CLAYSTONE**, Silty Lean Clay with Sand, red, hard, gypsum lenses present (CL)	SPEARFISH FORMATION	50/.4	M	MC	11					<1
21			50/.4	M	MC	11					ND
26			NSR	M	MC	0	9	115			<1
30			50/.3	M	MC	10					NSR
	Bottom of Boring										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS						
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
30.0	**3.25" HSA**	**5/9/18**	**13:15**	**30.8**	**30.0**	**NA**	**NA**	**None**

BORING COMPLETED: **5/9/18**

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

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

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 5/30/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B- 7 (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

SURFACE ELEVATION: **94.1**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	PID (ppm)
1	**LIMESTONE AGGREGATE SURFACING**, 10 inches	SURFACING									
2	**FILL**, Coal, black	FILL									
3			69	M	MC	18					ND
4	**FILL**, Silty Lean Clay with Sand, reddish brown, gypsum fragments present (CL)										
5											
6			17	M	MC	18					74
7	**GYPSUM**, white, hard to firm	SPEARFISH FORMATION									
8			50/.3	M	MC	10					115
9											
10				▽							
11			6	W	MC	18					120
12	**CLAYSTONE**, Silty Lean Clay, red, very stiff to hard, gypsum lenses present (CL)										
13			22	M	MC	18					195
14											
15											
16			48	M	MC	18					147
17											
18											
19											
20											
21			50/.4	M	MC	11					58
22											
23											
24											
25											
26			50/.4	M	MC	5					NSR
27											
28											
29											
30			50/.3	M	MC	4					NSR
	Sampler Refusal at 30.3'										

DEPTH:	DRILLING METHOD
30.0	**3.25" HSA**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
5/9/18	**14:25**	**30.3**	**30.0**	**NA**	**NA**	**10.5**

BORING COMPLETED: **5/9/18**

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

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

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 5/30/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B- 8 (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

SURFACE ELEVATION: **92.5**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	PID (ppm)
1	**LIMESTONE AGGREGATE SURFACING**, 9 inches	SURFACING									
2	**FILL**, Coal, black	FILL									
3	**FILL**, Silty Lean Clay with Sand, reddish brown to dark brown, gypsum, claystone, and coal fragmnets present (CL)		50/.5	M	MC	6					NSR
4											
5											
6			10	M	MC	18	16	100			ND
7											
8	**CLAYSTONE**, Silty Lean Clay with Sand, red, hard, gypsum lenses present (CL)	SPEARFISH FORMATION	61	M	MC	18	8	131			ND
9											
10											
11			50/.5	M	MC	12					59
12											
13			50/.4	M	MC	11	14				11
14											
15											
16			50/.3	M	MC	10	11				NSR
17											
18											
19											
20											
21			50/.2	M	MC	3					NSR
22											
23											
24											
25											
26			NSR	M	MC	0					ND
27											
28											
29											
30			50/.2	M	MC	3					NSR
	Sampler Refusal at 30.2'										

DEPTH:	DRILLING METHOD
30.0	**3.25" HSA**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
5/9/18	**15:50**	**30.2**	**30.0**	**NA**	**NA**	**None**

BORING COMPLETED: **5/9/18**

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

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

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 5/30/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B- 9 (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

SURFACE ELEVATION: **95.1**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	PID (ppm)
1	**LIMESTONE AGGREGATE SURFACING**, 10 inches	SURFACING									
2	**FILL**, Silty Lean Clay, reddish brown to brown, gypsum and coal fragments present (CL)	FILL									
3			53	M	MC	18	19	103			14
4											
5											
6			28	M	MC	18					5
7											
8			16	M	MC	18	26	99	46	25	76
9											
10											
11			10	M	MC	18					<1
12											
13	**SILTY LEAN CLAY**, reddish brown, stiff to very stiff, gypsum and claystone fragments present (CL)	ALLUVIUM	20	M	MC	18	23	99			37
14											
15											
16			10	M	MC	18					NSR
17											
18											
19											
20											
21			14	M	MC	18					<1
22											
23											
24											
25											
26	**CLAYSTONE**, Silty Lean Clay, red, hard, gypsum lenses present (CL)	SPEARFISH FORMATION	50/.4	M	MC	11					<1
27											
28											
29											
30			50/.3	M	MC	4					NSR
	Sampler Refusal at 30.3'										

DEPTH:	DRILLING METHOD
30.0	**3.25" HSA**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
5/9/18	**6:45**	**30.3**	**30.0**	**NA**	**NA**	**None**

BORING COMPLETED: **5/9/18**

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

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

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 5/30/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B-10 (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

SURFACE ELEVATION: **93.5**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	PID (ppm)
1	**LIMESTONE AGGREGATE SURFACING**, 10 inches	SURFACING									
2	**FILL**, Silty Lean Clay, reddish brown, claystone, gypsum and coal fragments present (CL)	FILL									
3			NSR	M	MC	0	21				ND
4											
5											
6			42	M	MC	18	13				NSR
7											
8			18	M	MC	18	15				NSR
9											
10	**SILTY LEAN CLAY**, reddish brown, stiff to very stiff, claystone and gypsum fragments present (CL)	ALLUVIUM									
11			12	M	MC	18	21	112			<1
12											
13			16	M	MC	18					11
14											
15	**CLAYSTONE**, Silty Lean Clay, red, hard, gypsum lenses present (CL)	SPEARFISH FORMATION		▽							
16			61	W	MC	18					ND
17											
18											
19											
20											
21			53	M	MC	18	12	125			ND
22											
23											
24											
25											
26			57	M	MC	18					ND
27											
28											
29											
30	Sampler Refusal at 30.0'		NSR	M	MC	0					NSR

DEPTH:	DRILLING METHOD
30.0	**3.25" HSA**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
5/9/18	**17:30**	**30.0**	**30.0**	**NA**	**NA**	**15.0**

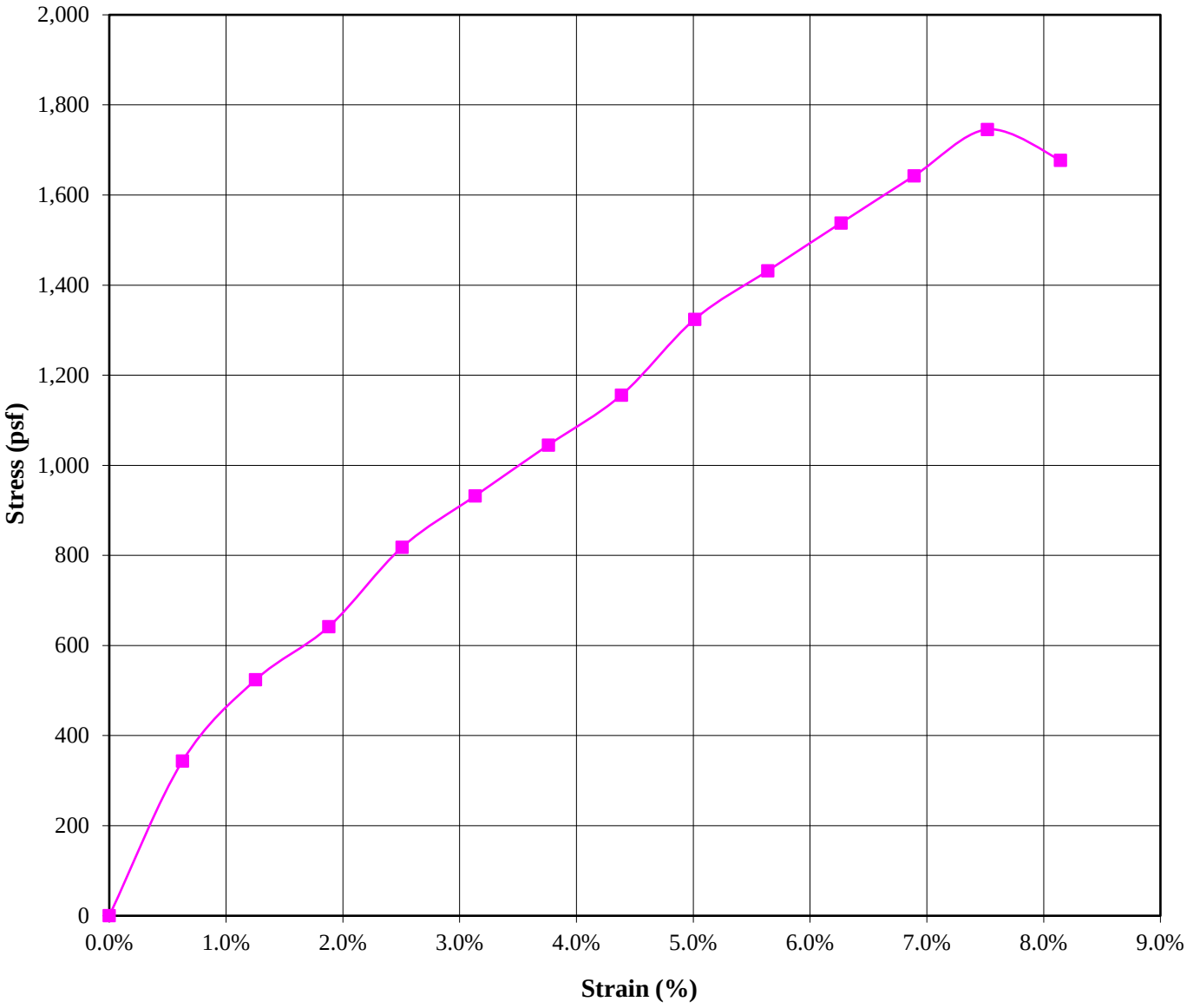
BORING COMPLETED: **5/9/18**

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

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

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 5/30/18

Stress vs. Strain



Test Results

Boring	Sample	Depth	Stress at Failure	Strain at Failure	Dry Density	% Moisture
1	3	7.5-9'	1,745 psf	7.5%	110.3 pcf	18.9%

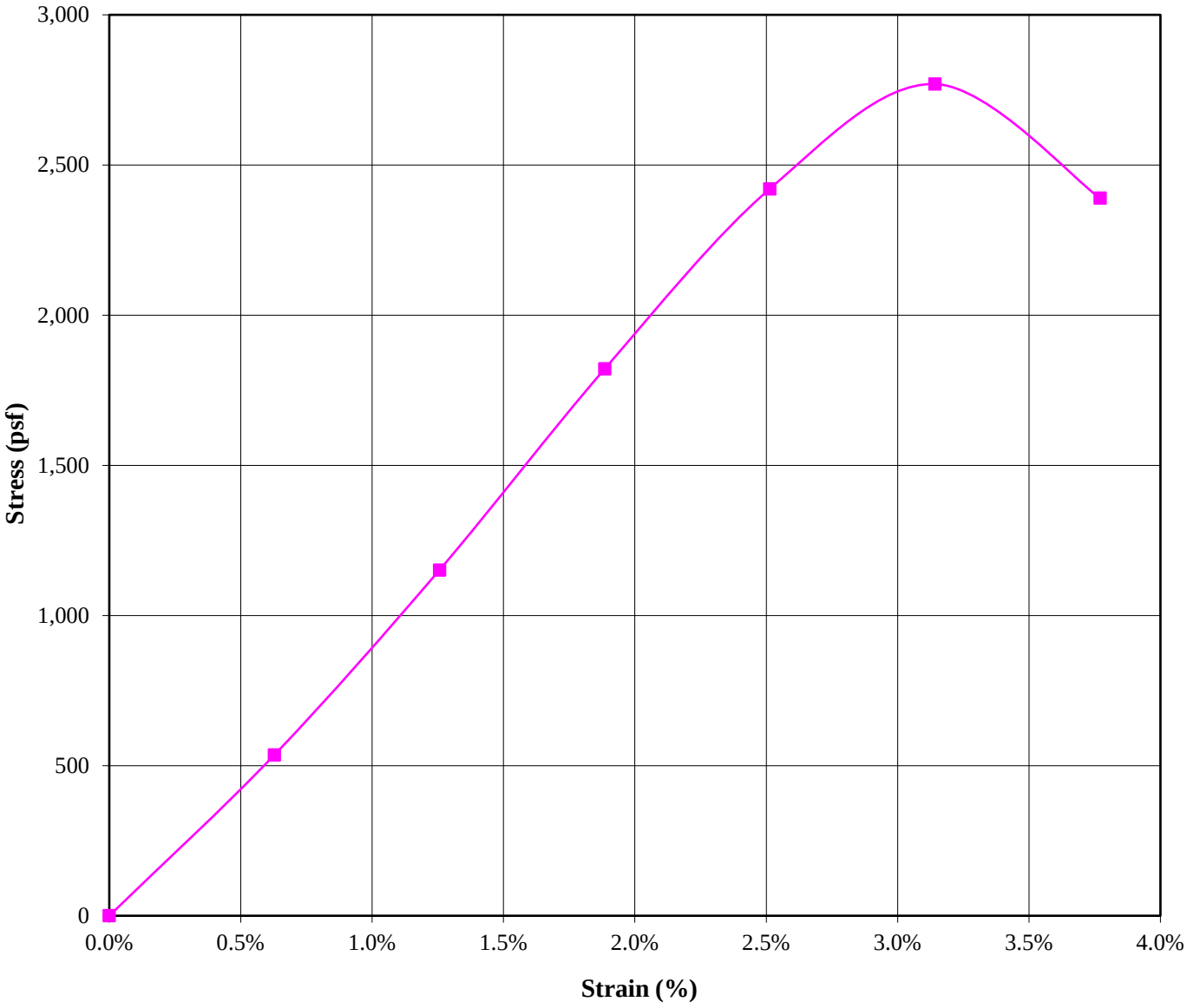
Project Information

Project:	West Rapid Substation	**Job Number:**	17-03356
Location:	Rapid City, South Dakota	**Date:**	5/30/2018

AMERICAN ENGINEERING TESTING, INC.

UNCONFINED COMPRESSION TEST RESULTS

Stress vs. Strain



Test Results

Boring	Sample	Depth	Stress at Failure	Strain at Failure	Dry Density	% Moisture
5	6	15-16.5'	2,769 psf	3.1%	126.2 pcf	8.9%

Project Information

Project:	West Rapid Substation	**Job Number:**	17-03356
Location:	Rapid City, South Dakota	**Date:**	5/29/2018

AMERICAN ENGINEERING TESTING, INC.

UNCONFINED COMPRESSION TEST RESULTS

Appendix B

Geotechnical Report Limitations and Guidelines for Use

Geotechnical Report Limitations and Guidelines for Use
AET Project No. 17-03356

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.

AMERICAN
ENGINEERING
TESTING, INC.

CONSULTANTS
· GEOTECHNICAL
· MATERIALS
· ENVIRONMENTAL

December 5, 2018

Black Hills Energy
7001 Mt. Rushmore Road
Rapid City South Dakota 57702

Attn: Ron Williams, PE

Subject: Investigative Borings – Proposed West Rapid Substation
Rapid City Service Center
Deadwood Avenue
Rapid City, South Dakota
AET Project No. 17-03356

Dear Ron,

As you are aware, AET recently completed the geotechnical services for the proposed West Rapid Substation project, and submitted our findings and recommendations in our Report No. 17-03356, dated May 31, 2018.

As requested, a total of forty-three (43) investigative auger borings were drilled at locations selected by DGR Engineering; thirty-eight (38) borings were drilled to depths of about 18 feet below grade and five (5) borings were drilled to depths of about 30 feet below grade. The boring location map, borings logs, and boring coordinate sheet are included at the end of this transmittal letter.

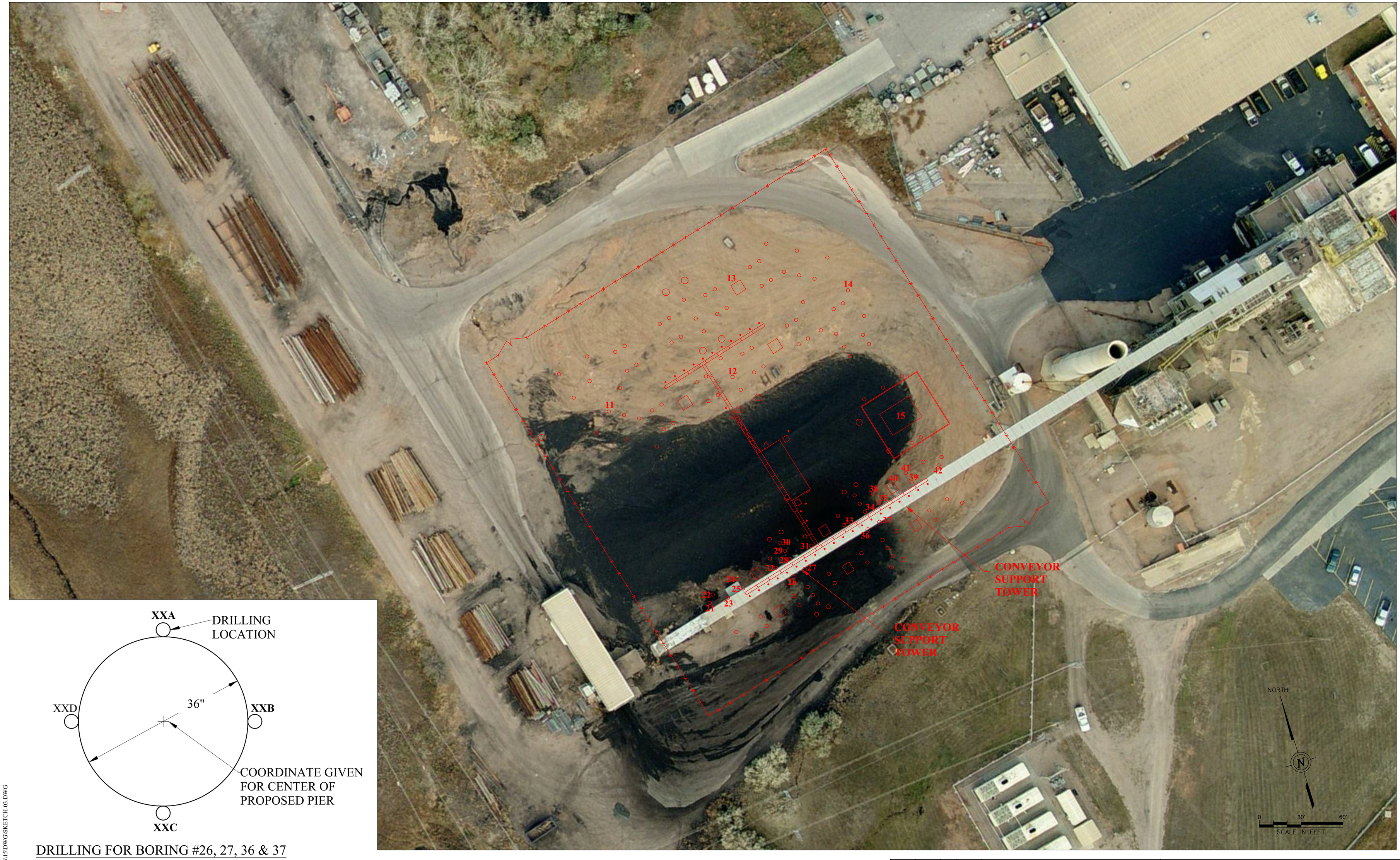
If you have any questions or we can be of further service, please contact our office at (605) 388-0029.

Sincerely,
American Engineering Testing, Inc.

Walt Feeger, P.E.
Senior Geotechnical Engineer

Robert Temme, P.E.
Vice President Western Region

Attachments: Boring Location Map
Coordinates Sheet
Boring Logs



DRILLING FOR BORING #26, 27, 36 & 37

XX = BORING #

P:\04\233115\DWG\SKETCH-03.DWG

DGR ENGINEERING

ROCK RAPIDS, IOWA
(712) 472-2531

DATE	DRAWN BY	NO.	APPROVED BY	REVISION DESCRIPTION
10-18	KLV	A	PDK	PRELIMINARY

BLACK HILLS ENERGY

WEST RAPID CITY SUBSTATION

AERIAL WITH COAL SYSTEM

DRAWN BY KLV DATE 10-18

APPROVED BY PDK DATE 10-18

DWG NO. SKETCH-03

REVISION A

West Rapid City Substation
Boring Location Coordinates
Rev. 11-02-18

Boring #	Boring Location(s)	Depth	Northing	Easting	Notes:
1	Geotech Report Boring B-1				
2	Geotech Report Boring B-2				
3	Geotech Report Boring B-3				
4	Geotech Report Boring B-4				
5	Geotech Report Boring B-5				
6	Geotech Report Boring B-6				
7	Geotech Report Boring B-7				
8	Geotech Report Boring B-8				
9	Geotech Report Boring B-9				
10	Geotech Report Boring B-10				
11	Additional for Geotech Report	30'	652883.8174	1198680.209	44.0873440°, -103.2638968°
12	Additional for Geotech Report	30'	652908.8381	1198769.636	44.0874213°, -103.2635600°
13	Additional for Geotech Report	30'	652973.3087	1198773.754	44.0875984°, -103.2635530°
14	Additional for Geotech Report	30'	652971.4715	1198853.095	44.0876011°, -103.2632509°
15	Additional for Geotech Report	30'	652881.2041	1198892.338	44.0873574°, -103.2630896°
21	Center of proposed pier	18'	652745.4244	1198753.2	44.0869717°, -103.2636006°
22	Center of proposed pier	18'	652751.474	1198755.298	44.0869885°, -103.2635934°
23	Center of proposed pier	18'	652748.9701	1198766.331	44.0869827°, -103.2635511°
24	Center of proposed pier	18'	652757.7977	1198771.625	44.0870074°, -103.2635321°
25	Center of proposed pier	18'	652755.8943	1198777.317	44.0870027°, -103.2635102°
26	Center of proposed pier	N/A	652764.3968	1198813.327	44.0870295°, -103.2633744°
26A	N Quadrant of proposed 36" ϕ pier	18'	N/A	N/A	
26B	S Quadrant of proposed 36" ϕ pier	18'	N/A	N/A	
26C	E Quadrant of proposed 36" ϕ pier	18'	N/A	N/A	
26D	W Quadrant of proposed 36" ϕ pier	18'	N/A	N/A	
27	Center of proposed pier	N/A	652769.7275	1198821.788	44.0870450°, -103.2633429°
27A	N Quadrant of proposed 36" ϕ pier	18'	N/A	N/A	
27B	S Quadrant of proposed 36" ϕ pier	18'	N/A	N/A	
27C	E Quadrant of proposed 36" ϕ pier	18'	N/A	N/A	
27D	W Quadrant of proposed 36" ϕ pier	18'	N/A	N/A	
28	Center of proposed pier	18'	652777.2173	1198811.159	44.0870645°, -103.2633844°
29	Center of proposed pier	18'	652783.1398	1198807.428	44.0870803°, -103.2633994°
30	Center of proposed pier	18'	652789.0622	1198803.696	44.0870962°, -103.2634144°
31	Center of proposed pier	18'	652786.8127	1198826.389	44.0870922°, -103.2633277°
32	Center of proposed pier	18'	652770.8204	1198801.006	44.0870459°, -103.2634221°
33	Center of proposed pier	18'	652801.7387	1198850.078	44.0871355°, -103.2632396°
34	Center of proposed pier	18'	652811.3341	1198865.308	44.0871633°, -103.2631830°
35	Center of proposed pier	18'	652817.731	1198875.46	44.0871818°, -103.2631452°
36	Quadrants of proposed 36" ϕ pier		652798.5135	1198867.476	44.0871283°, -103.2631730°
36A	N Quadrant of proposed 36" ϕ pier	18'	N/A	N/A	
36B	S Quadrant of proposed 36" ϕ pier	18'	N/A	N/A	
36C	E Quadrant of proposed 36" ϕ pier	18'	N/A	N/A	
36D	W Quadrant of proposed 36" ϕ pier	18'	N/A	N/A	
37	Quadrants of proposed 36" ϕ pier		652803.8443	1198875.936	44.0871437°, -103.2631416°
37A	N Quadrant of proposed 36" ϕ pier	18'	N/A	N/A	
37B	S Quadrant of proposed 36" ϕ pier	18'	N/A	N/A	
37C	E Quadrant of proposed 36" ϕ pier	18'	N/A	N/A	
37D	W Quadrant of proposed 36" ϕ pier	18'	N/A	N/A	
38	Center of proposed pier	18'	652824.4995	1198871.196	44.0871999°, -103.2631624°
39	Center of proposed pier	18'	652832.6571	1198899.15	44.0872026°, -103.2630560°
40	Center of proposed pad	18'	652828.5614	1198885.151	44.0872124°, -103.2631098°
41	Center of proposed pier	18'	652839.4256	1198894.886	44.0872431°, -103.2630743°
42	Center of proposed pier	18'	652844.9235	1198918.624	44.0872605°, -103.2629847°

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B-11 (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: _____ MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1	**LIMESTONE AGGREGATE SURFACING**, 10 inches	SURFACIING									
2	**FILL**, Silty Lean Clay with Sand, reddish brown (CL)	FILL									
3											
4	**FILL**, Gypsum boulder										
5	**FILL**, Silty Lean Clay, reddish brown (CL)										
6											
7											
8											
9				M							
10											
11											
12											
13											
14											
15	**SILTY LEAN CLAY**, red-brown (CL)	ALLUVIUM									
16											
17				▽							
18											
19											
20											
21											
22											
23				W							
24											
25											
26											
27											
28											
29											
30	Bottom of Boring										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS						
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
30.0	**4" FA**	**11/27/18**	**13:50**	**30.0**	**NA**	**NA**	**NA**	**17.0**
BORING COMPLETED: **11/27/18**								
DR: **BT** LG: **JR** Rig: **RC-1**								

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

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 12/3/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B-12 (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: _____ MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1	**LIMESTONE AGGREGATE SURFACING**, 10 inches	SURFACING									
2	**GYPSUM**, white	SPEARFISH FORMATION									
8	**CLAYSTONE**, Silty Lean Clay, red, gypsum lenses and laminations present (CL)			M							
17	**GYPSUM**, white										
19	**CLAYSTONE**, Silty Lean Clay, red, gypsum lenses and laminations present (CL)										
22	▽										
26	W										
30	Bottom of Boring										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
30.0	**4" FA**	**11/27/18**	**14:45**	**30.0**	**NA**	**NA**	**NA**	**22.5**	
BORING COMPLETED: **11/27/18**									
DR: **BT** LG: **JR** Rig: **RC-1**									

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 12/3/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B-13 (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: _____ MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1	**LIMESTONE AGGREGATE SURFACING**, 10 inches	SURFACIING									
2	**FILL**, Silty Lean Clay with Sand, reddish brown (CL)	FILL									
5	**GYPSUM**, white	SPEARFISH FORMATION									
8	**CLAYSTONE**, Silty Lean Clay, red, gypsum lenses and laminations present (CL)										
15				M							
21	color grading to reddish brown										
30	Bottom of Boring										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS						
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
30.0	**4" FA**	**11/27/18**	**15:25**	**30.0**	**NA**	**NA**	**NA**	**None**
BORING COMPLETED: **11/27/18**								
DR: **BT** LG: **JR** Rig: **RC-1**								

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

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 12/3/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B-14 (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: _____ MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1	**LIMESTONE AGGREGATE SURFACING**, 10 inches	SURFACIING									
2	**FILL**, Coal, black	FILL									
3	**FILL**, Silty Lean Clay, reddish brown (CL)										
4											
5											
6											
7											
8											
9											
10											
11	**CLAYSTONE**, Silty Lean Clay, red, gypsum lenses and laminations present (CL)	SPEARFISH FORMATION									
12											
13											
14											
15				M							
16											
17											
18	increasing gypsum lenses with depth										
19											
20											
21											
22											
23											
24											
25											
26	**GYPSUM**, white										
27											
28											
29											
30	Bottom of Boring										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS						
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
30.0	**4" FA**	**11/27/18**	**8:40**	**30.0**	**NA**	**NA**	**NA**	**None**
BORING COMPLETED: **11/27/18**								
DR: **BT** LG: **JR** Rig: **RC-1**								

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

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 12/3/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B-15 (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: _____ MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1	**LIMESTONE AGGREGATE SURFACING**, 10 inches	SURFACIING									
2	**FILL**, Silty Lean Clay, dark reddish brown to black (CL)	FILL									
6	**LEAN CLAY**, brown (CL)	ALLUVIUM		M							
15	**SILTY LEAN CLAY**, reddish brown (CL)										
18	▽										
24				W							
30	Bottom of Boring										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS						
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
30.0	**4" FA**	**11/27/18**	**16:10**	**30.0**	**NA**	**NA**	**NA**	**18.0**
BORING COMPLETED:	**11/27/18**							
DR: **BT**	LG: **JR** Rig: **RC-1**							

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

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 12/3/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B-21 (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: _____ MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1	**LIMESTONE AGGREGATE SURFACING**, 10 inches	SURFACIING									
2	**FILL**, Silty Lean Clay with Sand, reddish brown, gypsum, claystone and coal fragments present (CL)	FILL									
3											
4	**CONCRETE**, 6 inches										
5	**FILL**, Silty Lean Clay with Sand, reddish brown, gypsum, claystone and coal fragments present (CL)										
6				M							
7	**CONCRETE**, 6 inches										
8	**FILL**, Silty Lean Clay with sand, reddish brown, gypsum, claystone and coal fragments present (CL)	ALLUVIUM									
9											
10	**SILTY LEAN CLAY**, red (CL)										
11											
12				▽							
13											
14											
15				W							
16											
17											
18	Bottom of Boring										

DEPTH:	DRILLING METHOD
18.0	**4" FA**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
11/28/18	**15:35**	**18.0**	**NA**	**NA**	**NA**	**12.0**

BORING COMPLETED: **11/28/18**

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

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

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 12/3/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B-22 (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: _____ MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1	**LIMESTONE AGGREGATE SURFACING**, 10 inches	SURFACIING									
2	**FILL**, Silty Lean Clay with Sand, reddish brown, gypsum, claystone and coal fragments (CL)	FILL									
5	**SILTY LEAN CLAY**, red (CL)	ALLUVIUM		M							
14	▽										
16	**CLAYSTONE**, Silty Lean Clay, red, gypsum lenses present (CL)	SPEARFISH FORMATION		W							
18	Bottom of Boring										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS						
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
18.0	**4" FA**	**11/28/18**	**16:00**	**18.0**	**NA**	**NA**	**NA**	**14.0**
BORING COMPLETED: **11/28/18**								
DR: **BT** LG: **JR** Rig: **RC-1**								

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

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 12/3/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B-23 (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: _____ MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1	**LIMESTONE AGGREGATE SURFACING**, 10 inches	SURFACIING									
2	**FILL**, Silty Lean Clay with Sand, reddish brown, gypsum, claystone and coal fragments present (CL)	FILL									
6	**SILTY LEAN CLAY**, red (CL)	ALLUVIUM		M							
13	▽										
15				W							
16	**CLAYSTONE**, Silty Lean Clay, red, gypsum lenses present (CL)	SPEARFISH FORMATION									
18	Bottom of Boring										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS						
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
18.0	**4" FA**	**11/28/18**	**15:15**	**18.0**	**NA**	**NA**	**NA**	**13.0**
BORING COMPLETED: **11/28/18**								
DR: **BT** LG: **JR** Rig: **RC-1**								

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

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 12/3/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B-24 (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: _____ MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1	**LIMESTONE AGGREGATE SURFACING**, 10 inches	SURFACIING									
2	**FILL**, Silty Lean Clay with Sand, reddish brown, gypsum, claystone and coal fragments present (CL)	FILL									
7	**SILTY LEAN CLAY**, red (CL)	ALLUVIUM		M							
15	▽										
16	**CLAYSTONE**, Silty Lean Clay, red, gypsum lenses present (CL)	SPEARFISH FORMATION		W							
18	Bottom of Boring										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS						
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
18.0	**4" FA**	**11/28/18**	**15:00**	**18.0**	**NA**	**NA**	**NA**	**15.0**
BORING COMPLETED: **11/28/18**								
DR: **BT** LG: **JR** Rig: **RC-1**								

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

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 12/3/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B-25 (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: _____ MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1	**LIMESTONE AGGREGATE SURFACING**, 10 inches	SURFACIING									
2	**FILL**, Silty Lean Clay with Sand, reddish brown, gypsum, claystone and coal fragments present (CL)	FILL									
7	**SILTY LEAN CLAY**, red (CL)	ALLUVIUM		M							
15	▽										
16	**CLAYSTONE**, Silty Lean Clay, red, gypsum lenses present (CL)	SPEARFISH FORMATION		W							
18	Bottom of Boring										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
18.0	**4" FA**	**11/28/18**	**14:35**	**18.0**	**NA**	**NA**	**NA**	**15.0**	
BORING COMPLETED: **11/28/18**									
DR: **BT** LG: **JR** Rig: **RC-1**									

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 12/3/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B-26 (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: _____ MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1	**LIMESTONE AGGREGATE SURFACING**, 10 inches	SURFACIING									
2	**FILL**, Silty Lean Clay with Sand, reddish brown, gypsum, claystone and coal fragments present (CL)	FILL									
3											
4											
5											
6											
7											
8											
9				M							
10	**SILTY LEAN CLAY**, red (CL)	ALLUVIUM									
11											
12											
13											
14											
15											
16											
17				▽ W							
18	**CLAYSTONE**, Silty Lean Clay, red, gypsum lenses present (CL)	SPEARFISH FORMATION									
	Bottom of Boring										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS						
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
18.0	**4" FA**	**11/28/18**	**12:20**	**18.0**	**NA**	**NA**	**NA**	**17.0**
BORING COMPLETED: **11/28/18**								
DR: **BT** LG: **JR** Rig: **RC-1**								

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

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 12/3/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B-26A (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: _____ MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1	**LIMESTONE AGGREGATE SURFACING**, 10 inches	SURFACIING									
2	**FILL**, Silty Lean Clay with Sand, reddish brown, gypsum, claystone and coal fragments present (CL)	FILL									
3											
4											
5											
6											
7											
8											
9				M							
10	**SILTY LEAN CLAY**, red (CL)	ALLUVIUM									
11											
12											
13											
14											
15											
16											
17				▽ W							
18	**CLAYSTONE**, Silty Lean Clay, red, gypsum lenses present (CL)	SPEARFISH FORMATION									
	Bottom of Boring										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS						
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
18.0	**4" FA**	**11/28/18**	**12:05**	**18.0**	**NA**	**NA**	**NA**	**17.0**
BORING COMPLETED: **11/28/18**								
DR: **BT** LG: **JR** Rig: **RC-1**								

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

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 12/3/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B-26B (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: _____ MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1	**LIMESTONE AGGREGATE SURFACING**, 10 inches	SURFACIING									
2	**FILL**, Silty Lean Clay with Sand, reddish brown, gypsum, claystone and coal fragments present (CL)	FILL									
3											
4											
5											
6											
7											
8											
9				M							
10	**SILTY LEAN CLAY**, red (CL)	ALLUVIUM									
11											
12											
13											
14											
15											
16											
17				▽ W							
18	**CLAYSTONE**, Silty Lean Clay, red, gypsum lenses present (CL)	SPEARFISH FORMATION									
	Bottom of Boring										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS						
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
18.0	**4" FA**	**11/28/18**	**12:55**	**18.0**	**NA**	**NA**	**NA**	**17.0**
BORING COMPLETED: **11/28/18**								
DR: **BT** LG: **JR** Rig: **RC-1**								

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

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 12/3/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B-26C (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: _____ MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1	**LIMESTONE AGGREGATE SURFACING**, 10 inches	SURFACIING									
2	**FILL**, Silty Lean Clay with Sand, reddish brown, gypsum, claystone and coal fragments present (CL)	FILL									
3											
4											
5											
6											
7											
8											
9				M							
10	**SILTY LEAN CLAY**, red (CL)	ALLUVIUM									
11											
12											
13											
14											
15											
16											
17				▽ W							
18	**CLAYSTONE**, Silty Lean Clay, red, gypsum lenses present (CL)	SPEARFISH FORMATION									
	Bottom of Boring										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS						
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
18.0	**4" FA**	**11/28/18**	**13:35**	**18.0**	**NA**	**NA**	**NA**	**17.0**
BORING COMPLETED: **11/28/18**								
DR: **BT** LG: **JR** Rig: **RC-1**								

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

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 12/3/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B-26D (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: _____ MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1	**LIMESTONE AGGREGATE SURFACING**, 10 inches	SURFACIING									
2	**FILL**, Silty Lean Clay with Sand, reddish brown, gypsum, claystone and coal fragments present (CL)	FILL									
3											
4											
5											
6											
7											
8											
9				M							
10	**SILTY LEAN CLAY**, red (CL)	ALLUVIUM									
11											
12											
13											
14											
15											
16											
17				▽ W							
18	**CLAYSTONE**, Silty Lean Clay, red, gypsum lenses present (CL)	SPEARFISH FORMATION									
	Bottom of Boring										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS						
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
18.0	**4" FA**	**11/28/18**	**12:25**	**18.0**	**NA**	**NA**	**NA**	**17.0**
BORING COMPLETED: **11/28/18**								
DR: **BT** LG: **JR** Rig: **RC-1**								

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

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 12/3/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B-27 (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: _____ MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1	**LIMESTONE AGGREGATE SURFACING**, 10 inches	SURFACIING									
2	**FILL**, Silty Lean Clay with Sand, reddish brown, gypsum, claystone and coal fragments present (CL)	FILL									
3											
4											
5											
6											
7											
8											
9				M							
10											
11											
12											
13	**CLAYSTONE**, Silty Lean Clay, red, gypsum lenses present (CL)	SPEARFISH FORMATION									
14											
15											
16											
17											
18	Bottom of Boring										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
18.0	**4" FA**	**11/28/18**	**10:35**	**18.0**	**NA**	**NA**	**NA**	**None**	
BORING COMPLETED: **11/28/18**									
DR: **BT** LG: **JR** Rig: **RC-1**									

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 12/3/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B-27A (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: _____ MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1	**LIMESTONE AGGREGATE SURFACING**, 10 inches	SURFACIING									
2	**FILL**, Silty Lean Clay with Sand, reddish brown, gypsum, claystone and coal fragments present (CL)	FILL									
3											
4											
5											
6											
7											
8											
9				M							
10											
11											
12											
13	**CLAYSTONE**, Silty Lean Clay, red, gypsum lenses present (CL)	SPEARFISH FORMATION									
14											
15											
16											
17											
18	Bottom of Boring										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
18.0	**4" FA**	**11/28/18**	**10:55**	**18.0**	**NA**	**NA**	**NA**	**None**	
BORING COMPLETED: **11/28/18**									
DR: **BT** LG: **JR** Rig: **RC-1**									

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 12/3/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B-27B (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: _____ MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1	**LIMESTONE AGGREGATE SURFACING**, 10 inches	SURFACIING									
2	**FILL**, Silty Lean Clay with Sand, reddish brown, gypsum, claystone and coal fragments present (CL)	FILL									
3											
4											
5											
6											
7											
8											
9				M							
10											
11											
12											
13	**CLAYSTONE**, Silty Lean Clay, red, gypsum lenses present (CL)	SPEARFISH FORMATION									
14											
15											
16											
17											
18	Bottom of Boring										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
18.0	**4" FA**	**11/28/18**	**11:18**	**18.0**	**NA**	**NA**	**NA**	**None**	
BORING COMPLETED: **11/28/18**									
DR: **BT** LG: **JR** Rig: **RC-1**									

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 12/3/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B-27C (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: _____ MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1	**LIMESTONE AGGREGATE SURFACING**, 10 inches	SURFACIING									
2	**FILL**, Silty Lean Clay with Sand, reddish brown, gypsum, claystone and coal fragments present (CL)	FILL									
3											
4											
5											
6											
7											
8											
9				M							
10											
11											
12											
13	**CLAYSTONE**, Silty Lean Clay, red, gypsum lenses present (CL)	SPEARFISH FORMATION									
14											
15											
16											
17											
18	Bottom of Boring										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
18.0	**4" FA**	**11/28/18**	**11:40**	**18.0**	**NA**	**NA**	**NA**	**None**	
BORING COMPLETED: **11/28/18**									
DR: **BT** LG: **JR** Rig: **RC-1**									

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 12/3/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B-27D (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: _____ MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1	**LIMESTONE AGGREGATE SURFACING**, 10 inches	SURFACIING									
2	**FILL**, Silty Lean Clay with Sand, reddish brown, gypsum, claystone and coal fragments present (CL)	FILL									
3											
4											
5											
6											
7											
8											
9				M							
10											
11											
12											
13	**CLAYSTONE**, Silty Lean Clay, red, gypsum lenses present (CL)	SPEARFISH FORMATION									
14											
15											
16											
17											
18	Bottom of Boring										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
18.0	**4" FA**	**11/28/18**	**11:10**	**18.0**	**NA**	**NA**	**NA**	**None**	
BORING COMPLETED: **11/28/18**									
DR: **BT** LG: **JR** Rig: **RC-1**									

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 12/3/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B-28 (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: _____ MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1	**LIMESTONE AGGREGATE SURFACING**, 10 inches	SURFACIING									
2	**FILL**, Silty Lean Clay with Sand, reddish brown, gypsum, claystone and coal fragments present (CL) with metal debris	FILL									
3											
4											
5											
6											
7				M							
8											
9											
10											
11											
12	**SILTY LEAN CLAY**, reddish brown (CL)	ALLUVIUM									
13											
14				▽							
15											
16				W							
17											
18	Bottom of Boring										

DEPTH:	DRILLING METHOD
18.0	**4" FA**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
11/28/18	**10:15**	**18.0**	**NA**	**NA**	**NA**	**14.0**

BORING COMPLETED: **11/28/18**

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

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

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 12/3/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B-29 (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: _____ MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1	**LIMESTONE AGGREGATE SURFACING**, 10 inches	SURFACIING									
2	**FILL**, Silty Lean Clay with Sand, reddish brown, gypsum, claystone and coal fragments present (CL)	FILL		M							
3											
4											
5											
6											
7	with metal debris at 7'										
	Auger Refsual at 7'										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS						
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
7.0	**4" FA**	**11/28/18**	**9:20**	**18.0**	**NA**	**NA**	**NA**	**None**
BORING COMPLETED: **11/28/18**								
DR: **BT** LG: **JR** Rig: **RC-1**								

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

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 12/3/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B-30 (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: _____ MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1	**LIMESTONE AGGREGATE SURFACING**, 12 inches	SURFACING									
2	**FILL**, Silty Lean Clay with Sand, reddish brown, gypsum, claystone and coal fragments present (CL)	FILL									
3											
4											
5											
6											
7											
8											
9	**GYPSUM**, white	SPEARFISH FORMATION		M							
10											
11											
12											
13											
14											
15	**CLAYSTONE**, Silty Lean Clay, red, gypsum lenses present (CL)										
16											
17											
18	Bottom of Boring										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
18.0	**4" FA**	**11/28/18**	**9:45**	**18.0**	**NA**	**NA**	**NA**	**None**	
BORING COMPLETED: **11/28/18**									
DR: **BT** LG: **JR** Rig: **RC-1**									

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 12/3/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B-31 (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: _____ MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1	**LIMESTONE AGGREGATE SURFACING**, 9 inches	SURFACING									
2	**FILL**, Silty Lean Clay with Sand, reddish brown, gypsum, claystone and coal fragments present (CL)	FILL									
3											
4											
5											
6											
7											
8											
9	**CLAYSTONE**, Silty Lean Clay, red, gypsum lenses present (CL)	SPEARFISH FORMATION		M							
10											
11											
12											
13											
14											
15											
16											
17											
18	Bottom of Boring										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
18.0	**4" FA**	**11/28/18**	**9:10**	**18.0**	**NA**	**NA**	**NA**	**None**	
BORING COMPLETED: **11/28/18**									
DR: **BT** LG: **JR** Rig: **RC-1**									

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 12/3/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B-32 (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: _____ MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1	**LIMESTONE AGGREGATE SURFACING**, 10 inches	SURFACIING									
2	**FILL**, Silty Lean Clay with Sand, reddish brown, gypsum, claystone and coal fragments present (CL)	FILL									
3											
4											
5											
6											
7											
8											
9				M							
10											
11											
12											
13	**CLAYSTONE**, Silty Lean Clay, red, gypsum lenses present (CL)	SPEARFISH FORMATION									
14											
15											
16											
17											
18	Bottom of Boring										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
18.0	**4" FA**	**11/28/18**	**10:05**	**18.0**	**NA**	**NA**	**NA**	**None**	
BORING COMPLETED: **11/28/18**									
DR: **BT** LG: **JR** Rig: **RC-1**									

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 12/3/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B-33 (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: _____ MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1	**LIMESTONE AGGREGATE SURFACING**, 10 inches	SURFACIING									
2	**FILL**, Silty Lean Clay with Sand, reddish brown, gypsum, claystone and coal fragments present (CL)	FILL									
5	**SILTY LEAN CLAY**, red (CL)	ALLUVIUM		M							
15				▽ W							
18	Bottom of Boring										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
18.0	**4" FA**	**11/29/18**		**18.0**	**NA**	**NA**	**NA**	**15.0**	
BORING COMPLETED: **11/29/18**									
DR: **BT** LG: **BB** Rig: **RC-1**									

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 12/3/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B-34 (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: _____ MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1	**LIMESTONE AGGREGATE SURFACING**, 10 inches	SURFACIING									
2	**FILL**, Silty Lean Clay with Sand, reddish brown, gypsum, claystone and coal fragments present (CL)	FILL									
3											
4											
5											
6											
7											
8											
9				M							
10	**SILTY LEAN CLAY**, red (CL)	ALLUVIUM									
11											
12	**CLAYSTONE**, Silty Lean Clay, red, gypsum lenses present (CL)	SPEARFISH FORMATION									
13											
14											
15											
16											
17											
18	Bottom of Boring										

DEPTH:	DRILLING METHOD
18.0	**4" FA**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
11/29/18		**18.0**	**NA**	**NA**	**NA**	**None**

BORING COMPLETED: **11/29/18**

DR: **BT** LG: **BB** Rig: **RC-1**

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

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 12/3/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B-35 (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: _____ MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1	**LIMESTONE AGGREGATE SURFACING**, 10 inches	SURFACIING									
2	**FILL**, Silty Lean Clay with Sand, reddish brown, gypsum, claystone and coal fragments present (CL)	FILL									
3											
4											
5											
6											
7											
8											
9				M							
10	**SILTY LEAN CLAY**, reddish brown (CL)	ALLUVIUM									
11											
12											
13											
14											
15											
16											
17											
18	Bottom of Boring										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
18.0	**4" FA**	**11/29/18**		**18.0**	**NA**	**NA**	**NA**	**None**	
BORING COMPLETED: **11/29/18**									
DR: **BT** LG: **BB** Rig: **RC-1**									

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 12/3/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B-36 (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: _____ MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1	**LIMESTONE AGGREGATE SURFACING**, 10 inches	SURFACIING									
2	**FILL**, Silty Lean Clay with Sand, reddish brown, gypsum, claystone and coal fragments present (CL)	FILL									
3											
4											
5											
6											
7											
8											
9				M							
10	**SILTY LEAN CLAY**, reddish brown (CL)	ALLUVIUM									
11											
12											
13											
14											
15											
16											
17											
18	Bottom of Boring										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
18.0	**4" FA**	**11/29/18**		**18.0**	**NA**	**NA**	**NA**	**None**	
BORING COMPLETED: **11/29/18**									
DR: **BT** LG: **BB** Rig: **RC-1**									

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 12/3/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B-36A (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: _____ MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1	**LIMESTONE AGGREGATE SURFACING**, 10 inches	SURFACIING									
2	**FILL**, Silty Lean Clay with Sand, reddish brown, gypsum, claystone and coal fragments present (CL)	FILL									
3											
4											
5											
6											
7											
8											
9				M							
10	**SILTY LEAN CLAY**, reddish brown (CL)	ALLUVIUM									
11											
12											
13											
14											
15											
16											
17											
18	Bottom of Boring										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
18.0	**4" FA**	**11/29/18**		**18.0**	**NA**	**NA**	**NA**	**None**	
BORING COMPLETED: **11/29/18**									
DR: **BT** LG: **BB** Rig: **RC-1**									

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 12/3/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B-36B (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: _____ MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1	**LIMESTONE AGGREGATE SURFACING**, 10 inches	SURFACIING									
2	**FILL**, Silty Lean Clay with Sand, reddish brown, gypsum, claystone and coal fragments present (CL)	FILL									
3											
4											
5											
6											
7											
8											
9				M							
10	**SILTY LEAN CLAY**, reddish brown (CL)	ALLUVIUM									
11											
12											
13											
14											
15											
16											
17											
18	Bottom of Boring										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
18.0	**4" FA**	**11/29/18**		**18.0**	**NA**	**NA**	**NA**	**None**	
BORING COMPLETED: **11/29/18**									
DR: **BT** LG: **BB** Rig: **RC-1**									

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 12/3/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B-36C (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: _____ MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1	**LIMESTONE AGGREGATE SURFACING**, 10 inches	SURFACIING									
2	**FILL**, Silty Lean Clay with Sand, reddish brown, gypsum, claystone and coal fragments present (CL)	FILL									
3											
4											
5											
6											
7											
8											
9				M							
10	**SILTY LEAN CLAY**, reddish brown (CL)	ALLUVIUM									
11											
12											
13											
14											
15											
16											
17											
18	Bottom of Boring										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
18.0	**4" FA**	**11/29/18**		**18.0**	**NA**	**NA**	**NA**	**None**	
BORING COMPLETED: **11/29/18**									
DR: **BT** LG: **BB** Rig: **RC-1**									

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 12/3/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B-36D (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: _____ MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1	**LIMESTONE AGGREGATE SURFACING**, 10 inches	SURFACIING									
2	**FILL**, Silty Lean Clay with Sand, reddish brown, gypsum, claystone and coal fragments present (CL)	FILL									
3											
4											
5											
6											
7											
8											
9				M							
10	**SILTY LEAN CLAY**, reddish brown (CL)	ALLUVIUM									
11											
12											
13											
14											
15											
16											
17											
18	Bottom of Boring										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
18.0	**4" FA**	**11/29/18**		**18.0**	**NA**	**NA**	**NA**	**None**	
BORING COMPLETED: **11/29/18**									
DR: **BT** LG: **BB** Rig: **RC-1**									

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 12/3/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B-37 (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: _____ MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1	**LIMESTONE AGGREGATE SURFACING**, 10 inches	SURFACIING									
2	**FILL**, Silty Lean Clay with Sand, reddish brown, gypsum, claystone and coal fragments present (CL)	FILL									
3											
4											
5											
6											
7											
8											
9				M							
10	**SILTY LEAN CLAY**, reddish brown (CL)	ALLUVIUM									
11											
12											
13											
14											
15											
16											
17											
18	Bottom of Boring										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
18.0	**4" FA**	**11/29/18**		**18.0**	**NA**	**NA**	**NA**	**None**	
BORING COMPLETED: **11/29/18**									
DR: **BT** LG: **BB** Rig: **RC-1**									

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 12/3/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B-37A (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: _____ MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1	**LIMESTONE AGGREGATE SURFACING**, 10 inches	SURFACIING									
2	**FILL**, Silty Lean Clay with Sand, reddish brown, gypsum, claystone and coal fragments present (CL)	FILL									
3											
4											
5											
6											
7											
8											
9				M							
10	**SILTY LEAN CLAY**, reddish brown (CL)	ALLUVIUM									
11											
12											
13											
14											
15											
16											
17											
18	Bottom of Boring										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
18.0	**4" FA**	**11/29/18**		**18.0**	**NA**	**NA**	**NA**	**None**	
BORING COMPLETED: **11/29/18**									
DR: **BT** LG: **BB** Rig: **RC-1**									

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 12/3/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B-37B (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: _____ MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1	**LIMESTONE AGGREGATE SURFACING**, 10 inches	SURFACIING									
2	**FILL**, Silty Lean Clay with Sand, reddish brown, gypsum, claystone and coal fragments present (CL)	FILL									
3											
4											
5											
6											
7											
8											
9				M							
10	**SILTY LEAN CLAY**, reddish brown (CL)	ALLUVIUM									
11											
12											
13											
14											
15											
16											
17											
18	Bottom of Boring										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
18.0	**4" FA**	**11/29/18**		**18.0**	**NA**	**NA**	**NA**	**None**	
BORING COMPLETED: **11/29/18**									
DR: **BT** LG: **BB** Rig: **RC-1**									

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 12/3/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B-37C (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: _____ MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1	**LIMESTONE AGGREGATE SURFACING**, 10 inches	SURFACIING									
2	**FILL**, Silty Lean Clay with Sand, reddish brown, gypsum, claystone and coal fragments present (CL)	FILL									
3											
4											
5											
6											
7											
8											
9				M							
10	**SILTY LEAN CLAY**, reddish brown (CL)	ALLUVIUM									
11											
12											
13											
14											
15											
16											
17											
18	Bottom of Boring										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
18.0	**4" FA**	**11/29/18**		**18.0**	**NA**	**NA**	**NA**	**None**	
BORING COMPLETED: **11/29/18**									
DR: **BT** LG: **BB** Rig: **RC-1**									

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 12/3/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B-37D (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: _____ MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1	**LIMESTONE AGGREGATE SURFACING**, 10 inches	SURFACIING									
2	**FILL**, Silty Lean Clay with Sand, reddish brown, gypsum, claystone and coal fragments present (CL)	FILL									
3											
4											
5											
6											
7											
8											
9				M							
10	**SILTY LEAN CLAY**, reddish brown (CL)	ALLUVIUM									
11											
12											
13											
14											
15											
16											
17											
18	Bottom of Boring										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
18.0	**4" FA**	**11/29/18**		**18.0**	**NA**	**NA**	**NA**	**None**	
BORING COMPLETED: **11/29/18**									
DR: **BT** LG: **BB** Rig: **RC-1**									

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 12/3/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B-38 (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: _____ MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1	**LIMESTONE AGGREGATE SURFACING**, 10 inches	SURFACIING									
2	**FILL**, Silty Lean Clay with Sand, reddish brown, gypsum, claystone and coal fragments present (CL)	FILL									
3											
4											
5											
6											
7											
8											
9				M							
10	**SILTY LEAN CLAY**, reddish brown (CL)	ALLUVIUM									
11											
12											
13											
14											
15											
16	**CLAYSTONE**, Silty Lean Clay, red, gypsum lenses present (CL)	SPEARFISH FORMATION									
17				$\bar{W}$							
18	Bottom of Boring										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
18.0	**4" FA**	**11/29/18**		**18.0**	**NA**	**NA**	**NA**	**17.0**	
BORING COMPLETED: **11/29/18**									
DR: **BT** LG: **BB** Rig: **RC-1**									

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 12/3/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B-39 (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: _____ MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1	**LIMESTONE AGGREGATE SURFACING**, 10 inches	SURFACIING									
2	**FILL**, Silty Lean Clay with Sand, reddish brown, gypsum, claystone and coal fragments present (CL)	FILL									
3											
4	with possible gypsum boulder present										
5											
6											
7											
8				M							
9											
10	**SILTY LEAN CLAY**, reddish brown (CL)	ALLUVIUM									
11											
12											
13											
14											
15											
16	with strong hydrocarbon odor and discoloration			▽							
17	**CLAYSTONE**, Silty Lean Clay, red, gypsum lenses present (CL)	SPEARFISH FORMATION		W							
18	Bottom of Boring										

DEPTH:	DRILLING METHOD
18.0	**4" FA**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
11/29/18		**18.0**	**NA**	**NA**	**NA**	**16.0**

BORING COMPLETED: **11/29/18**

DR: **BT** LG: **BB** Rig: **RC-1**

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

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 12/3/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B-40 (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: _____ MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1	**LIMESTONE AGGREGATE SURFACING**, 10 inches	SURFACIING									
2	**FILL**, Silty Lean Clay with Sand, reddish brown, gypsum, claystone and coal fragments present (CL)	FILL									
3											
4											
5											
6											
7											
8				M							
9											
10	**SILTY LEAN CLAY**, reddish brown (CL)	ALLUVIUM									
11											
12											
13											
14											
15				▽							
16	**CLAYSTONE**, Silty Lean Clay, red, gypsum lenses present (CL)	SPEARFISH FORMATION									
17				W							
18	Bottom of Boring										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS						
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
18.0	**4" FA**	**11/29/18**		**18.0**	**NA**	**NA**	**NA**	**15.5**
BORING COMPLETED: **11/29/18**								
DR: **BT** LG: **BB** Rig: **RC-1**								

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

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 12/3/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B-41 (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: _____ MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1	**LIMESTONE AGGREGATE SURFACING**, 10 inches	SURFACIING									
2	**FILL**, Silty Lean Clay with Sand, reddish brown, gypsum, claystone and coal fragments present (CL)	FILL									
3											
4											
5											
6											
7											
8				M							
9											
10	**SILTY LEAN CLAY**, reddish brown (CL)	ALLUVIUM									
11											
12											
13											
14											
15											
16				▽							
17	**CLAYSTONE**, Silty Lean Clay, red, gypsum lenses present (CL)	SPEARFISH FORMATION		W							
18	Bottom of Boring										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS						
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
18.0	**4" FA**	**11/29/18**		**18.0**	**NA**	**NA**	**NA**	**16.0**
BORING COMPLETED: **11/29/18**								
DR: **BT** LG: **BB** Rig: **RC-1**								

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

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 12/3/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B-42 (p. 1 of 1)**

PROJECT: **West Rapid Substation; Rapid City, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: _____ MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1	**LIMESTONE AGGREGATE SURFACING**, 10 inches	SURFACIING									
2	**FILL**, Silty Lean Clay with Sand, reddish brown, gypsum, claystone and coal fragments present (CL)	FILL									
3											
4											
5											
6											
7											
8											
9				M							
10	**SILTY LEAN CLAY**, reddish brown (CL)	ALLUVIUM									
11											
12											
13											
14											
15											
16	**CLAYSTONE**, Silty Lean Clay, red, gypsum lenses present (CL)	SPEARFISH FORMATION									
17				$\bar{W}$							
18	Bottom of Boring										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
18.0	**4" FA**	**11/29/18**		**18.0**	**NA**	**NA**	**NA**	**17.0**	
BORING COMPLETED: **11/29/18**									
DR: **BT** LG: **BB** Rig: **RC-1**									

AET_CORP 17-03356.GPJ AET+CPT+WELL.GDT 12/3/18

AMERICAN ENGINEERING TESTING, Inc.

CONSULTANTS
- GEOTECHNICAL
- MATERIALS
- ENVIRONMENTAL
- FORENSICS

REPORT OF GEOTECHNICAL EXPLORATION AND REVIEW

WEST RAPID SUBSTATION TRANSMISSION LINE POLES
RAPID CITY, SOUTH DAKOTA

AET No. 17-03356

Date:

January 16, 2019

Prepared for:

Black Hills Energy
7001 Mt. Rushmore Road
Rapid City, South Dakota 57702

www.amengtest.com

AMERICAN
ENGINEERING
TESTING, INC.

CONSULTANTS
· GEOTECHNICAL
· MATERIALS
· ENVIRONMENTAL

January 16, 2019

Black Hills Energy
7001 Mt. Rushmore Road
Rapid City, South Dakota 57702

Attn: Mr. Ron Williams, PE

RE: Geotechnical Exploration and Review
West Rapid Substation
Transmission Line Poles
Rapid City, South Dakota
Report No.17-03356

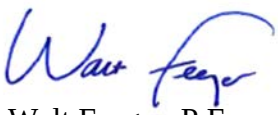
Dear Ron,

American Engineering Testing, Inc. (AET) is pleased to present the results of our subsurface exploration program and geotechnical engineering review for the proposed transmission line poles to be constructed as part of the West Rapid Substation project, in Rapid City, South Dakota. These services were performed in general accordance with our proposal dated December 5, 2018 and the signed Statement of Services No. 38863, Change Order No. 4, dated December 17, 2018. We are submitting one (1) 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 our office if you have any questions about the report. We can also be contacted to arrange the observation and testing services during construction of the project.

Sincerely,
American Engineering Testing, Inc.



Walt Feeger, P.E.
Senior Geotechnical Engineer
Phone: (605) 388-0029
wfeeger@amengtest.com

SIGNATURE PAGE

Prepared for:

Black Hills Energy
7001 Mt. Rushmore Road
Rapid City, South Dakota 57701

Attn: Mr. Ron Williams, PE

Prepared by:

American Engineering Testing, Inc.
1745 Samco Road
Rapid City, South Dakota 57702

Report Authored By:

Walt Feeger, P.E.
Senior Geotechnical Engineer

Peer Review Conducted By:

Robert Temme, P.E.
Vice President – Western Region

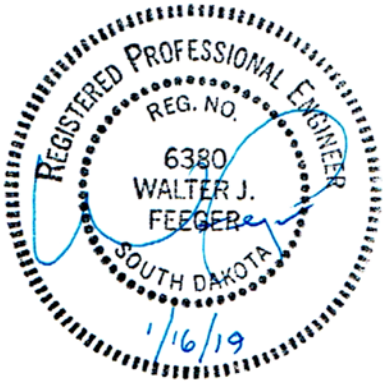


TABLE OF CONTENTS

1.0 INTRODUCTION

We understand a new transmission line will be constructed as part of the proposed West Rapid Substation project in Rapid City, South Dakota. Please refer to the Site Location Map in Appendix A for the approximate location of the sites. To assist with the planning and design, American Engineering Testing, Inc. (AET) has been authorized to conduct a subsurface exploration program at the locations of the transmission poles, conduct soil laboratory testing, 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 in general accordance with our proposal dated December 5, 2018. The authorized scope consists of the following:

- Eight (8) standard penetration test (SPT) borings at the proposed transmission pole locations to depths of about 50 feet below existing grade.
- Soil laboratory testing.
- Geotechnical engineering analysis based on the gained data and preparation of this report.

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

3.0 PROJECT INFORMATION

AET recently completed the geotechnical services for the proposed West Rapid Substation project, and submitted our findings and recommendations in our Report No. 17-03356, dated May 31, 2018. We understand that, as part of the new substation, a transmission line will also be required. Furthermore, we understand these types of pole structures are typically placed on reinforced concrete drilled piers (caissons). The following loading information at the respective boring locations was provided by HDR Engineering, Inc.

- B-1
  Moment: 13,000 ft-k
  Shear Force: 185 kips
  Vertical Force: 85 kips
- B-3
  Moment: 18,900 ft-k
  Shear Force: 205 kips
  Vertical Force: 125 kips

- B-4
  Moment: 11,100 ft-k
  Shear Force: 135 kips
  Vertical Force: 65 kips
- B-5
  Moment: 3,000 ft-k
  Shear Force: 35 kips
  Vertical Force: 65 kips
- B-6
  Moment: 2,000 ft-k
  Shear Force: 40 kips
  Vertical Force: 25 kips
- B-7
  Moment: 5,300 ft-k
  Shear Force: 75 kips
  Vertical Force: 35 kips
- B-8
  Moment: 3,500 ft-k
  Shear Force: 55 kips
  Vertical Force: 100 kips

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 the project consisted of eight (8) SPT borings which were drilled on December 19-21 and 27, 2018. The borings were located in the field by HDR personnel at the approximate locations shown on the Boring Location Map within Appendix A. Surface elevations at the boring locations were also provided by HDR.

The logs of the borings and details of the methods used appear in Appendix A. The logs contain information concerning soil layering, soil 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).

4.2 Laboratory Testing

The laboratory test program included water content, dry density, unconfined compression, swell-consolidation. The laboratory test results appear in Appendix A on the individual boring logs adjacent to the samples upon which they were performed with the exception of the unconfined compression and swell-consolidation tests, which can be found on separate sheets within Appendix A of this report.

5.0 SITE CONDITIONS

5.1 Surface Observations

At the time of our field work, the areas surrounding the proposed transmission pole locations consisted of the existing Black Hills Energy Service Center (Borings B-3 through B-8) facility as well as vacant tracts of property around Borings B-1 and B-2, which were vegetated with native grasses and weeds.

5.2 Subsurface Soils/Geology

Underlying a thin layer of gravel surfacing or topsoil, the following subsurface conditions were encountered at the boring locations:

Boring B-1: Approximately 19½ feet of alluvium comprised of medium dense silty sands, firm to hard sandy lean clays, and dense to very dense sandy gravels overlying shale bedrock, associated with the Sundance Formation, which extended to the total depth explored.

Boring B-2: Approximately 7 feet of alluvium comprised of very stiff fat clay and hard silty lean clay overlying stiff to very stiff weathered to hard, competent shale bedrock, associated with the Spearfish Formation, which extended to the total depth explored.

Boring B-3: Approximately 9½ feet of alluvium comprised of hard silty lean clays and very dense sandy gravels overlying hard shale of the Sundance Formation, over gypsum and hard siltstone bedrock of the Gypsum Spring Formation, which extended to the total depth explored.

Boring B-4: Near surface hard shale of the Sundance Formation was encountered overlying gypsum, and interbedded hard siltstone and shale bedrock of the Gypsum Spring Formation, which extended to the total depth explored.

Boring B-5: Approximately 14 feet of lean to fat clay fill was encountered overlying about 3½ feet of firm sandy lean clay alluvium. The alluvium in underlain by hard weathered to competent shale of the Spearfish Formation, which extended to the terminal boring depth.

Boring B-6: About 9 feet of silty lean clay fill overlying approximately 13½ feet of alluvium comprised of soft to firm lean clays. The alluvium is underlain by stiff to hard weathered to competent shale, associated with the Spearfish Formation.

Boring B-7: Near surface stiff to hard weathered to competent shale bedrock, associated with the Spearfish Formation was encountered to the total depth explored. Approximately 10 feet of gypsum was encountered at a depth of about 25 feet below grade.

Boring B-8: Approximately 4½ feet of lean clay fill was encountered overlying about 9½ feet of alluvium comprised of very stiff fat clay and very stiff lean clay. The alluvium is underlain by hard weathered to competent shale bedrock of the Spearfish Formation.

Conditions encountered at each boring location are indicated on the individual boring logs in Appendix A of this report.

5.3 Groundwater

At the time of our field work, measurable groundwater was encountered at the approximate noted depths in the following borings:

B-1: 7½ feet below grade (BG)
B-2: 15 feet BG
B-5: 8 feet BG
B-6: 11 feet BG
B-7: 20 feet BG

The presence or lack of groundwater noted at the boring locations should not be taken as an accurate representation of the actual groundwater levels. Groundwater level fluctuations occur due to seasonal variations in the amount of precipitation, surface drainage, local irrigation practices, level of water in Rapid Creek, and other factors not evident at the time the borings were performed. Due to the relatively low permeability of the clay/silt soils and shale/siltstone bedrock encountered in the borings, a relatively long period of time may be needed for a groundwater level to develop and/or stabilize in the borings.

The possibility of encountering groundwater and associated fluctuations in groundwater levels should be considered when developing the design and construction plans for the project.

6.0 RECOMMENDATIONS

6.1 Discussion

Our recommendations in the following sections are based on our understanding of the project details at this time. The geotechnical engineer should be allowed to review the final project plans to verify the following recommendations remain applicable for construction.

Based on the field and laboratory data, it is our opinion drilled pier foundations can be used to support the proposed transmission line poles. For drilled piers, loadings should provide a theoretical safety factor of 2 or more with total and differential movements not exceeding 1-inch and 1/2-inch, respectively.

Additionally, it should be noted that gypsum is a common geologic feature found in the Spearfish Formation derived soils at this site. Once exposed, gypsum material can degrade which could cause future movement related distress to the structures, especially if water is introduced to the gypsum matrix. Therefore, drilled pier foundations should not terminate (end bear) on gypsum.

6.2 Drilled Pier Foundation Recommendations

Based on the results of the borings, laboratory testing, and our analysis, we have developed the following design parameters. We recommend all drilled piers bear at least 5 feet into the noted bedrock stratum with the recommended minimum length.

Boring B-1

Soil Type	Allowable Skin Friction (psf)	Allowable End Bearing Pressure (psf)
Frost Zone (0 – 5')	Ignore	Ignore
Lean Clay Alluvium	300	na
Gravel Alluvium	200	na
Shale Bedrock	1,000	20,000 (minimum pier length – 25')

Boring B-2

Soil Type	Allowable Skin Friction (psf)	Allowable End Bearing Pressure (psf)
Frost Zone (0 – 5')	Ignore	Ignore
Lean Clay Alluvium	300	na
W. Shale Bedrock	300	na
Shale Bedrock	1,000	20,000 (minimum pier Length – 28')

Boring B-3

Soil Type	Allowable Skin Friction (psf)	Allowable End Bearing Pressure (psf)
Frost Zone (0 – 5')	Ignore	Ignore
Lean Clay Alluvium	300	na
Gravel Alluvium	200	na
Shale Bedrock	1,000	20,000 (minimum pier length – 15') Do not end bear in gypsum formation
Siltstone Bedrock	750	20,000

Boring B-4

Soil Type	Allowable Skin Friction (psf)	Allowable End Bearing Pressure (psf)
Frost Zone (0 – 5')	Ignore	Ignore
Gypsum	na	na
Siltstone Bedrock	750	20,000 (minimum pier length – 20')

Boring B-5

Soil Type	Allowable Skin Friction (psf)	Allowable End Bearing Pressure (psf)
Frost Zone (0 – 5')	Ignore	Ignore
Lean to Fat Clay Fill	150	na
Lean Clay Alluvium	200	na
W. Shale Bedrock	300	na
Shale Bedrock	1,000	20,000 (minimum pier length – 28')

Boring B-6

Soil Type	Allowable Skin Friction (psf)	Allowable End Bearing Pressure (psf)
Frost Zone (0 – 5')	Ignore	Ignore
Lean Clay Fill	150	na
Lean Clay Alluvium	200	na
W. Shale Bedrock	300	na
Shale Bedrock	1,000	20,000 (minimum pier length – 43')

Boring B-7

Soil Type	Allowable Skin Friction (psf)	Allowable End Bearing Pressure (psf)
Frost Zone (0 – 5')	Ignore	Ignore
W. Shale Bedrock	300	na
Shale Bedrock	1,000	na
Gypsum	na	na
Shale Bedrock	1,000	20,000 (minimum pier length 40')

Boring B-8

Soil Type	Allowable Skin Friction (psf)	Allowable End Bearing Pressure (psf)
Frost Zone (0 – 5')	Ignore	Ignore
Lean to Fat Clay Alluvium	300	na
W. Shale Bedrock	300	na
Shale Bedrock	1,000	20,000 (minimum pier length – 23')

In designing to resist uplift, ⅔ of the allowable side friction values provided for compressive loading could be used along with the effective weight of the drilled shafts. Straight shaft piers with a minimum diameter of 18-inches are recommended. Proper reinforcing steel should be included in the drilled shaft designs.

Lateral deflections of drilled shafts should be evaluated using an appropriate design procedure, and would be dependent on shaft diameter, length, configuration, stiffness and "fixed head" or "free head" conditions.

Single pier lateral load capacity can be estimated using the following design parameters for the soil profile in a p-y analysis such as conducted using the computer program LPILE:

Boring B-1

Design Parameter	Lean Clay Alluvium	Gravel Alluvium	Shale Bedrock
Moist Unit Weight (pcf)	115	130	125
Undrained Shear Strength (psf)	500	na	4,000
Friction Angle (degrees)	18	34	15
Static Soil Modulus Parameter, k (pci)	100	125 (submerged)	2,000
Strain, ε_{50} (in/in)	0.010	na	0.005

Boring B-2

Design Parameter	Lean Clay Alluvium	W. Shale Bedrock	Shale Bedrock
Moist Unit Weight (pcf)	115	120	125
Undrained Shear Strength (psf)	1,000	1,500	4,000
Friction Angle (degrees)	18	15	15
Static Soil Modulus Parameter, k (pci)	500	500	2,000
Strain, ε_{50} (in/in)	0.005	0.005	0.004

Boring B-3

Design Parameter	Lean Clay Alluvium	Gravel Alluvium	Shale Bedrock	Gypsum	Siltstone Bedrock
Moist Unit Weight (pcf)	115	120	125	na	120
Undrained Shear Strength (psf)	1,000	na	4,000	na	6,000
Friction Angle (degrees)	18	34	10	na	15
Static Soil Modulus Parameter, k (pci)	500	225	2,000	na	2,000
Strain, ε_{50} (in/in)	0.005	na	0.005	na	0.004

Boring B-4

Design Parameter	Gypsum	Siltstone Bedrock	Shale Bedrock
Moist Unit Weight (pcf)	na	120	125
Undrained Shear Strength (psf)	na	4,000	6,000
Friction Angle (degrees)	na	15	18
Static Soil Modulus Parameter, k (pci)	na	1,000	2,000
Strain, ε_{50} (in/in)	na	0.004	0.004

Boring B-5

Design Parameter	Lean to Fat Clay Fill	Lean Clay Alluvium	W. Shale Bedrock	Shale Bedrock
Moist Unit Weight (pcf)	110	115	120	125
Undrained Shear Strength (psf)	250	500	1,500	6,000
Friction Angle (degrees)	18	18	15	15
Static Soil Modulus Parameter, k (pci)	100	100	500	2,000
Strain, ε_{50} (in/in)	0.020	0.010	0.005	0.004

Boring B-6

Design Parameter	Lean Clay Fill	Lean Clay Alluvium	W. Shale Bedrock	Shale Bedrock
Moist Unit Weight (pcf)	110	110	120	125
Undrained Shear Strength (psf)	250	250	1,000	6,000
Friction Angle (degrees)	18	18	15	15
Static Soil Modulus Parameter, k (pci)	100	30	1,000	2,000
Strain, ε_{50} (in/in)	0.010	0.020	0.005	0.004

Boring B-7

Design Parameter	W. Shale Bedrock	Shale Bedrock	Gypsum	Shale Bedrock
Moist Unit Weight (pcf)	120	120	na	125
Undrained Shear Strength (psf)	1,000	2,000	na	6,000
Friction Angle (degrees)	18	18	na	15
Static Soil Modulus Parameter, k (pci)	500	1,000	na	2,000
Strain, ε_{50} (in/in)	0.005	0.005	na	0.004

Boring B-8

Design Parameter	Lean to Fat Clay Alluvium	W. Shale Bedrock	Shale Bedrock
Moist Unit Weight (pcf)	115	120	125
Undrained Shear Strength (psf)	1,000	1,500	6,000
Friction Angle (degrees)	18	15	15
Static Soil Modulus Parameter, k (pci)	500	500	2,000
Strain, ε_{50} (in/in)	0.005	0.005	0.004

Drilling to design depths should be possible with conventional large drilled pier equipment. Difficult drilling should be anticipated where gypsum masses are encountered which may require rock cutting teeth and/or coring in order to advance the drilled pier hole. We highly recommend a separate bid item be provided in the bid documents that addresses drilling through the gypsum.

Additionally, it should be noted that cobbles and boulders as well as wet, sloughing soils should be expected within the gravel alluvium encountered in Boring B-1. The drilled pier contractor should have the proper muck buckets, casing and dewatering equipment on-site prior to advancing the pier holes. Additionally, auger flites and cutting teeth should be capable of removing cobble to boulder sized rock from the pier holes.

Care should be taken so that the sides and bottom of the shaft excavations are not disturbed during drilling. The bottom of the shaft excavations should be free of loose material and water when concrete is placed. Concrete should be placed as soon as possible after the foundation excavation is completed to reduce the potential for disturbance of the bearing surface.

Groundwater was encountered at the time of our field work; therefore, the use of temporary casing will likely be required. The need for casing will depend on the conditions encountered at the time the pier excavations are made. A sufficient head of plastic concrete having a minimum slump on the order of 6-8 inches should be maintained inside the casing as it is withdrawn to prevent concrete arching and the influx of soil and water (if encountered) and creation of voids in the pier shaft.

Drilled shaft construction should be constructed in accordance with applicable portions of ACI 336.3R-93 or other similar, approved specification. Concrete mix should be designed utilizing cement to have a minimum 28-day compressive strength of 4,000 psi and a maximum water cement ratio of 0.45. A super plasticizer may be necessary to increase concrete slump/flow temporarily for drilled shaft placement.

Concrete should be on-site and ready for placement as soon as practical after each pier excavation is completed. Concrete placement in pier excavations should occur on the same day as pier excavation is completed.

We do not recommend free-fall concrete placement in piers. The use of a bottom-dump hopper, tremie, or pump, discharging near the bottom of the hole where concrete segregation will be minimized, is recommended.

A representative from AET should observe all drilled shaft excavations to evaluate the suitability of the bearing materials and to verify that conditions in the drilled shaft excavations are consistent with those encountered in the test borings. If unsuitable materials are encountered at planned depths, it may be necessary to deepen the shaft.

7.0 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”.

Appendix A

AET Project No. 17-03356

Boring Log Notes
Unified Soil Classification System
Site Location Map
Boring Location Map
Subsurface Boring Logs
Unconfined Compression Test Results
Swell-Consolidation Test Results

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 the Boring Location Map, preceding the Subsurface Boring Logs in this appendix.

A.2 SAMPLING METHODS

A.2.1 Ring-lined barrel Samples - Calibrated to N_{60} Values

Standard penetration (ring-lined barrel) samples were collected in general accordance with ASTM: D3550. The ASTM test method consists of driving a 2.5-inch O.D. thick-walled, split-barrel sampler lined with brass rings 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.5.2 Atterberg Limits Tests
Conducted per AET Procedure 01-LAB-030, which is performed in general accordance with ASTM: D4318 and AASHTO: T89, T90.

A.5.3 Sieve Analysis of Soils (thru #200 Sieve)
Conducted per AET Procedure 01-LAB-040, which is performed in general conformance with ASTM: D6913, Method A.

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.

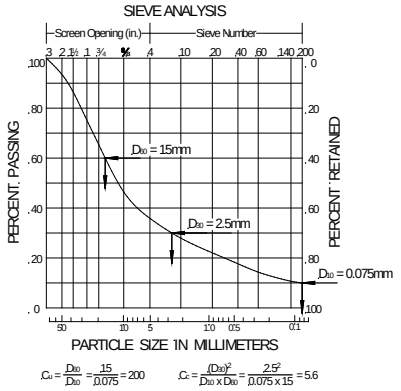
A.7 SAMPLE STORAGE

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

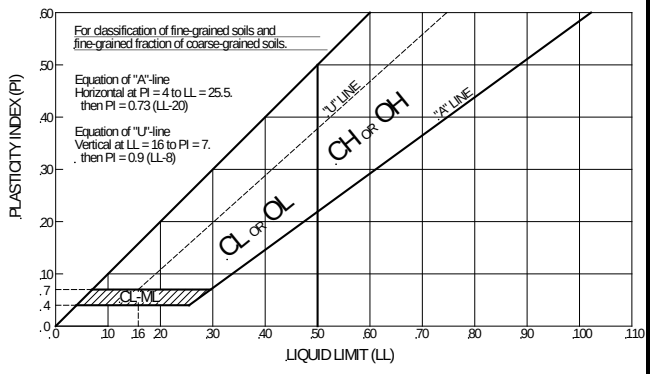
UNIFIED SOIL CLASSIFICATION SYSTEM
ASTM Designations: D 2487, D2488

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≥4 and 1≤Cc≤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≥6 and 1≤Cc≤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]



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



Plasticity Chart

Notes

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

[Q]PI plots below "A" line.

[R]Fiber Content description shown below.

ADDITIONAL TERMINOLOGY NOTES USED BY AET FOR SOIL IDENTIFICATION AND DESCRIPTION

Grain Size

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

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

Consistency of Plastic Soils

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

Relative Density of Non-Plastic Soils

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

Moisture/Frost Condition (MC Column)

D (Dry): Absence of moisture, dusty, dry to touch.

M (Moist): Damp, although free water not visible. Soil may still have a high water content (over "optimum").

W (Wet/ Waterbearing): Free water visible intended to describe non-plastic soils. Waterbearing usually relates to sands and sand with silt.

F (Frozen): Soil frozen

Layering Notes

Laminations: Layers less than ½" thick of differing material or color.

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

Fiber Content of Peat

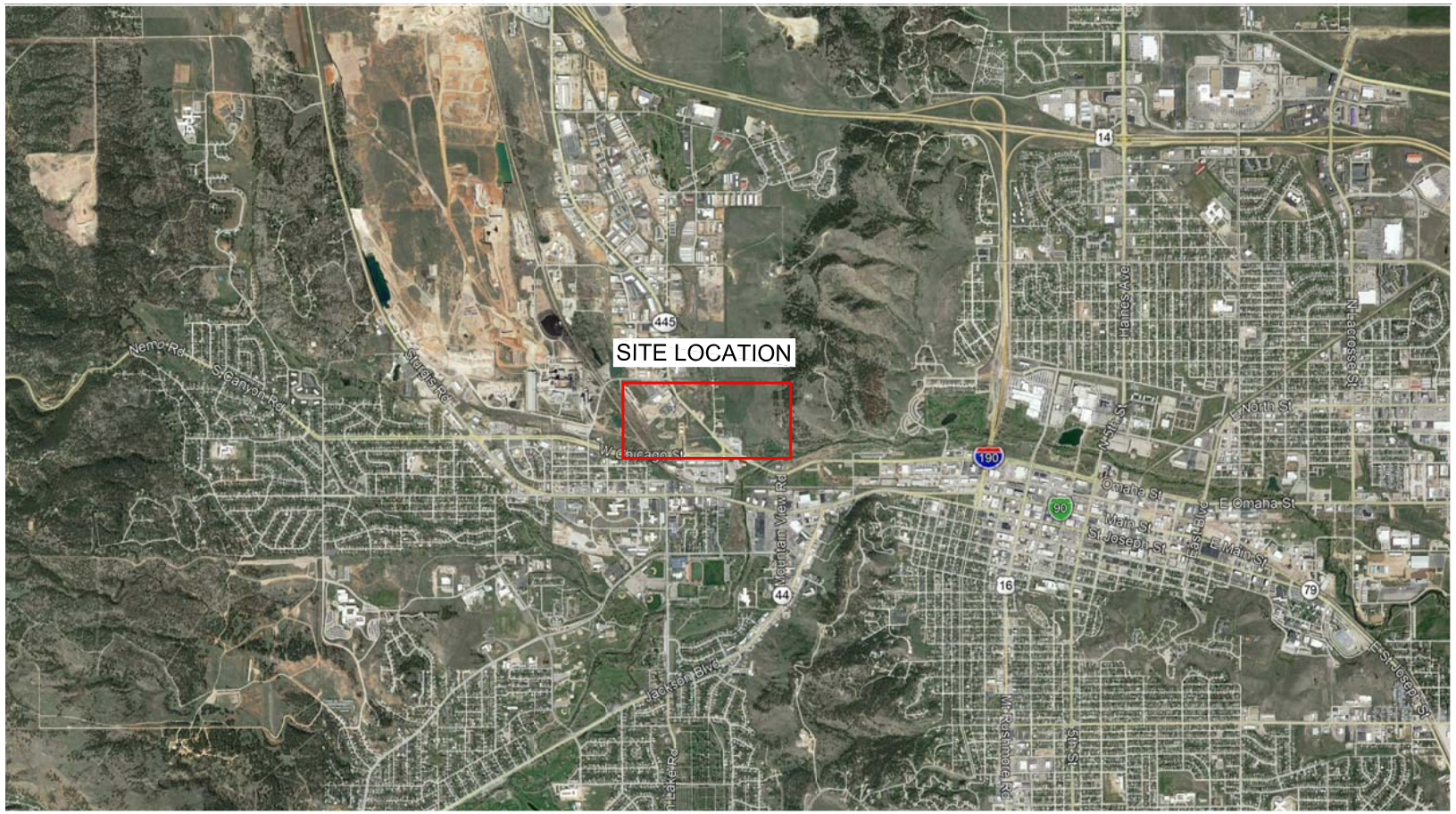
Term	Fiber Content (Visual Estimate)
Fibric Peat:	Greater than 67%
Hemic Peat:	33 – 67%
Sapric Peat:	Less than 33%

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.



AMERICAN ENGINEERING TESTING, INC.	PROJECT: WEST RAPID SUBSTATION – TRANSMISSION LINE POLES RAPID CITY, SOUTH DAKOTA		PROJECT NO. 17–03356
	SUBJECT: SITE LOCATION MAP		DATE: JANUARY 2, 2019
	SCALE: 1 INCH = 4000 FEET	DRAWN BY: JR	REVIEWED BY: WF

SCALE (FEET)

0 400

AMERICAN ENGINEERING TESTING, INC.	PROJECT: WEST RAPID SUBSTATION – TRANSMISSION LINE POLES RAPID CITY, SOUTH DAKOTA		PROJECT NO. 17–03356
	SUBJECT: BORING LOCATION MAP		DATE: JANUARY 2, 2019
	SCALE: 1 INCH = 400 FEET	DRAWN BY: JR	REVIEWED BY: WF

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B- 1 (p. 1 of 1)**

PROJECT: **West Rapid Substation - Transmission Line Poles; Rapid City, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: 3256.3 MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1	**TOPSOIL**	TOPSOIL									
2	**SILTY SAND**, brown, medium dense, gravel present (SM)	ALLUVIUM									
3			14	M	MC	18	11				
4											
5											
6	**SANDY LEAN CLAY**, brown to dark brown, hard to firm, gravel present (CL)		31	M	MC	18	6				
7				▽							
8			5	W	MC	18					
9											
10											
11	**SANDY GRAVEL**, brown, dense to very dense (GP)		34	W	MC	18					
12											
13	with cobbles		68	W	MC	18					
14											
15											
16			50/.3	W	MC	10					
17											
18											
19											
20											
21	**SHALE**, Silty Lean Clay, greenish gray, hard (CL)	SUNDANCE FORMATION	50/.4	M	MC	5					
22											
23											
24											
25											
26											
27											
28											
29											
30											
31			50/.4	M	MC	5					
32											
33											
34											
35											
36											
37											
38											
39											
40											
41			50/.4	M	MC	5					
42											
43											
44											
45											
46											
47											
48											
49											
50			50/.4	M	MC	5					
	Bottom of Boring										

DEPTH:	DRILLING METHOD
50.0	**3.25" HSA**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
12/27/18	**15:00**	**50.4**	**--**	**--**	**--**	**7.5**

BORING COMPLETED: **12/27/18**

DR: **ES** LG: **BB** Rig: **RC-2**

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

AET_CORP 17-03356 TRANSMISSION LINES.GPJ AET+CPT+WELL.GDT 1/14/19

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B- 2 (p. 1 of 1)**

PROJECT: **West Rapid Substation - Transmission Line Poles; Rapid City, South Dakota**

SURFACE ELEVATION: **3289.8**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1	**TOPSOIL**	TOPSOIL									
2	**FAT CLAY**, tan, very stiff (CH)	ALLUVIUM									
3			22	M	MC	18	13				
4											
5	**SILTY LEAN CLAY**, tan-brown, hard, sand and gravel present (CL)		80	M	MC	18	7				
6											
7											
8	**WEATHERED SHALE**, Silty Lean Clay, red, very stiff to stiff (CL)	SPEARFISH FORMATION	29	M	MC	18	16	111			
9											
10											
11			14	M	MC	18	19				
12											
13	with concretions		14	M	MC	18	17				
14											
15				▽							
16			11	W	MC	18					
17											
18											
19											
20											
21			39	M	MC	18					
22											
23	**SHALE**, Silty Lean Clay, red, hard, siltstone lenses present (CL)										
24											
25											
26			50/.4	M	MC	5					
27											
28											
29											
30											
31											
32											
33											
34											
35											
36			50/.4	W	MC	5					
37											
38											
39											
40											
41											
42											
43											
44											
45											
46			50/.4	W	MC	NSR					
47											
48											
49											
50			50/.4	W	MC	NSR					
	Bottom of Boring										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS						
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
50.0	**3.25" HSA**	**12/27/18**	**12:00**	**50.5**	**--**	**--**	**--**	**15.0**
BORING COMPLETED: **12/27/18**								
DR: **ES** LG: **BB** Rig: **RC-2**								

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

AET_CORP 17-03356 TRANSMISSION LINES.GPJ AET+CPT+WELL.GDT 1/14/19

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B- 3 (p. 1 of 1)**

PROJECT: **West Rapid Substation - Transmission Line Poles; Rapid City, South Dakota**

SURFACE ELEVATION: **3350.9**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1	**TOPSOIL**	TOPSOIL									
2	**SILTY LEAN CLAY**, red, hard, gypsum present (CL)	ALLUVIUM									
3			37	M	MC	18					
4											
5			50/.5	M	MC	18	5				
6											
7											
8	**SANDY GRAVEL**, gray, very dense, cobbles present (GP)		50/.4	M	MC	18	4				
9											
10											
11	**SHALE**, Fat Clay, gray-green, hard (CH)	SUNDANCE FORMATION	62	M	MC	18	23	98			
12											
13			80	M	MC	18					
14											
15											
16			86/.9	M	MC	17	23	97			
17											
18											
19											
20											
21											
22											
23											
24											
25											
26	**GYPSUM**, white, very dense	GYPSUM SPRING FORMATION	50/.4	M	MC	5					
27											
28											
29											
30											
31											
32											
33											
34											
35											
36			50/.1	M	MC	2					
37											
38											
39											
40											
41	**SILTSTONE**, Silt, red, hard (ML)										
42											
43											
44											
45											
46			50/.3	M	MC	4					
47											
48											
49											
50											
	Sampler Refusal at 50.1'		50/.1	M	MC	2					

DEPTH:	DRILLING METHOD
50.0	**3.25" HSA**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
12/19/18	**15:00**	**50.1**	**--**	**--**	**--**	**None**

BORING COMPLETED: **12/19/18**

DR: **ES** LG: **BB** Rig: **RC-2**

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

AET_CORP 17-03356 TRANSMISSION LINES.GPJ AET+CPT+WELL.GDT 1/14/19

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B- 4 (p. 1 of 1)**

PROJECT: **West Rapid Substation - Transmission Line Poles; Rapid City, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: 3327.1 MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1	**CRUSHED LIMESTONE AGGREGATE**, 12 inches	SURFACING									
3	**SHALE**, Fat Clay, green-gray, hard (CH)	SUNDANCE FORMATION	50/.0	M	MC	NSR					
6	**GYPSUM**, white, very dense	GYPSUM SPRING FORMATION	50/.4	M	MC	5					
8			50/.1	M	MC	2					
11			50/.1	M	MC	2					
13			50/.1	M	MC	2					
16	**SILTSTONE**, Silt, red, hard (ML)		50/.4	M	MC	5					
26			50/.0	M	MC	NSR					
36	**SHALE**, Fat Clay, green-gray, hard (CH)		50/.4	M	MC	5					
46	**SILTSTONE**, Silt, red, hard (ML)	SPEARFISH FORMATION	50/.4	M	MC	5					
50	Sampler Refusal at 50.1'		50/.1	M	MC	2					

DEPTH:	DRILLING METHOD
50.0	**3.25" HSA**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
12/21/18	**12:30**	**50.1**	**--**	**--**	**--**	**None**

BORING COMPLETED: **12/21/18**

DR: **ES** LG: **BB** Rig: **RC-2**

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

AET_CORP 17-03356 TRANSMISSION LINES.GPJ AET+CPT+WELL.GDT 1/14/19

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B- 5 (p. 1 of 1)**

PROJECT: **West Rapid Substation - Transmission Line Poles; Rapid City, South Dakota**

SURFACE ELEVATION: **3298.9**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1–2	**CRUSHED LIMESTONE AGGREGATE**, 7 inches	ROAD SURFACING									
3–6	**FILL**, Lean Clay, black, ash/slag present (CL) gravel present	FILL	10 13	M M	MC MC	18 18					
7–8	▽										
8–14	**FILL**, Fat Clay, brown-gray (CH)		6 2 3	W W W	MC MC MC	18 18 18					
15–17	**SANDY LEAN CLAY**, red-brown, firm, gravel present (CL)	ALLUVIUM	6	W	MC	18					
18–23	**WEATHERED SHALE**, Silty Lean Clay, red, hard (CL)	SPEARFISH FORMATION	43	M	MC	18					
23–50	**SHALE**, Silty Lean Clay, red, hard (CL)		50/.4 50/.4 50/.4 50/.4	M M M M	MC MC MC MC	5 5 5 5	12	128			
	Bottom of Boring										

DEPTH:	DRILLING METHOD
50.0	**3.25" HSA**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
12/19/18	**14:40**	**50.4**	**--**	**--**	**--**	**8.0**

BORING COMPLETED: **12/19/18**

DR: **ES** LG: **BB** Rig: **RC-2**

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

AET_CORP 17-03356 TRANSMISSION LINES.GPJ AET+CPT+WELL.GDT 1/14/19

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B- 6 (p. 1 of 1)**

PROJECT: **West Rapid Substation - Transmission Line Poles; Rapid City, South Dakota**

SURFACE ELEVATION: **3292.0**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1	**FILL**, Lean Clay with gravel, brown (CL)	FILL									
2	**FILL**, Silty Lean Clay, red, organics present (CL)										
3			22	M	MC	18	17				
4											
5	gypsum present										
6			13	M	MC	18	19				
7											
8			8	M	MC	18	27				
9											
10	**LEAN CLAY**, brown-gray, firm to soft, organics present (CL)	ALLUVIUM									
11			6	W	MC	18					
12											
13			3	W	MC	18					
14											
15											
16			4	W	MC	18					
17											
18											
19	**SILTY LEAN CLAY**, red-brown, firm (CL)										
20											
21			6	W	MC	18					
22											
23											
24	**WEATHERED SHALE**, Silty Lean Clay, red, stiff to very stiff (CL)	SPEARFISH FORMATION									
25											
26			16	M	MC	18					
27											
28											
29											
30											
31			27	M	MC	18					
32											
33											
34											
35											
36			26	M	MC	18					
37											
38											
39	**SHALE**, Silty Lean Clay, red, hard (CL)										
40											
41			50/.3	M	MC	4					
42											
43											
44											
45											
46											
47											
48											
49											
50			50/.3	M	MC	4					
	Bottom of Boring										

DEPTH:	DRILLING METHOD
50.0	**3.25" HSA**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
12/19/18	**10:30**	**50.3**	**--**	**--**	**--**	**11.0**

BORING COMPLETED: **12/19/18**

DR: **ES** LG: **BB** Rig: **RC-2**

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

AET_CORP 17-03356 TRANSMISSION LINES.GPJ AET+CPT+WELL.GDT 1/14/19

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B- 7 (p. 1 of 1)**

PROJECT: **West Rapid Substation - Transmission Line Poles; Rapid City, South Dakota**

SURFACE ELEVATION: **3312.1**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1–2	**CRUSHED LIMESTONE AGGREGATE**, 5 inches	SURFACING									
3–4	**WEATHERED SHALE**, Silty Lean Clay, red, stiff to hard (CL)	SPEARFISH FORMATION	22	M	MC	18					
5–6			22	M	MC	18	16				
7–8			11	M	MC	18	22				
9–11			19	M	MC	18	21	115			
12–13	with gypsum		46	M	MC	18					
14–16			32	M	MC	18					
17–21	**SHALE**, Silty Lean Clay, red, hard, interbedded siltstone and gypsum present (CL)		73/.8	M	MC	16	14				
22–25											
26–31	**GYPSUM**, white, hard		50/.4	M	MC	5					
32–35											
36–41	**SHALE**, Silty Lean Clay, red, hard, interbedded siltstone and gypsum present (CL)		50/.4	M	MC	5					
42–50			50/.3	M	MC	4					
	Bottom of Boring										

DEPTH: **50.0** DRILLING METHOD: **3.25" HSA**

BORING COMPLETED: **12/20/18**

DR: **ES** LG: **BB** Rig: **RC-2**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
12/20/18	**10:15**	**50.3**	**--**	**--**	**--**	**20.0**

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

AET_CORP 17-03356 TRANSMISSION LINES.GPJ AET+CPT+WELL.GDT 1/14/19

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **17-03356** LOG OF BORING NO. **B- 8 (p. 1 of 1)**

PROJECT: **West Rapid Substation - Transmission Line Poles; Rapid City, South Dakota**

SURFACE ELEVATION: **3310.1**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
1–2	**CRUSHED LIMESTONE AGGREGATE**, 6 inches	SURFACING									
3–4	**FILL**, Silty Lean Clay, red (CL)	FILL	21	M	MC	18					
5–6	**FAT CLAY**, gray-red, very stiff (CH)	ALLUVIUM	17	M	MC	18	20				
7–8			20	M	MC	18	23	110			
9–10	**LEAN CLAY**, red, very stiff, gypsum present (CL)		25	M	MC	18	21	114			
11–12	**SILTY LEAN CLAY**, red, very stiff, hydrocarbon odor noted (CL)		24	M	MC	18	17				
13–14	**WEATHERED SHALE**, Silty Lean Clay, red, hard, siltstone lenses present (CL)	SPEARFISH FORMATION	50	M	MC	18	12	128			
15–16	**SHALE**, Silty Lean Clay, red, hard, siltstone lenses present (CL)		50/.1	M	MC	8					
17–18											
19–20											
21–22											
23–24											
25–26											
27–28											
29–30			50/.3	M	MC	4	9				
31–32											
33–34											
35–36											
37–38											
39–40											
41–42	gypsum present		50/.3	M	MC	4					
43–44											
45–46											
47–48											
49–50			50/.3	M	MC	4					
	Bottom of Boring										

DEPTH:	DRILLING METHOD
50.0	**3.25" HSA**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
12/19/18	**17:00**	**50.3**	**--**	**--**	**--**	**None**

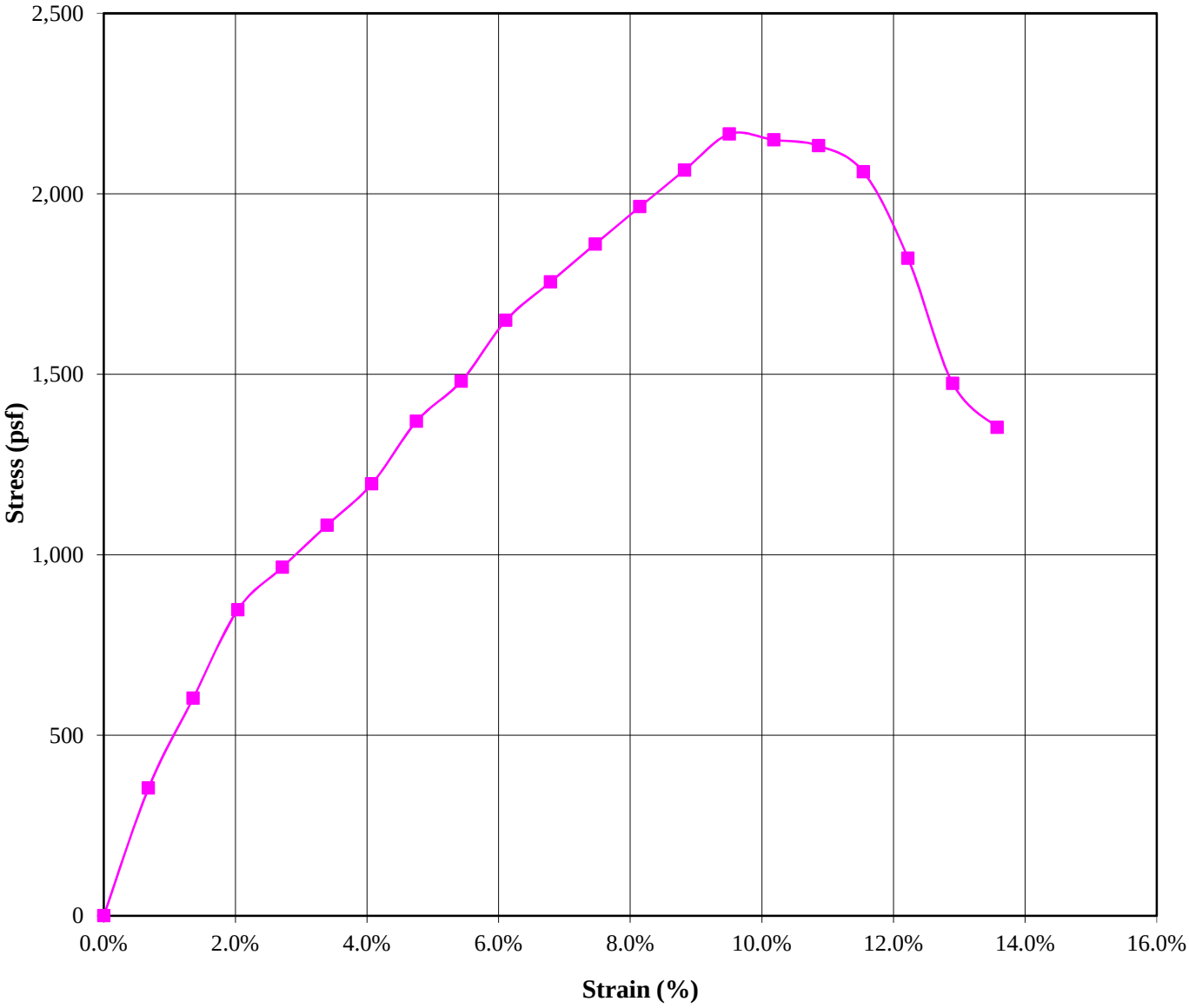
BORING COMPLETED: **12/19/18**

DR: **ES** LG: **BB** Rig: **RC-2**

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

AET_CORP 17-03356 TRANSMISSION LINES.GPJ AET+CPT+WELL.GDT 1/14/19

Stress vs. Strain



Test Results

Boring	Sample	Depth	Stress at Failure	Strain at Failure	Dry Density	% Moisture
2	3	7.5-9'	2165 psf	9.5%	110.7 pcf	16.1%

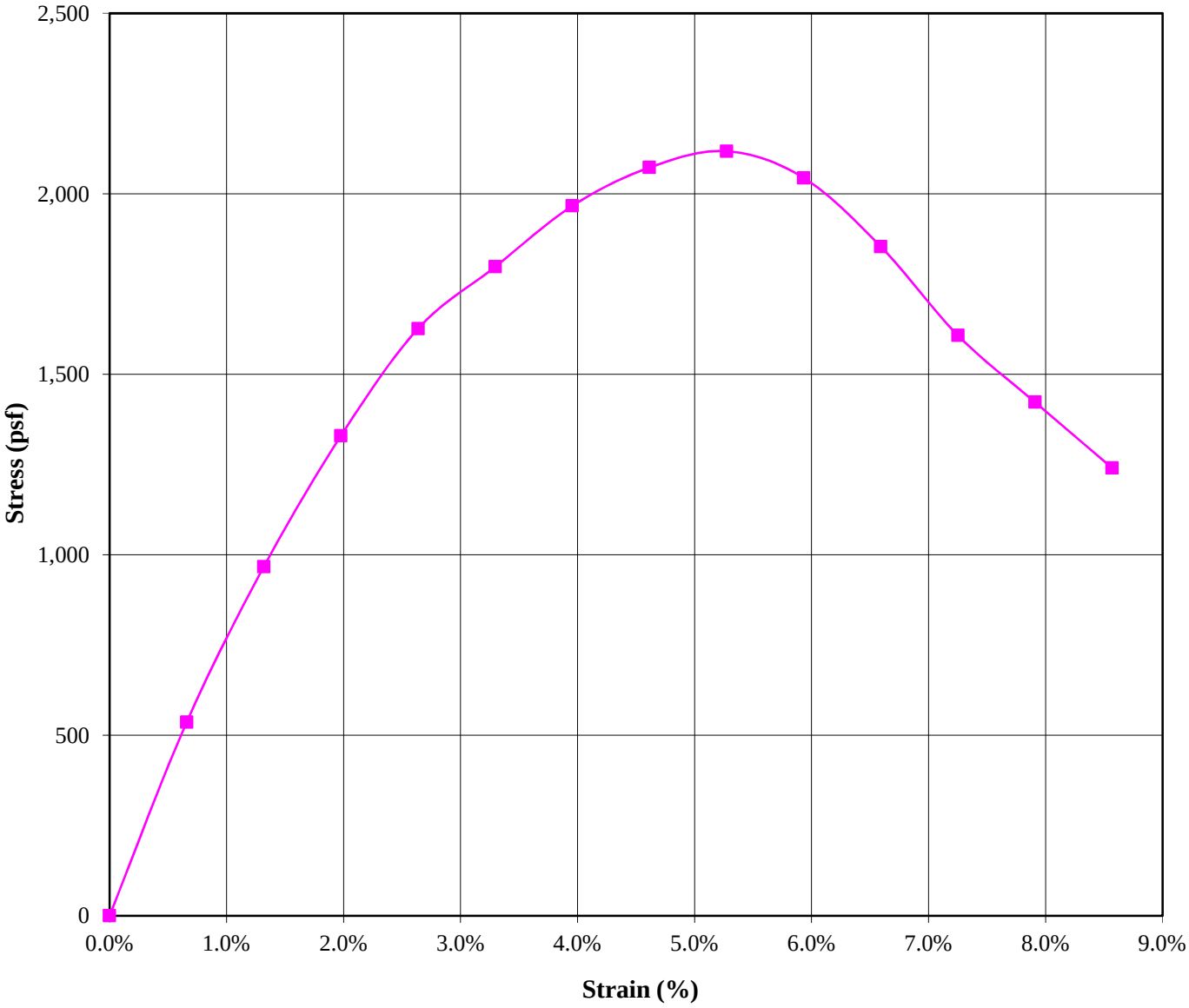
Project Information

Project:	West Rapid Substation - Transmission Line Poles	**Job Number:**	17-03356
Location:	Rapid City, South Dakota	**Date:**	1/2/2019

AMERICAN ENGINEERING TESTING, INC.

UNCONFINED COMPRESSION TEST RESULTS

Stress vs. Strain



Test Results

Boring	Sample	Depth	Stress at Failure	Strain at Failure	Dry Density	% Moisture
5	9	35-36.5	2118 pcf	5.3%	127.7 pcf	12.1%

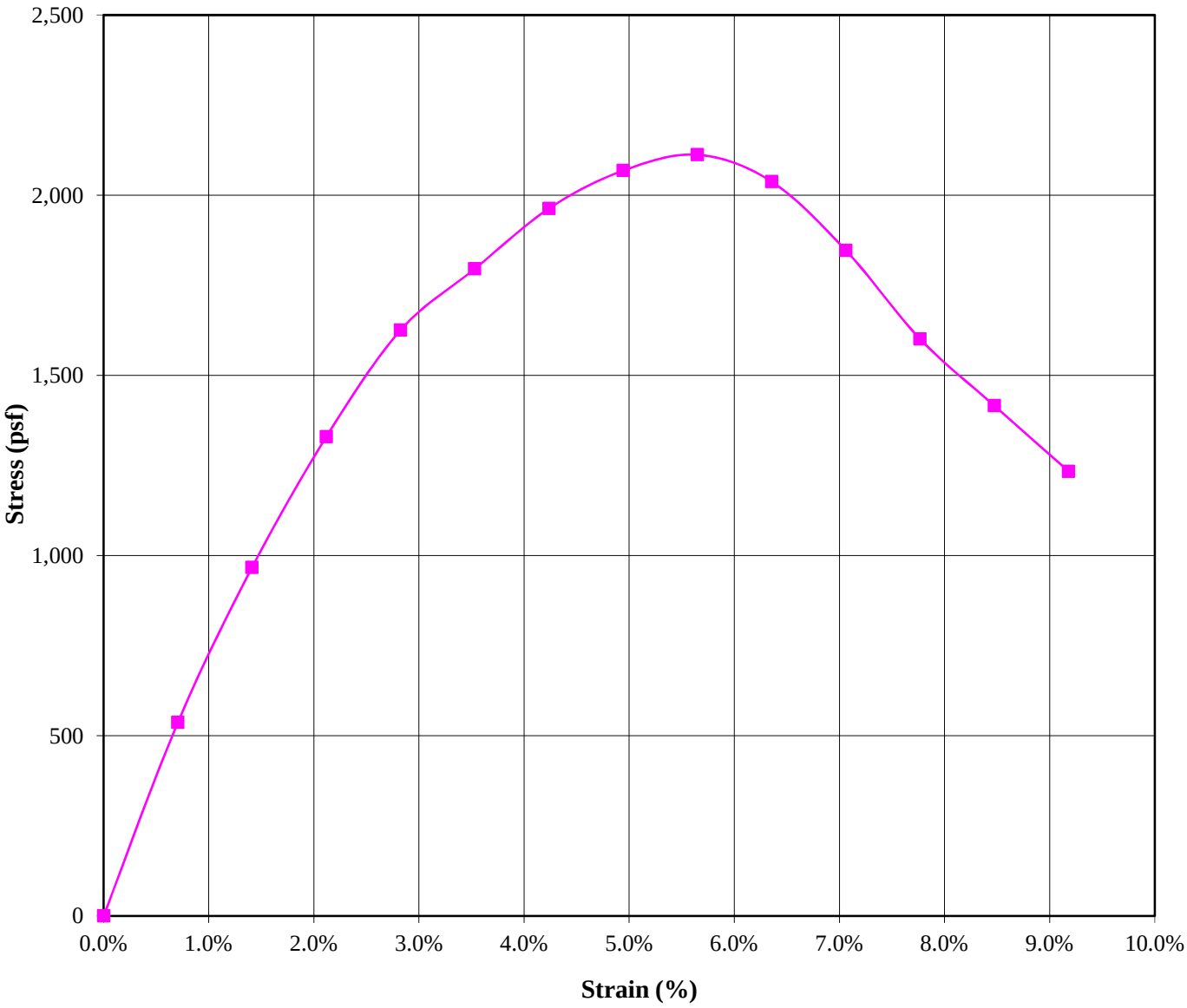
Project Information

Project:	West Rapid Substation - Transmission Line Poles	**Job Number:**	17-03356
Location:	Rapid City, South Dakota	**Date:**	1/2/2018

AMERICAN ENGINEERING TESTING, INC.

UNCONFINED COMPRESSION TEST RESULTS

Stress vs. Strain



Test Results

Boring	Sample	Depth	Stress at Failure	Strain at Failure	Dry Density	% Moisture
8	6	15-16.5'	2,112 psf	5.6%	128.4 pcf	12.2%

Project Information

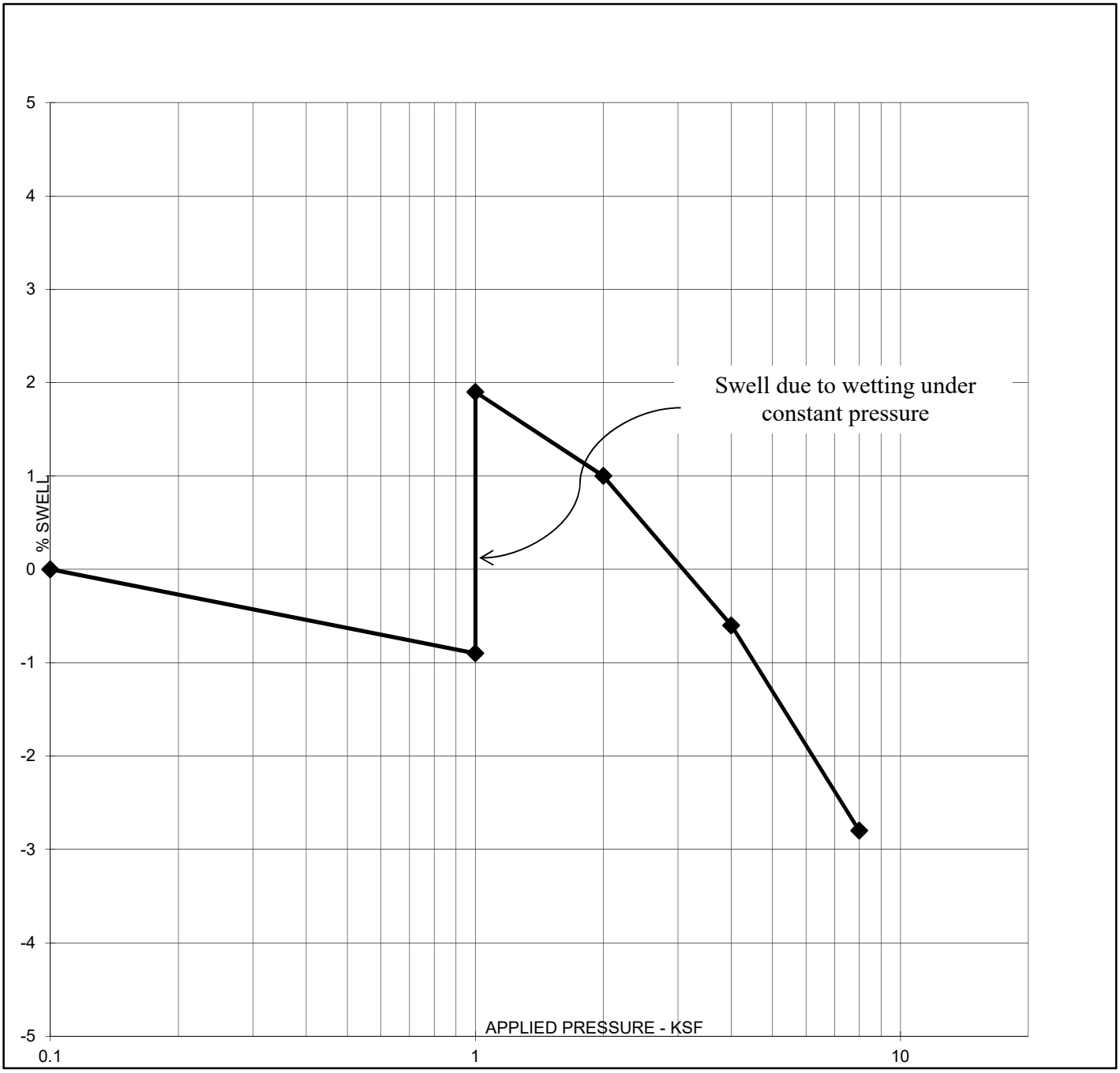
Project:	West Rapid Substation - Transmission Line Poles	**Job Number:**	17-03356
Location:	Rapid City, South Dakota	**Date:**	1/2/2018

AMERICAN ENGINEERING TESTING, INC.

UNCONFINED COMPRESSION TEST RESULTS

AMERICAN ENGINEERING TESTING, INC.

MOISTURE CONTENT:	22.8 percent
DRY UNIT WEIGHT:	96.57 pcf
BORING/DEPTH:	B-3 15'
SOIL DESCRIPTION:	Fat Clay, gray (CH)
% Swell	2.8
Swell Pressure	4,500 psf



AET Project # 17-03356	**SWELL-CONSOLIDATION TEST RESULTS**	

Appendix B

Geotechnical Report Limitations and Guidelines for Use

Geotechnical Report Limitations and Guidelines for Use
AET Project No. 17-03356

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.