Report of Geotechnical Exploration
KNRI Sewer and Septic Improvements
Knife River Indian Villages
Stanton, ND

AET Project No. P-0045747

Date:
April 8, 2026

Prepared for:

HDR Engineering, Inc.
703 Main Street, Suite 200
Rapid City, SD 57701

Geotechnical • Materials
Forensic • Environmental
Building Technology
Petrography/Chemistry

American Engineering Testing
99 26th Street E
Dickinson, North Dakota 58601
TeamAET.com • 701.483.4288

April 8, 2026

HDR Engineering, Inc.
703 Main Street, Suite 200
Rapid City, SD 57701

Attn: Mr. Chris Bailey, PE

RE: Report of Geotechnical Exploration
KNRI Sewer and Septic Improvements
Knife River Indian Villages
Stanton, North Dakota
AET Report No. P-0045747

Dear Mr. Bailey:

American Engineering Testing (AET) has completed the enclosed report of geotechnical engineering services for the above referenced project site near Stanton, North Dakota. This service was performed in accordance with our proposal agreement dated July 29, 2025, and authorized via Subconsultant Agreement on September 5, 2025.

We appreciate the opportunity to have been of service to you on this project. If you have any questions regarding the information presented in this report or if we can be of additional assistance, please contact me.

Sincerely,
American Engineering Testing

Connor J. Thompson, EI
Western North Dakota Manager
cthompson@teamaet.com
Office: 701.483.4288
Cell: 701.390.4520

This document shall not be reproduced, except in full, without written approval from American Engineering Testing, Inc.

SIGNATURE PAGE

Prepared for:

HDR Engineering, Inc.
703 Main Street, Suite 200
Rapid City, South Dakota 57701

Attn: Mr. Chris Bailey, PE

Prepared by:

American Engineering Testing, Inc.
99 26th Street East
Dickinson, North Dakota 58601
(701) 483-4288/www.amengtest.com

Authored by:

Connor J. Thompson, EI
Engineer I

Reviewed by:

Kristen R. Yates, PE (ND/SD)
Director of Operations – West Division

REGISTERED PROFESSIONAL ENGINEER
KRISTEN R. YATES
PE-9974
DATE 4/8/26
NORTH DAKOTA

TABLE OF CONTENTS

Transmittal Letter i
Signature Page ii
TABLE OF CONTENTS iii
1.0 INTRODUCTION 1
2.0 SCOPE OF SERVICES 1
3.0 PROJECT INFORMATION 1
4.0 SUBSURFACE EXPLORATION AND TESTING 2
4.1 Field Exploration Program 2
4.2 Laboratory Testing 2
5.0 SITE CONDITIONS 2
5.1 Surface Observations 2
5.2 Subsurface Soils/Geology 2
5.3 Groundwater 3
6.0 RECOMMENDATIONS 3
6.1 Approach Discussion 3
6.2 Subgrade Preparation 3
6.3 Foundation Design 4
6.4 Lateral Earth Pressures 4
6.5 Utilities 5
6.6 Materials and Compaction 6
6.7 Testing Frequencies 7
6.8 Site Grading 7
7.0 CONSTRUCTION CONSIDERATIONS 7
7.1 Potential Difficulties 7
7.2 Soil Chemistry Information 8
7.3 Site Seismic Classification 8
7.4 Observation and Testing 9
8.0 ASTM STANDARDS 9
9.0 LIMITATIONS 9

TABLE OF CONTENTS

STANDARD SHEETS
- Freezing Weather Effects on Building Construction

APPENDIX A – Geotechnical Field Exploration and Testing
- Boring Log Notes
- Unified Soil Classification System
- Figure 1 – Site Location Map
- Figure 2 – Boring Location Map
- Subsurface Boring Logs
- Percolation Testing Summary
- Proctor Test Report

APPENDIX B – Geotechnical Report Limitations and Guidelines for Use

1.0 INTRODUCTION

The project consists of the construction of a lift station and associated manholes and drain field at the Knife River Indian Villages historical site near Stanton, North Dakota. The approximate site location is provided in Figure 1- Site Location Map within Appendix A. To assist planning and design, you have authorized American Engineering Testing, Inc. (AET) 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 performed their services according to our proposal written for you dated July 29, 2025, which was authorized on September 5, 2025. The authorized scope consists of the following.

- Perform two standard penetration test (SPT) borings to a depth of 15 feet below ground surface
- Perform 4 percolation tests
- Soil laboratory testing
- Geotechnical engineering review based on the 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 in the soil or groundwater.

3.0 PROJECT INFORMATION

The project site is located at the Knife River Indian Villages Visitor Center near Stanton, North Dakota. The approximate site location is shown on Figure 1 in Appendix A.

The proposed project will include constructing a lift station and associated manholes and drain field. Minimal site grading is anticipated for the proposed project. Dimensions for the lift station and manhole have not been provided to us. We assume the lift station will be a pre-cast or cast-in-place concrete structure. Tolerable settlement criteria for this structure have not been provided. Unless otherwise informed, we have assumed that total and differential settlements on the order of 1 inch and ½ inch in 25 feet are acceptable.

The above-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 2 SPT borings and 4 field percolation tests. HDR Engineering personnel provided the boring locations, number of borings, and the depths of the borings. AET personnel staked the borings in the field. The logs of the borings and details of the methods used appear in Appendix A.

Soil samples were obtained by Standard Penetration Test (SPT) split spoon samplers. The logs contain information concerning soil layering, soil classification, geologic origins, and moisture condition. A density description or consistency is also noted for the natural soils, which is based on penetration resistance. The boring locations are shown on Figure 2 within Appendix A.

4.2 LABORATORY TESTING

The laboratory testing program included natural moisture contents, gradation (sieve) analyses, moisture-density relationship (Standard Proctor), and soil pH, soluble sulfates, and resistivity. The test results appear in Appendix A on the individual boring logs adjacent to the samples upon which they were performed, or on the data sheets following the logs.

5.0 SITE CONDITIONS

5.1 SURFACE OBSERVATIONS

The drainfield site is currently a fairly flat, mostly grass covered area to the southeast of the Visitor Center. The lift station site is also fairly flat and located in the landscaped area directly south of the Visitor Center. There are some scattered trees within the proposed construction footprint.

5.2 SUBSURFACE SOILS/GEOLOGY

The site geology consisted to 9 to 10 inches of organic topsoil/fill underlain by 2 to 3 feet of fill. Underlying the fill, we encountered coarse alluvium followed by glacial till to boring termination depths. The fill soils generally consisted of sands with varying amounts of silt and trace amounts of gravel. The alluvium consisted of sands with varying amounts of silt and trace amounts of gravel. The glacial till soils consisted of sandy lean clays with trace gravel.

The relative density of the non-cohesive sandy soils ranged from loose to medium dense as indicated by the N-values ranging from 9 to 15. The consistency of the clay soils were stiff to very stiff, as indicated by the N-values ranging from 9 to 16. We present detailed conditions for each boring location on the individual subsurface boring logs in Appendix A of this report.

The soils at this site are frost susceptible. Maximum estimated frost depth is 6 feet below exterior grade for un-heated structures.

5.3 GROUNDWATER

We did not encounter groundwater in the borings during our subsurface exploration. It should be noted that our exploration took place in March, and groundwater elevations will likely fluctuate due to climactic conditions such as varying seasonal and annual rainfall and snow melt amounts, and locally heavy precipitation events. The evaluation of these factors is beyond the scope of this report.

6.0 RECOMMENDATIONS

6.1 APPROACH DISCUSSION

The following geotechnical recommendations are presented to assist the planning, design, and construction of the lift station and drain field at the Knife River Indian Villages historical site near Stanton, North Dakota. Our recommendations are based on the results of our boring-based field exploration, field and laboratory testing, our experience in the area with similar soil conditions, and our understanding of the proposed construction. We specifically outline geotechnical design criteria, opinions, and recommendations regarding the soil conditions encountered. We also rely on geotechnical continuity, communication between all project team members specific to risk- and cost-based decisions, and good construction practices to achieve the desired project outcome for HDR. Therefore, our recommendations must be reviewed at the time civil and construction plans are finalized to verify their applicability to the proposed project.

Exploration only allows observation of a small portion of the site subsurface conditions. Subsurface variations are possible between exploration locations and may not be apparent until construction. Where such variations exist, they may impact the opinions and recommendations presented in this report, as well as construction timing and costs. If design plans change, or if the subsurface conditions encountered during construction vary from those observed during our field evaluation, we must be notified to review the report recommendations and make necessary revisions.

6.2 SUBGRADE PREPARATION

We recommend removal of any unsuitable materials such as topsoil, fill, or any components of existing structures encountered within the lift station footprint. If the fill soils are free from deleterious materials (organics, roots, etc.) they may be stockpiled for reuse as structural fill, as is common in the area. Where grading is not required outside the limits of construction, we recommend topsoil remain in place to reduce erosion and maintain green space during construction. Stripped topsoil should be stockpiled separately for use in re-seeding.

Following removal of unsuitable materials, excavation may continue to the design lift station bottom depth. Conventional construction equipment should be able to excavate to the desired depths. Excavation bottoms should terminate in native, undisturbed subgrade soils. If subgrade soils become disturbed or wet, we recommend excavating the disturbed or wet soils, moisture conditioning, and recompacting as *General Structural Fill* as described in Table 6.6-1 located in Section 6.6 “Materials and Compaction”.

If soft or unstable subgrade soil is encountered, over-excavation criteria shall be determined during construction with AET, HDR, the owner, and the contractor. We recommend AET’s geotechnical engineer review and approve the exposed subgrade. Once approved by the geotechnical engineer, it is the contractor’s sole responsibility to protect subgrades from degradation.

6.3 FOUNDATION DESIGN

After the site preparation described above, in our judgment, the stiff sandy lean clay soils from approximately 5 ½ to 16 feet below ground surface are capable of supporting the lift station and associated manhole. Soils above 5 ½ feet, specifically around Boring B-1, are considered very loose to loose and do not have the capability of supporting significant structures. We recommend placing the foundations for un-heated structures a minimum of 60 inches below final grade for frost protection.

If the structures are constructed as recommended, the structure foundations may be designed based on a net maximum allowable bearing capacity of 2,000 pounds per square foot (psf). We estimate total settlement of less than 1 inch, and differential settlement of less than ½ inch over 25 feet.

6.4 LATERAL EARTH PRESSURES

The following soil parameters for the site soils should be considered in the design and construction of the lift station structure:

Sandy Lean Clay

- Coefficient of Friction……0.28
- Friction Angle……18°
- Moist Unit Weight……120 pcf

Silty Sand

- Coefficient of Friction……0.32
- Friction Angle……30°
- Moist Unit Weight……125 pcf

The "at-rest" earth pressure condition is appropriate for designing the buried lift station. Therefore, recommended values of 75 psf/ft (as an equivalent fluid pressure) and 60 psf/ft for backfill material consisting of the sandy lean clay and silty sand site soils, respectively, should be used. The lateral earth pressure is presented as an ultimate value, so an appropriate safety factor should be incorporated into the structural design of the buried walls.

6.5 UTILITIES

6.5.1 TRENCH EXCAVATION

Conventional construction equipment such as tracked excavators should be able to make the required trench excavations within the site soils. If excavation faces are not retained, the excavations should maintain maximum allowable slopes in accordance with *OSHA Regulations (Standards 29 CFR), Part 1926, Subpart P, "Excavations"* (can be found on www.osha.gov). Even with the required OSHA sloping, water seepage or surface runoff can potentially induce side slope erosion or running which could require slope maintenance.

The loose to medium dense silty sand and stiff to very stiff sandy lean clay soil classify as Type C soils under the OSHA guidelines. Temporary excavation slopes may be required for utility trenches. Excavations less than 20 feet in depth shall have a maximum allowable slope of 1.5H:1V for Type C soils. Deeper excavations and/or in saturated soils or below the groundwater table should be considered on an individual basis. Water levels, due to climatic conditions, should be evaluated at the time of construction. Construction vibrations can cause excavations to slough or cave.

If the previously listed trench layback recommendations are not feasible, due to space limitations or other factors, the OSHA rules should be consulted for alternative trench stabilization methods. Trench boxes or shoring in compliance with OSHA rules may be acceptable alternatives and is common practice in municipal projects.

6.5.2 UTILITY SUBGRADE PREPARATION

Excavate soil to the proposed utility subgrade elevations. Remove any unsuitable material, including soft and/or organic soil, if encountered. Soil disturbance negatively impacts the soil's performance. Remove any disturbed soil below the proposed utilities. If soil is disturbed, moisture condition and recompact the top 12 inches of soil as *General Structural Fill* as described in Table 6.6-1 located in Section 6.6 "Materials and Compaction."

6.5.3 UTILITY BACKFILL CONSIDERATIONS

We anticipate that the site soil excavated for utility construction will be re-used for trench backfill. The subsurface soil generally consisted of silty sand and sandy lean clay soils. Based on our laboratory testing and experience with similar soils in the area, the excavated site soils for the new utility lines may require processing and moisture conditioning to bring the trench spoils close

to the optimum moisture content before their reuse as trench backfill. Compact utility trenches in accordance with Table 6.6-1 located in Section 6.6 “Materials and Compaction.”

6.5.4 PERCOLATION TEST RESULTS

Four percolation tests were performed in approximately 3 feet deep borings advanced within the proposed drain field. The percolation tests were performed referencing North Dakota Administrative Code Chapter 62-03.1-03-05. The percolation test hole was filled with water after completion. After permitting the soil to saturate, AET returned the following day and added water to the hole and measured the rate of water drop. Our percolation test results indicated an average percolation rate of 6.7 minutes per inch of water level drop. The detailed percolation test measurements/results can be found in Appendix A. The initial water level described on the Percolation Testing Summary is the measured height of water from the bottom of the borehole.

6.6 MATERIALS AND COMPACTION

We provide our recommended materials and compaction specifications in the following table.

Table 6.6-1 Materials and Compaction Specifications

Material	Allowable Use	Material Specifications	Minimum Compaction Requirements (ASTM D1557)	Moisture Content (% of optimum)
General Structural Fill	Subgrade Preparation, Lift Station Backfill	• Soil classified as GM, GW, GC, SM, SC, SW, CL, or ML according to the USCS • May not contain particles larger than 6 inches in median diameter • Soil must be reasonably free from deleterious substances such as wood, metal, plastic, waste, etc.	95%	± 3%
Utility Trench Backfill	Utility Trench Backfill	• Soil classified as GM, GW, GC, SM, SC, SW, CL, or ML according to the USCS • May not contain particles larger than 6 inches in median diameter • Soil must be reasonably free from deleterious substances such as wood, metal, plastic, waste, etc.	90% (non-structural fill areas, grass areas) 95% (below structures)	± 4% ± 3%

6.7 TESTING FREQUENCIES

We recommend performing the following tests at the recommended frequencies.

- **General Structural Fill** – one (1) compaction test at least every 750 square feet, per each 8-inch lift.
- **Utility Trench Backfill** – one (1) compaction test at least every 150 linear feet, or two (2) per trench, whichever results in the greater number of tests, per each 8-inch lift of backfill.

To verify that construction conforms to the intent of this report, we recommend American Engineering Testing, Inc. be retained to observe, test, and record the following.

- Earthwork Observations – including monitoring and recording deviations from subsurface soil conditions as presented in the Boring Logs in Appendix A.
- Observe the proof-roll on the recompacted subgrade soils.
- Observe and approve all excavations and over-excavations prior to placing backfill/fill materials.
- Approve additional excavation, replacement, or stabilization if unsuitable soil as identified by the geotechnical engineer during excavation.

6.8 SITE GRADING

Site grading should provide surface drainage away from the proposed construction. Improper management of surface water, by not providing an effective grading and drainage design, can result in moisture entering the subgrade soil, and causing settlement of the building and soft subgrade below the parking and drive areas. Possible sources of surface water include rainwater, snowmelt, roof drains, or leaking water lines. Downspouts should discharge into solid piping below grade and be routed to storm drains or detention areas.

7.0 CONSTRUCTION CONSIDERATIONS

7.1 POTENTIAL DIFFICULTIES

7.1.1 RUNOFF WATER IN EXCAVATION

Water can be expected to collect in the excavation bottom during times of inclement weather or snow melt. To allow observation of the excavation bottom, to reduce the potential for soil disturbance, and to facilitate filling operations, we recommend water be removed from within the excavation during construction.

7.1.2 DISTURBANCE OF SOILS

The on-site soils can be 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.

7.2 SOIL CHEMISTRY INFORMATION

AET has submitted one soil sample (B-2 from 4.5-6 feet) for water soluble sulfates, resistivity, and pH. Sulfate attack is a deterioration resulting from chemical reactions occurring when concrete components react with sulfate ions (SO_4^{2-}) present in solution in contact with concrete. The results of this testing are currently pending at this time. Upon completion, they will be submitted to you under separate copy.

7.3 SITE SEISMIC CLASSIFICATION

We utilized the site soil and geologic data, the project location, the 2024 *International Building Code* (IBC), and the American Society of Civil Engineers (ASCE 7-22) to establish a seismic site classification of D at the project site. We recommend seismic design reference the seismic parameters provided in the table below based on the soil conditions and project location.

Table 7.3-1 Site Seismic Parameters

Elevation:	1719 ft (NAVD 88)
Lat:	47.330938
Long:	-101.385408
Standard:	ASCE/SEI 7-22
Risk Category:	I
Soil Class:	D - Stiff Soil
Seismic Data	
S_S	0.056
S_1	0.017
S_{MS}	0.076
S_{M1}	0.037
S_{DS}	0.051
S_{D1}	0.025
T_L	4
PGA_M	0.027
V_{S30}	260
Seismic Design Category	A
Note	Where values of the multi-period 5%-damped MCER response spectrum are not available from the USGS Seismic Design Geodatabase, the design response spectrum shall be permitted to be determined in accordance with Section 11.4.5.2

We encountered very loose to medium dense sands and firm to very stiff clay soils at the site. We did not encounter groundwater within the borings. Due to the lack of groundwater and the

low historic probability of earthquakes in the region, the probability of an earthquake with ground accelerations large enough to induce liquefaction at this site is very low.

7.4 OBSERVATION AND TESTING

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

8.0 ASTM STANDARDS

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

9.0 LIMITATIONS

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

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

Standard Data Sheets

EARTHWORK QUALITY CONTROL INFORMATION

EXCAVATION BASE ELEVATION

Judgments of supporting soils are based on soils exposed, and on local samples of soils retrieved by hand auguring and probing. Because conditions in the subsurface are hidden, it is not possible to fully characterize the subsurface conditions. Therefore, the client must accept that our judgments are limited to those soils which are directly observable to us.

As soil conditions may be variable at depth, it is best that excavation base observation be aided by deeper exploratory test borings (usually done prior to construction). Although these deeper borings may not totally reveal what is in the subsurface they greatly reduce the risk of deeper poor soils going undetected.

The presence of ground water within the excavation can also limit the supporting soil evaluation process. Also, if standing ground water is present, there is a risk to the client that soft or loose compressible soils may not be observed and that these soft or loose compressible may potentially remain beneath the water during excavation. The compressible materials can become trapped beneath or within the subsequently placed fill; thus, allowing adverse movements to occur in structures and fill materials placed over these materials.

FILLING

Structural fill placement is commonly monitored by performing local compaction tests, which entails comparing a field density test to a laboratory Proctor test to arrive at a percent compaction. Field Density tests of fill only provide the compaction level of the fill at the location and elevation of the test. As many factors control compaction, such as fill lift thickness, moisture content, material type and compactive effort, compaction variation within fill materials can exist that may not be represented by the tests. Field Density (compaction) tests are considered representative when used in a conscientious program of controlled fill placement, where the factors influencing compaction are closely monitored. Conclusions about fill suitability to support structural loadings from the results of a limited number of compaction tests includes increased risk, unless the individual drawing the conclusions has complete knowledge of the afore-mentioned variables during placement. For this reason, part-time testing on a "trip" basis includes more risk to the client than "full-time" monitoring/testing.

OVERSIZING

Structural elements also exert loadings laterally; and because of this, the excavation and subsequent fill system needs to be oversized to accommodate these loadings. The extent of lateral oversizing is normally associated with the movement sensitivity of the structure and the strength/compressibility properties of the soils remaining along the excavation sidewalls. Oversizing on the order of 1H (horizontal):1V (vertical) is typically provided for foundations in "normal" conditions. However, oversizing on the order of 12H:1V or more is oftentimes needed in highly compressible situations such as swamp deposits.

AET does not practice in the field of surveying and must rely on location and elevation staking of proposed construction by the client or their representative. Our measurements in the field are made in relation to those stakes or other location and elevation information provided to us. The reliability of AET's opinions, conclusions and recommendations based on those measurements is dependent on the accuracy of the staking or information provided by the client or their representative.

FREEZING WEATHER

Soils that are allowed to freeze will heave & lose density. Upon thawing, these soils will not regain their full original strength & density. The extent of heave and density/strength loss depends on the soil type and moisture condition; and is usually more pronounced in finer grained soils, and particularly silty soils. Foundations, slabs, and other improvements affected by such frost movements should be protected from frost intrusion during freezing weather. If filling takes place during freezing weather, all frozen soils, snow and ice should be stripped from all areas to be filled prior to new fill placement; and the new fill should not be allowed to freeze during or after placement. For this reason, it is usually more beneficial to perform excavate/refill operations during freezing weather in smaller plan areas where grade can be attained quickly rather than working larger areas where a large amount of frost stripping is needed.

STRUCTURAL SUPPORT ON UNCONSTROLLED FILL

Risks are associated with supporting structures on fill which has not been placed in a controlled and well documented manner. Even where existing fill appears to be well compacted (including when soil borings have been performed), hidden poorer or looser soils can potentially exist below or within the fill; or previous excavation and extension of the compacted fill may be have been provided with sufficient oversize in all directions to accommodate the new lateral loadings. Risks can be reduced by means of increasing the amount of testing and observations.

FREEZING WEATHER EFFECTS ON BUILDING CONSTRUCTION

GENERAL

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

DESIGN CONSIDERATIONS

Clayey and silty soils can be used as perimeter backfill, although the effect of their poor drainage and frost properties should be considered. Basement areas will have special drainage and lateral load requirements which are not discussed here. Frost heave may be critical in doorway areas. Stoops or sidewalks adjacent to doorways could be designed as structural slabs supported on frost footings with void spaces below. With this design, movements may then occur between the structural slab and the adjacent on-grade slabs. Non-frost susceptible sands (with less than 12% passing a #200 sieve) can be used below such areas. Depending on the function of surrounding areas, the sand layer may need a thickness transition away from the area where movement is critical. With sand placement over slower draining soils, subsurface drainage would be needed for the sand layer. High density extruded insulation could be used within the sand to reduce frost penetration, thereby reducing the sand thickness needed. We caution that insulation placed near the surface can increase the potential for ice glazing of the surface.

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

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

CONSTRUCTION CONSIDERATIONS

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

Appendix A

Geotechnical Field Exploration and Testing
Boring Log Notes
Unified Soil Classification System
Figure 1 – Site Location Map
Figure 2 – Boring Location Map
Subsurface Boring Logs
Percolation Testing Summary
Proctor Test Report

A.1 FIELD EXPLORATION

The subsurface conditions at the site were explored by drilling and sampling three (2) penetration test borings. The locations of the borings appear on Figure 1, preceding the Subsurface Boring Logs in this appendix.

A.2 SAMPLING METHODS

A.2.1 Split-Spoon Samples (SS)

Standard penetration (split-spoon) samples were collected in general accordance with ASTM: D1586. The ASTM test method consists of driving a 2-inch O.D. split-barrel sampler into the in-situ soil with a 140-pound hammer dropped from a height of 30 inches. The sampler is driven a total of 18 inches into the soil. After an initial set of 6 inches, the number of hammer blows to drive the sampler the final 12 inches is known as the standard penetration resistance or N-value.

A.2.2 Thin-wall tube (Shelby) Samples (TW)

Sample types described as “TW” on the boring logs are obtained using a thin-wall tube (Shelby Tube) sampler, which are relatively undisturbed samples of cohesive soils. The tube is typically 2 to 3 inches in outside diameter. Soil samples are obtained by pushing the tube into soils instead of driven into the soils with a hammer.

A.2.3 Modified California Samples (MC)

Sample types described as “MC” on the boring logs are obtained using a Modified California (MC) sampler, which is a large lined tube sampler. The sampler is thick-walled with an outside diameter of 2.5 inches and an inside diameter of 2 inches. The sampler is driven 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.

A.2.4 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.2.5 Sampling Limitations

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

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

A.3 CLASSIFICATION METHODS

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

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

A.4 WATER LEVEL MEASUREMENTS

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

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

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

A.5 LABORATORY TEST METHODS

A.5.1 Water Content Tests

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

A.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.5.4 One-Dimensional Consolidation of Soils Using Incremental Loading

Conducted per AET Procedure 20-SOI-014, which is performed in general accordance with ASTM: D2435.

A.6 TEST STANDARD LIMITATIONS

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

A.7 SAMPLE STORAGE

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

BORING LOG NOTES

DRILLING AND SAMPLING SYMBOLS

Symbol	Definition
B,H,N:	Size of flush-joint casing
CA:	Crew Assistant (initials)
CAS:	Pipe casing, number indicates nominal diameter in inches
CC:	Crew Chief (initials)
COT:	Clean-out tube
DC:	Drive casing; number indicates diameter in inches
DM:	Drilling mud or bentonite slurry
DR:	Driller (initials)
DS:	Disturbed sample from auger flights
FA:	Flight auger; number indicates outside diameter in inches
HA:	Hand auger; number indicates outside diameter
HSA:	Hollow stem auger; number indicates inside diameter in inches
LG:	Field logger (initials)
MC:	Column used to describe moisture condition of samples and for the ground water level symbols
N (BPF):	Standard penetration resistance (N-value) in blows per foot (see notes)
NQ:	NQ wireline core barrel
PQ:	PQ wireline core barrel
RD:	Rotary drilling with fluid and roller or drag bit
REC:	In split-spoon (see notes) and thin-walled tube sampling, the recovered length (in inches) of sample. In rock coring, the length of core recovered (expressed as percent of the total core run). Zero indicates no sample recovered.
REV:	Revert drilling fluid
SS:	Standard split-spoon sampler (steel; 1d" is inside diameter; 2" outside diameter); unless indicated otherwise
SU	Spin-up sample from hollow stem auger
TW:	Thin-walled tube; number indicates inside diameter in inches
WASH:	Sample of material obtained by screening returning rotary drilling fluid or by which has collected inside the borehole after Afalling@ through drilling fluid
WH:	Sampler advanced by static weight of drill rod and 140-pound hammer
WR:	Sampler advanced by static weight of drill rod
94mm:	94 millimeter wireline core barrel
▼:	Water level directly measured in boring
▽:	Estimated water level based solely on sample appearance

TEST SYMBOLS

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

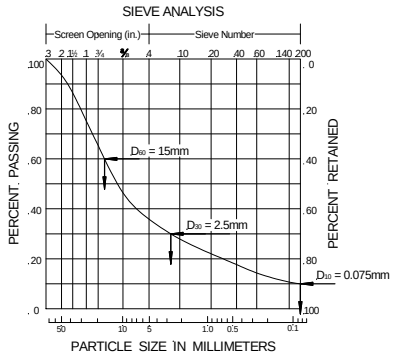
STANDARD PENETRATION TEST NOTES

The standard penetration test consists of driving the sampler with a 140 pound hammer and counting the number of blows applied in each of three 6" increments of penetration. If the sampler is driven less than 18" (usually in highly resistant material), permitted in ASTM:D1586, the blows for each complete 6" increment and for each partial increment is on the boring log. For partial increments, the number of blows is shown to the nearest 0.1' below the slash.

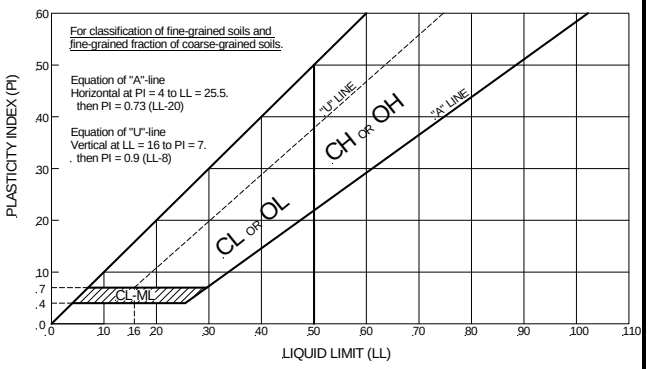
The length of sample recovered, as shown on the "REC" column, may be greater than the distance indicated in the N column. The disparity is because the N-value is recorded below the initial 6" set (unless partial penetration defined in ASTM:D1586 is encountered) whereas the length of sample recovered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

UNIFIED SOIL CLASSIFICATION SYSTEM
ASTM Designations: D 2487, D2488

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



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



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

Layering Notes

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

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

Fiber Content of Peat

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

Organic/Roots Description (if no lab tests)

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

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

Figure 1 - Site Vicinity Map

P-0045747 KNRI Sewer and Septic Improvements
Stanton, North Dakota

Figure 2 - Boring Location Map

P-0045747 KNRI Sewer and Septic Improvements
Stanton, North Dakota

SUBSURFACE BORING LOG

AET JOB NO: **P-0045747** LOG OF BORING NO. **B-1 (p. 1 of 1)**

PROJECT: **KNRI Sewer and Septic Improvements; Stanton, ND**

SURFACE ELEVATION: **1721.0** LATITUDE: **47.330938** LONGITUDE: **-101.385408**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
	FILL, sandy loam topsoil, with vegetation and roots (9")	FILL/TOPSOIL									
1	FILL, sand, coarse, brown	FILL	34	F/M	SS	24	24				
2	FILL, silty sand, with trace gravel, dark brown										
	SILTY SAND, very fine, brown, very loose to loose (SM)	COARSE ALLUVIUM									
3			3	M	SS	24	10				
4											
5			9	M	SS	18	16				
6	SANDY LEAN CLAY, with trace gravel, trace lignite, trace oxidized iron, brown, stiff (CL)	GLACIAL TILL									
7											
8			12	M	SS	18	18				72
9											
10			13	M	SS	18	18				
11											
12											
13			14	M	SS	18	17				
14											
15			13	M	SS	18	17				
16	END OF BORING										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS						
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
0-14½'	**3.25" HSA**	**3/19/26**		**16.0**	**NA**	**NA**	**NA**	**None**
BORING COMPLETED:	**3/19/26**							
DR: **AA**	LG: **KM** Rig: **B-57**							

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

AET_CORP W-LAT-LONG KNRI SEWER AND SEPTIC.GPJ AET+CPT+WELL.GDT 4/7/26

SUBSURFACE BORING LOG

AET JOB NO: **P-0045747** LOG OF BORING NO. **B-2 (p. 1 of 1)**

PROJECT: **KNRI Sewer and Septic Improvements; Stanton, ND**

SURFACE ELEVATION: **1721.0** LATITUDE: **47.330955** LONGITUDE: **-101.385628**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	%-#200
	FILL, sandy loam topsoil, with vegetation and roots, dark brown (10")	FILL/TOPSOIL									
1	FILL, sand, coarse, brown	FILL	49	F/M	SS	24	20				
2	FILL, silty sand, with trace gravel, brown										
3	SAND, very coarse, with trace gravel, trace lignite, brown, medium dense (SP)	COARSE ALLUVIUM	10	M	SS	24	7				
4											
5			15	M	SS	18					
6											
7	SANDY LEAN CLAY, with trace lignite, trace gravel, trace oxidized iron, brown, stiff (CL)	GLACIAL TILL									
8			10	M	SS	18	19				
9											
10			11	M	SS	18	18				
11											
12											
13			10	M	SS	18	17				
14											
15			9	M	SS	18	19				
16	END OF BORING										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS						
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
0-14½'	**3.25" HSA**	**3/19/26**		**16.0**	**NA**	**NA**	**NA**	**None**

BORING COMPLETED: **3/19/26**

DR: **AA** LG: **KM** Rig: **B-57**

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

AET_CORP W-LAT-LONG KNRI SEWER AND SEPTIC.GPJ AET+CPT+WELL.GDT 4/7/26

Percolation Testing Summary

Project: **KNRI Sewer and Septic Improvements**

Stanton, ND

AET No.: P-0045747
Date: 9/19/2025

	P-1			P-2			P-3			P-4		
	3' Perc Test Depth Initial WL = 11"			Initial WL = 12"			Initial WL = 12"			Initial WL =12"		
Test Interval Number	Time Elapsed (min)	Water Drop (in)	Perc Rate (min/in)	Time Elapsed (min)	Water Drop (in)	Perc Rate (min/in)	Time Elapsed (min)	Water Drop (in)	Perc Rate (min/in)	Time Elapsed (min)	Water Drop (in)	Perc Rate (min/in)
1	10	0.50	20.00	2.9	1.00	2.90	0.6	1.00	0.55	7.7	1.00	7.72
2	10	0.75	13.33	3.3	1.00	3.33	1.3	1.00	1.27	8.0	1.00	8.02
3	10	0.75	13.33	3.5	1.00	3.47	1.6	1.00	1.63	8.1	1.00	8.08
4	10	0.75	13.33	3.8	1.00	3.80	1.6	1.00	1.62			
5				3.9	1.00	3.92	1.6	1.00	1.63			
6												
7												
8												
9												
10												
Stabilized Perc Rate			13.33			3.73			1.63			7.94

Soil Profile Summary		Soil Profile Summary		Soil Profile Summary		Soil Profile Summary	
Depth (ft)	Visual Classification	Depth (ft)	Visual Classification	Depth (ft)	Visual Classification	Depth (ft)	Visual Classification
0-5"	SILTY SAND, with vegitation, trace gravel, brown	0-5"	SILTY SAND, with vegitation, trace gravel, brown	0-4"	SILTY SAND, with vegitation, trace gravel, brown	0-6"	SILTY SAND, with vegitation, trace gravel, brown
5"-2'	SILTY SAND, tan	5"-2'	SILTY SAND, tan	4"-3'	SILTY SAND, with trace gravel, tan	6"-3'	SILTY SAND, tan
2'-3'	SILTY SAND, with trace gravel, tan	2'-3'	SILTY SAND, with trace gravel, tan				

Water Depth	Not Encountered	Not Encountered	Not Encountered	Not Encountered

American Engineering Testing, Inc.
Dickinson
99 26th St E
Dickinson, ND 58601
(701) 483-4288
www.teamAET.com

Proctor Report

Report No: PTR:AET-240634-S1
Issue No: 1

Client: HDR Engineering, Inc.-Sioux Falls-SD **CC:**

Project: KNRI Sewer and Septic Improvements

Stanton ND

Job No: P-0045747

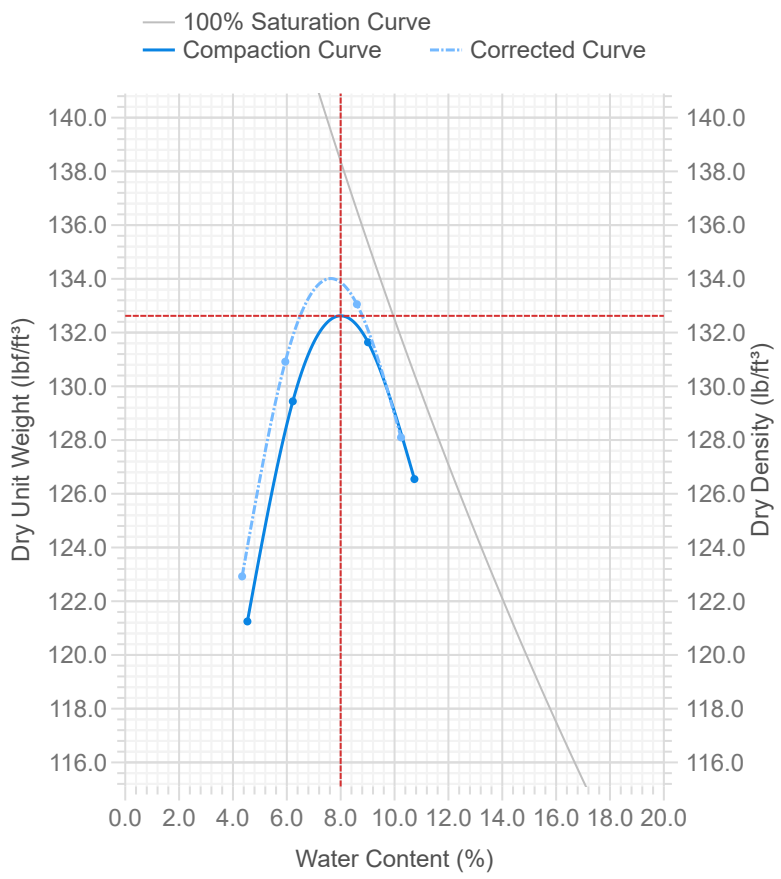
This document shall not be reproduced, except in full, without written approval from American Engineering Testing, Inc.

Date of Issue: 4/7/2026
Reviewed By: Connor Thompson
Dickinson Manager

Sample Details

Sample ID: AET-240634-S1 **Field ID:** Proctor 1
Date Sampled: 3/19/2026
Date Received: 3/20/2026
Sampling Method: Cuttings
Source: In Place
Material: Gravelly Silty Sand, brown
General Location: Knife River Indian Villages Historical Site
Location: B-2 (1-5')
Sampled By: Williston

Dry Unit Weight - Water Content Relationship



Test Results

ASTM D698

Std. Maximum Dry Unit Weight (lbf/ft³):	**132.6**
Std. Optimum Water Content (%):	**8.0**
Test Portion As-received Water Content (%):	2
Retained on 3/4″ Sieve (%):	5
Passing 3/4″ Sieve (%):	95
Cumulative Retained on 3/8″ Sieve (%):	18
Retained on 3/8″ Sieve (%):	13
Passing 3/8″ Sieve (%):	82
Cumulative Retained on No.4 Sieve (%):	39
Retained on No.4 Sieve (%):	21
Passing No.4 Sieve (%):	61
Method:	C
Preparation Method:	Moist
Rammer Type:	Automatic
Test Portion Specific Gravity:	2.70
Determined By:	Estimated
Tested By:	Christopher Hanberg
Date Tested:	3/26/2026

Comments

© 2000-2026 QESTLab by SpectraQEST.com

Appendix B

Geotechnical Report Limitations and Guidelines for Use

Appendix B
Geotechnical Report Limitations and Guidelines for Use
Report No. P-0045747

B.1 REFERENCE

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

B.2 RISK MANAGEMENT INFORMATION

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

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

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

B.2.2 Geotechnical Engineering Services are Performed for Specific Purposes, Persons, and Projects, and At Specific Times

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

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

Do <u>not</u> rely on this report if your geotechnical engineer prepared it:

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

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

1 Geoprofessional Business Association, 1300 Piccard Drive, LL14, Rockville, MD 20850
Telephone: 301/565-2733: www.geoprofessional.org, 2019

B.2.3 Read the Full Report
Costly problems have occurred because those relying on a geotechnical-engineering report did not read the report in its entirety. Do not rely on an executive summary. Do not read selective elements only. Read and refer to the report in full.

B.2.4 You Need to Inform Your Geotechnical Engineer About Change
Your geotechnical engineer considered unique, project-specific factors when developing the scope of study behind this report and developing the confirmation-dependent recommendations the report conveys. Typical changes that could erode the reliability of this report include those that affect:

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

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

B.2.5 Most of the "Findings" Related in This Report Are Professional Opinions
Before construction begins, geotechnical engineers explore a site's subsurface using various sampling and testing procedures. Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing is performed. The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgement to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team through project completion to obtain informed guidance quickly, whenever needed.

B.2.6 This Report's Recommendations Are Confirmation-Dependent
The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, they are not final, because the geotechnical engineer who developed them relied heavily on judgement and opinion to do so. Your geotechnical engineer can finalize the recommendations only after observing actual subsurface conditions exposed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.

B.2.7 This Report Could Be Misinterpreted
Other design professionals' misinterpretation of geotechnical engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a continuing member of the design team, to:

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

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

B.2.8 Give Constructors a Complete Report and Guidance
Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious

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

B.2.9 Read Responsibility Provisions Closely

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

B.2.10 Geoenvironmental Concerns Are Not Covered

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

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

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