GEOTEK ENGINEERING
& TESTING SERVICES, INC.
909 East 50th Street North
Sioux Falls, South Dakota 57104
Phone 605-335-5512 Fax 605-335-0773

February 9, 2022

Mills Development Corporation
1323 Main Avenue South
Brookings, South Dakota 57006

Attn: Jacob Mills

Subj: Geotechnical Exploration
Proposed Site Development
20th Street South & Main Avenue South
Brookings, South Dakota
GeoTek #22-061

This correspondence presents our written report of the geotechnical exploration program for the referenced project. Our work was performed in accordance with your authorization. We are transmitting an electronic copy of our report for your use. An additional copy of our report is also being sent as noted below.

We thank you for the opportunity of providing our services on this project and look forward to continued participation during the design and construction phases. If you have any questions regarding this report, please contact our office at (605) 335-5512.

Respectfully Submitted,
GeoTek Engineering & Testing Services, Inc.

Jared Haskins

Jared Haskins, PE
Geotechnical Manager

Cc: Banner Associates, Attn: Justin Bucher, PE

TABLE OF CONTENTS

INTRODUCTION 4
PROJECT INFORMATION 4
SCOPE OF SERVICES 4
SITE & SUBSURFACE CONDITIONS 5
SITE LOCATION & DESCRIPTION 5
GROUND SURFACE ELEVATIONS & TEST BORING LOCATIONS 5
SUBSURFACE CONDITIONS 5
SOIL TYPES 6
Existing Fill Materials 6
Topsoil Materials 6
Fine Alluvium Soils 6
Coarse Alluvium Soils 6
Glacial Till Soils 7
WATER LEVELS 7
ENGINEERING REVIEW & RECOMMENDATIONS 8
PROJECT DESIGN DATA 8
GENERAL SITE GRADING 8
UTILITY IMPROVEMENTS 9
Subgrade Soils 9
Water Control 9
OSHA Requirements 10
Trench Backfill 10
STREET IMPROVEMENTS 11
Subgrade Soils 11
Stripping & Removals 12
Filling 12
Cut Areas 12
Proofroll/Unstable Subgrade 13
Asphalt Pavement Section Thicknesses 13
Aggregate Base Course Material & Asphalt 14
FUTURE BUILDINGS 14
Single-Family Residential Structures 14
Multi-Family & Commercial Structures 14
SHRINKAGE FACTORS 15
EXCAVATION & EARTH MOVING ACTIVITIES 15
CORROSIVE POTENTIAL 15
DRAINAGE 17
CONSTRUCTION CONSIDERATIONS 17
GROUNDWATER & SURFACE WATER 17
DISTURBANCE OF SOILS 17
COLD WEATHER PRECAUTIONS 17

EXCAVATION SIDESLOPES 18
OBSERVATIONS & TESTING 18
EXCAVATION 18
TESTING 19

SUBSURFACE EXPLORATION PROCEDURES 19

TEST BORINGS 19
SOIL CLASSIFICATION 20
WATER LEVEL MEASUREMENTS 20
LABORATORY TESTS 20

LIMITATIONS 21

STANDARD OF CARE 21

APPENDIX A
FIGURE 1 – SITE LOCATION MAP
FIGURE 2 – TEST BORING LOCATION MAP
FIGURE 3 – DIPRA 10-POINT SYSTEM
BORING LOGS
SOILS CLASSIFICATION
SYMBOLS & DESCRIPTIVE TERMINOLOGY
PROCTOR DATA SHEETS

GEOTECHNICAL EXPLORATION
PROPOSED SITE DEVELOPMENT
20TH STREET SOUTH & MAIN AVENUE SOUTH
BROOKINGS, SOUTH DAKOTA
GEOTEK #22-061

INTRODUCTION

Project Information

This report presents the results of the recent geotechnical exploration program for the proposed site development located along the south side of 20th Street South between Main Avenue South and Medary Avenue South in Brookings, South Dakota.

Scope of Services

Our work was performed in accordance with the authorization of Jacob Mills with Mills Development Corporation. The scope of work as presented in this report is limited to the following:

1. To perform 11 standard penetration test (SPT) borings to gather data on the subsurface conditions at the site.

2. To perform laboratory tests that include moisture content, dry density, Atterberg limits (liquid and plastic limits), standard Proctor, pH, sulfate content, chloride content, resistivity, redox potential and sulfide content.

3. To prepare an engineering report that includes the results of the field and laboratory tests as well as our geotechnical engineering opinions and recommendations regarding the following:

    - Subsurface conditions;
    - General site grading;
    - Underground utility excavation and backfilling;
    - Earthwork and grading for the roadway subgrade;
    - Pavement section thicknesses;
    - Discussion for the future buildings;
    - Corrosive potential of the soils;
    - Quality control observations and testing;
    - Comments regarding factors that may impact the constructability and final performance of the project.

The scope of our work was intended for geotechnical purposes only. This scope of work did not include determining the presence or extent of environmental contamination at the site or to characterize the site relative to wetlands status.

SITE & SUBSURFACE CONDITIONS

Site Location & Description

The site is located along the south side of 20th Street South between Main Avenue South and Medary Avenue South in Brookings, South Dakota. A site location map (Figure 1) is attached showing the location of the site. The site was previously used for agricultural purposes. There are several wetland areas throughout the site.

Ground Surface Elevations & Test Boring Locations

The ground surface elevations at the test boring locations were provided by Banner Associates and varied from 1,601.5 feet at test boring 6 to 1,625.2 feet at test boring 8. A test boring location map (Figure 2) is attached showing the relative location of the test borings.

Subsurface Conditions

Eleven (11) test borings were performed at the site on January 31, 2022. The subsurface conditions encountered at the test boring locations are illustrated by means of the boring logs included in Appendix A.

The subsurface profile at the test boring locations consisted of the following soil types: topsoil materials, existing fill materials, fine alluvium soils, coarse alluvium soils and glacial till soils. The existing fill materials were encountered at test borings 2, 6, 7 and 11 and extended to depths varying from 3 feet to 7 feet. The topsoil materials were encountered at the surface at test borings 1, 3, 4, 5, 9 and 10 or beneath the existing fill materials at test borings 7 and 11. The fine alluvium soils were encountered at test borings 3, 4, 5, 8 and 10. The coarse alluvium soils were encountered at test borings 4, 5, 6 and 7. The glacial till soils were encountered at the majority of the test borings (not at test boring 5).

The consistency or relative density of the soils is indicated by the standard penetration resistance ("N") values as shown on the boring logs. A description of the soil consistency or relative density based on the "N" values can be found on the attached Soil Boring Symbols and Descriptive Terminology data sheet.

We wish to point out that the subsurface conditions at other times and locations at the site may differ from those found at our test boring locations. If different conditions are encountered during construction, then it is important that you contact us so that our recommendations can be reviewed.

Soil Types

Existing Fill Materials

The existing fill materials consisted of lean clay (CL), lean clay with sand (CL) and clayey sand (SC). "N" values within the existing fill materials were 12 and 17. The moisture condition of the existing fill materials was frozen and moist.

Topsoil Materials

The topsoil materials consisted of lean clay (CL), lean clay with sand (CL) and sandy lean clay (CL). The moisture condition of the topsoil materials was frozen and moist.

Fine Alluvium Soils

Fine alluvium soils are soils with more than 50 percent by weight passing the #200 sieve that have been deposited by moving water. The fine alluvium soils consisted of lean clay (CL). "N" values within the fine alluvium soils ranged from 6 to 10 (consistency of firm and stiff). The moisture condition of the fine alluvium soils was frozen, moist and wet.

Coarse Alluvium Soils

Coarse alluvium soils are soils with less than 50 percent by weight passing the #200 sieve that have been deposited by moving water. The coarse alluvium soils consisted of clayey sand (SC), sand with silt (SP-SM) and sand (SP). "N" values within the coarse alluvium soils ranged from 8

to 15 (relative density of loose and medium dense). The moisture condition of the coarse alluvium soils was frozen, dry, moist and waterbearing.

Glacial Till Soils

Glacial till soils are soils that have been deposited by a glacier. The glacial till soils consisted of lean clay with sand (CL). "N" values within the glacial till soils ranged from 7 to 20 (consistency of firm to very stiff). The moisture condition of the glacial till soils was frozen and moist.

Water Levels

Measurements to record the groundwater levels were made at the test boring locations. The time and level of the groundwater readings are recorded on the boring logs. Also, a summary of the groundwater levels is shown in Table 1.

Table 1. Groundwater Levels

Test Boring	Ground Surface Elevation, ft	Groundwater Level, ft	Elevation of Groundwater, ft
1	1,610.5	Dry to the Cave-In Depth*	N/A
2	1,610.4	Dry to the Cave-In Depth*	N/A
3	1,615.0	9	1,606.0
4	1,610.7	Dry to the Cave-In Depth*	N/A
5	1,608.0	6 ½	1,601.5
6	1,601.5	7	1,594.5
7	1,607.8	Dry to the Cave-In Depth*	N/A
8	1,625.2	Dry to the Cave-In Depth*	N/A
9	1,615.4	Dry to the Cave-In Depth*	N/A
10	1,613.6	Dry to the Cave-In Depth*	N/A
11	1,605.9	Dry to the Cave-In Depth*	N/A

Note: *We expect that groundwater would be encountered at some of these test borings if the boreholes were left open for an extended period of time.

The water levels may or may not be an accurate indication of the depth or lack of subsurface groundwater. The limited length of observation restricts the accuracy of the measurements. Long term groundwater monitoring was not included in our scope of work.

ENGINEERING REVIEW & RECOMMENDATIONS

Project Design Data

We understand that the project will consist of developing the site for residential and commercial use. The proposed development will include several new streets and new utilities (water, sanitary sewer and storm sewer). The deepest utility will likely be the sanitary sewer. Grade changes will include cutting and filling, but mostly filling. The cutting will only be performed in the southwest portion of the site. The majority of the cuts and fills will be less than 3 feet.

The information/assumptions detailed in the project design data section are important factors in our review and recommendations. If there are any corrections or additions to the information detailed in this section, then it is important that you contact us so that we can review our recommendations with regards to the revised plans.

General Site Grading

Based on the expected cuts and fills at the site, it is our opinion that the on-site existing fill materials, fine alluvium soils and glacial till soils will be the primary soil types encountered during general site grading. It is our opinion that the on-site existing fill materials, fine alluvium soils and glacial till soils can be used as general fill. Some moisture conditioning may be needed with the on-site existing fill materials, fine alluvium soils and glacial till soils in order to achieve proper placement of the general fill. In regards to the on-site topsoil materials, it is our opinion that the topsoil materials should not be used as general fill. The topsoil materials could be used as finishing material in green areas. We would like to point out that we recommend removing any topsoil materials prior to any site grading. Based on the test borings, the topsoil materials could vary in thickness from ½ foot to 2 feet.

Compaction of fill in structural areas, such as drives, sidewalks or within the footprint of structures, should be performed to a level of at least 95 percent of standard Proctor (ASTM:D698). Compaction of fill in non-structural areas, such as lawn or landscaping, should be performed to a level of at least 90 percent of standard Proctor (ASTM:D698).

The on-site clay soils are susceptible to disturbance and can experience strength loss caused by construction traffic and/or additional moisture. Precautions will be required during earthwork activities in order to reduce the risk of soil disturbance.

Utility Improvements

Subgrade Soils

The subgrade soils anticipated at the invert depths for the underground utilities will consist of clay soils or sand soils, but mostly clay soils. Where soils having moderate moisture and density values are encountered at the bottom of the trench excavations, it is our opinion that the soils are considered suitable for support of the proposed utilities, provided they are adequately dewatered, and are not disturbed by construction traffic. Localized areas of wet or soft soils may be encountered at the bottom of some of the trench excavations. These areas will require subexcavation and trench stabilization methods and materials. Appropriate bedding materials should be used for the utility pipes.

Water Control

Based on the groundwater measurements at the test boring locations (see Table 1 on page 7), it is our opinion that water will enter some of the trench excavations, especially at and around test borings 3, 5 and 6 (test borings with groundwater). Dewatering procedures will be needed in order to control and remove water entering some of the trench excavations. Where clay soils are encountered, it may be possible to remove and control water entering the excavations using normal sump pumping techniques. However, if waterbearing sand soils are encountered, then extensive dewatering techniques will likely be required due to the potentially large volumes of water. We would like to point out that waterbearing sand soils were encountered at test boring 6. The contractor should provide appropriate dewatering methods and equipment. Any water that accumulates at the bottom of the excavations should be immediately removed and surface drainage away from the excavations should be provided during construction.

OSHA Requirements

All excavations must comply with the requirements of OSHA 29 CFR, Part 1926, Subpart P, "Excavations and Trenches". This document states that the excavation safety is the responsibility of the contractor. Reference to this OSHA requirement should be included in the project specifications.

Trench Backfill

We recommend that the trench backfill be placed and compacted in uniform thin lifts (6-inch maximum lifts). The moisture content of clay backfill materials should be adjusted to a moisture level that is within plus or minus 2 percent of the optimum moisture content as determined by standard Proctor (ASTM:D698). The moisture content of granular backfill materials should be maintained at a level that will be conducive for vibratory compaction. Trench backfill should be compacted to a minimum of 95 percent of standard Proctor density (ASTM:D698).

We performed 2 standard Proctor tests for the project (1 on the fine alluvium soils at test boring 3 and 1 on the glacial till soils at test boring 4). The results of the standard Proctor tests are shown in Table 2.

Table 2. Standard Proctor Test Results

Test Boring	Depth (ft)	Soil Type	OMC (%)	Maximum Dry Density (pcf)
3	4 ½ to 12	Lean Clay (CL) – Fine Alluvium	18.1	107.2
4	6 to 12	Lean Clay w/ Sand (CL) – Glacial Till	15.8	113.7

Based on the results of the moisture content and standard Proctor tests, it is our general opinion that the majority of the existing fill materials and glacial till soils and portions of the fine alluvium soils have in-situ moisture content levels that range from 1 percent below to 4 percent above the optimum moisture content, while portions of the fine alluvium soils have in-situ moisture content levels that range from 7 percent above to 11 percent above the optimum moisture content. The fine alluvium soils with in-situ moisture content levels ranging from 7 percent above to 11 percent above the optimum moisture content are considered "wet". The wet

fine alluvium soils were encountered at test borings 3 and 5. We highlighted the wet fine alluvium soils on the boring logs.

In our opinion, the majority of the existing fill materials, coarse alluvium soils and glacial till soils and portions of the fine alluvium soils can likely be reused as trench backfill, while the wet fine alluvium soils are not suitable or ideal for use as trench backfill. Again, the wet fine alluvium soils were encountered at test borings 3 and 5. Also, the topsoil materials (encountered at test borings 1, 3, 4, 5, 7, 9, 10 and 11) should not be used as trench backfill. We highlighted the topsoil materials on the boring logs. Our opinions are based on our observations of the collected samples and the results of the laboratory tests. The wet fine alluvium soils will require extensive drying or will need to be replaced with an off-site borrow material or with suitable material available at other areas of the site. The topsoil materials should be replaced with an off-site borrow material or with suitable material available at other areas of the site.

Any off-site borrow material should consist of either a granular or clay material. If a granular material is used, then it should consist of a pit-run or processed sand or gravel having a maximum particle size of 1 inch. If a clay material is selected, then it should consist of a non-organic clay having a liquid limit less than 45. Scrutiny on the clay material's moisture content should be made prior to the acceptance and use. If granular materials are used, then the upper 2 feet to 3 feet of the trench backfill should consist of a clay material in order to provide a consistent subgrade condition beneath the pavement section.

Street Improvements

Subgrade Soils

Fill materials (existing and placed during general site grading), fine alluvium soils and glacial till soils are expected to be encountered as subgrade soils for the project. The fill materials, fine alluvium soils and glacial till soils have a Unified Soils Classification System symbol of CL and AASHTO classifications of A-6 and A-7. We would categorize the subgrade condition as a fair subgrade condition.

We estimate California Bearing Ratio (CBR) values of 2.5 to 3.5 for the fill materials, fine alluvium soils and glacial tills soils. The CBR value is a measure of the supporting value of the subgrade soils. The value can be determined from a soaked test or an unsoaked test. The value from a soaked test is used to simulate the worst conditions (wet periods of the year and the spring thaw), while the value from an unsoaked test is used to simulate normal field conditions (summer and fall). Values from soaked tests are much lower than values from unsoaked tests. The values discussed above represent values from soaked tests.

We understand that a geotextile fabric will be incorporated into the pavement section. In our opinion, the geotextile fabric will extend the life of the pavement section.

Stripping & Removals

We recommend removing any topsoil materials from the boundaries of the streets. Low-ground-pressure construction equipment or excavators with smooth-edged buckets should be used for the stripping and removals in areas where soft/wet soils are present. We recommend limiting the amount of heavy wheeled construction traffic on the subgrade.

Filling

If filling is required to achieve the design subgrade elevations, then the fill soils should consist of non-organic lean clay or sandy lean clay soils having a liquid limit less than 45. The majority of the on-site soils can be used as fill. The moisture content of the fill soils should be within plus or minus 2 percent of the optimum moisture content as determined by standard Proctor (ASTM:D698). The fill soils should be placed in compacted lifts having a maximum thickness of 6 inches. We recommend a minimum compaction specification of 95 percent of standard Proctor (ASTM:D698) for the fill soils. The on-site topsoil materials should not be used as fill within the boundaries of the streets.

Cut Areas

In the cut areas, we recommend that the exposed subgrade be scarified (with a disc harrow) to a minimum depth of 8 inches and adjusted to a moisture level that is within plus or minus 2 percent of the optimum moisture content as determined by standard Proctor (ASTM:D698). The

moisture-conditioned soils should then be compacted to a minimum density of 95 percent of standard Proctor (ASTM:D698).

Proofroll/Unstable Subgrade

Once the design subgrade elevations have been achieved and just prior to paving, we recommend that a proofroll test be performed on the exposed subgrade with a truck weighing 20 tons to 30 tons. During the proofroll test, unstable areas in the subgrade should be delineated from stable areas. An unstable area would be considered a location with at least 1 inch of rutting or deflection. Unstable areas will need additional corrections to provide a uniform and stable subgrade condition. Additional corrections may include the following: moisture conditioning the soils (e.g. drying the soils by scarification), an overexcavation to remove and replace the unstable subgrade soils, increasing the thickness of the aggregate base course material and/or the placement of a crushed subbase material at or below the subgrade surface. The type of correction performed should be determined after observing the performance of the subgrade during the proofroll test. Unstable areas should be expected, especially during the spring thaw and wetter periods of the year.

Asphalt Pavement Section Thicknesses

We were not provided a traffic volume for the streets; however, we assume that the traffic will consist of automobiles, maintenance vehicles, trash collection vehicles and a few trucks. Table 3 summarizes the recommended asphalt pavement section thicknesses based on the subsurface conditions and assumed traffic loads.

Table 3. Asphalt Pavement Section Thicknesses

Location	Asphalt Pavement Thickness, in	Aggregate Base Course Thickness, in	Subgrade Reinforcement
Residential Areas	4	8*	Geotextile Fabric**
Commercial Areas	5	9*	Geotextile Fabric**

Notes: The above sections assume that a stable subgrade condition is achieved during construction. *The thickness of the aggregate base course materials may need to the increased if poor subgrade conditions are encountered. **The geotextile fabric should consist of Mirafi HP 370, Propex Geotex 3x3 HF, Huesker Comtrac P 45/45 or an approved alternative.

Aggregate Base Course Material & Asphalt

We recommend that the aggregate base course material meet the requirements of Sections 260 and 882 of the SDDOT Standard Specifications. The aggregate base course material should be compacted to a minimum of 97 percent of standard Proctor (ASTM:D698). The asphalt pavement should meet the requirements of sections 320 and 321 for Class G.

Future Buildings

Single-Family Residential Structures

In our opinion, the fill materials (properly placed and compacted during general site grading), fine alluvium soils, coarse alluvium soils and glacial till soils are considered suitable for support of typical single-family residential structures. It is our opinion that the topsoil materials would not be considered suitable for support of the single-family residential structures.

Based on the groundwater levels at the test boring locations (see Table 1 on page 7), it is our opinion that long-term groundwater control will likely be needed if the single-family residential structures have basements. Therefore, single-family residential structures with basements should have a drainage system (drain tile and a sump).

Multi-Family & Commercial Structures

Due to the uncertainty of the multi-family (apartment) and commercial building foundation loads, we recommend that additional test borings be performed for individual properties once grading has been completed and foundation loads are known. Recommendations would be provided in separate geotechnical exploration reports.

We will discuss the soil types encountered and their general strength properties related to foundation support. It is our opinion that the fill materials and topsoil materials are not suitable for support of the future multi-family and commercial structures. The fine alluvium soils should only be considered suitable for support of lightly loaded structures. Additional site preparation may be needed with the fine alluvium soils. A net allowable soil bearing pressure of 1,500 pounds per square foot (psf) could be expected with the fine alluvium soils. Regarding the coarse alluvium soils

and glacial till soils, it is our opinion that the coarse alluvium soils and glacial till soils are considered suitable for support of lightly and moderately loaded structures. A net allowable soil bearing pressure between 2,500 psf and 4,000 psf could be expected with the coarse alluvium soils and glacial till soils.

Shrinkage Factors

Table 4 summarizes the estimated shrinkage factors for the various soils encountered at the test boring locations.

Table 4. Summary of the Shrinkage Factors of the Soils

Soil Type	Estimated Shrinkage Factors (%)
Topsoil Materials	30
Existing Fill Materials	25
Fine Alluvium Soils	25
Coarse Alluvium Soils	15
Glacial Till Soils	15

Excavation & Earth Moving Activities

Conventional scrapers can typically be utilized for soils having low to moderate moisture contents levels; however, if soils with high moisture content levels are encountered, then low-ground-pressure construction equipment should be used.

The clay soils are susceptible to disturbance and can experience strength loss caused by construction traffic and/or additional moisture. The clay soils should be considered frost-susceptible. Precautions will be required during earthwork activities in order to reduce the risk of soil disturbance.

Corrosive Potential

Soil samples were collected from test borings 4 and 5 and were submitted for pH, sulfate content, chloride content, resistivity, redox potential and sulfide content testing. The results of the pH, resistivity, redox potential and sulfide content testing are shown in Table 5 and the results of the chloride content and sulfate content testing are shown in Table 7.

Table 5. pH, Resistivity, Redox Potential & Sulfide Content Results

Test Boring	Depth (ft)	Soil Classification	pH	Resistivity (ohm-cm)	Redox Potential (mV)	Sulfide (mg/kg)
4	6 to 12	CL (Glacial Till)	8.6	2,479	112	ND
5	4 ½ to 9 ½	CL (Fine Alluvium)	8.4	1,407	120	ND

Notes: The resistivity values are minimum values (saturated condition). ND – not detected.

Using the Ductile Iron Pipe Research Association's (DIPRA) 10-point system and the lab results shown in Table 5, we evaluated the corrosive potential of the tested soils. The 10-point system is based on resistivity, pH, redox potential, sulfides and moisture. An explanation of the point system is shown on Figure 3. The results of the evaluation are shown in Table 6. According to DIPRA, a value of 10 or more indicates that the soil is corrosive to underground piping, while a value below 10 indicates that the soil is not corrosive to underground piping. Based on Table 6, the fine alluvium soils are corrosive and the glacial till soils are not corrosive. In our opinion, protective measures should be taken.

Table 6. Results of DIPRA 10-Point System Evaluation

Test Boring	Depth (ft)	Soil Classification	Total Value	Result
4	6 to 12	CL (Glacial Till)	7	Not Corrosive
5	4 ½ to 9 ½	CL (Fine Alluvium)	12	Corrosive

Note: A "poor drainage, continuously wet" was used for the moisture condition (2 points).

Table 7. Sulfate & Chloride Content Test Results

Test Boring	Depth (ft)	Soil Classification	Sulfate (mg/kg)	Chloride (mg/kg)
4	6 to 12	CL (Glacial Till)	30	9
5	4 ½ to 9 ½	CL (Fine Alluvium)	46	25

As shown in Table 7, the sulfate content levels were 30 mg/kg and 46 mg/kg and the chloride content levels were 9 mg/kg and 25 mg/kg. Generally, soils are considered mildly corrosive if the sulfate and chloride content levels are below 250 mg/kg. Therefore, the fine alluvium soils and glacial till soils are considered mildly corrosive (based on the sulfate and chloride content levels).

Drainage

Proper drainage should be maintained during and after construction. The general site grading should direct surface run-off waters away from the excavations. Water which accumulates in the excavations should be removed in a timely manner. Finished grades around the perimeter of the structures should be sloped such that positive drainage away from the structures is provided.

CONSTRUCTION CONSIDERATIONS

Groundwater & Surface Water

Water may enter the excavations due to subsurface water, precipitation or surface run off. Any water that accumulates in the bottom of the excavation should be immediately removed and surface drainage away from the excavation should be provided during construction.

Disturbance of Soils

The soils encountered at the test boring locations are susceptible to disturbance and can experience strength loss caused by construction traffic and/or additional moisture. Precautions will be required during earthwork activities in order to reduce the risk of soil disturbance.

Cold Weather Precautions

If site preparation and construction is anticipated during cold weather, then we recommend all foundations, slabs and other improvements that may be affected by frost movements be insulated from frost penetration during freezing temperatures. If filling is performed during freezing temperatures, then all frozen soils, snow and ice should be removed from the areas to be filled prior to placing the new fill. The new fill should not be allowed to freeze during transit, placement and compaction. Concrete should not be placed on frozen subgrades. Frost should not be allowed to penetrate below the footings. If floor slab subgrades freeze, then we recommend the frozen soils be removed and replaced, or completely thawed, prior to placement of the floor slab. The subgrade soils will likely require reworking and recompacting due to the loss of density caused by the freeze/thaw process.

Excavation Sideslopes

The excavations must comply with the requirements of OSHA 29 CFR, Part 1926, Subpart P, "Excavations and Trenches". This document states that the excavation safety is the responsibility of the contractor. Reference to this OSHA requirement should be included in the project specifications.

Observations & Testing

This report was prepared using a limited amount of information for the project and a number of assumptions were necessary to help us develop our conclusions and recommendations. It is recommended that our firm be retained to review the geotechnical aspects of the final design plans and specifications to check that our recommendations have been properly incorporated into the design documents.

The recommendations submitted in this report have been made based on the subsurface conditions encountered at the test boring locations. It is possible that there are subsurface conditions at the site that are different from those represented by the test borings. As a result, on-site observation during construction is considered integral to the successful implementation of the recommendations. We believe that qualified field personnel need to be on-site at the following times to observe the site conditions and effectiveness of the construction.

Excavation

We recommend that a geotechnical engineer or geotechnical engineering technician working under the direct supervision of a geotechnical engineer observe all excavations for foundations, slabs and pavements. These observations are recommended to determine if the exposed soils are similar to those encountered at the test boring locations, if unsuitable soils have been adequately removed and if the exposed soils are suitable for support of the proposed construction. These observations should be performed prior to placement of fill or foundations.

Testing

After the subgrade is observed by a geotechnical engineer/technician and approved, we recommend a representative number of compaction tests be taken during the placement of the structural fill and backfill placed below foundations, slabs and pavements, beside foundation walls and behind retaining walls. The tests should be performed to determine if the required compaction has been achieved. As a general guideline, we recommend at least 1 test be taken for every 2,000 square feet of structural fill placed in building and pavement areas, at least 1 test for every 75 feet to 100 feet in trench fill, and for every 2-foot thickness of fill or backfill placed. The actual number of tests should be left to the discretion of the geotechnical engineer. Samples of proposed fill and backfill materials should be submitted to our laboratory for testing to determine their compliance with our recommendations and project specifications.

SUBSURFACE EXPLORATION PROCEDURES

Test Borings

We performed 11 SPT borings on January 31, 2022 with a truck rig equipped with hollow-stem auger. Soil sampling was performed in accordance with the procedures described in ASTM:D1586. Using this procedure, a 2-inch O.D. split barrel sampler is driven into the soil by a 140-pound weight falling 30 inches. After an initial set of 6 inches, the number of blows required to drive the sampler an additional 12 inches is known as the penetration resistance, or "N" value. The "N" value is an index of the relative density of cohesionless soils and the consistency of cohesive soils. In addition, thin walled tube samples were obtained according to ASTM:D1587, where indicated by the appropriate symbol on the boring logs.

The test borings were backfilled with on-site materials and some settlement of these materials can be expected to occur. Final closure of the holes is the responsibility of the client or property owner.

The soil samples collected from the test boring locations will be retained in our office for a period of 1 month after the date of this report and will then be discarded unless we are notified otherwise.

Soil Classification

As the samples were obtained in the field, they were visually and manually classified by the crew chief according to ASTM:D2488. Representative portions of all samples were then sealed and returned to the laboratory for further examination and for verification of the field classification. In addition, select samples were then submitted to a program of laboratory tests. Where laboratory classification tests (sieve analysis and Atterberg limits) have been performed, classifications according to ASTM:D2487 are possible. Logs of the test borings indicating the depth and identification of the various strata, the "N" value, the laboratory test data, water level information and pertinent information regarding the method of maintaining and advancing the drill holes are also attached in Appendix A. Charts illustrating the soil classification procedures, the descriptive terminology and the symbols used on the boring logs are also attached in Appendix A.

Water Level Measurements

Subsurface groundwater levels should be expected to fluctuate seasonally and yearly from the groundwater readings recorded at the test boring locations. Fluctuations occur due to varying seasonal and yearly rainfall amounts and snowmelt, as well as other factors. It is possible that the subsurface groundwater levels during or after construction could be significantly different than the time the test borings were performed.

Laboratory Tests

Laboratory tests were performed on select samples to aid in determining the index properties of the soils. The index tests consisted of moisture content, dry density, Atterberg limits (liquid and plastic limits), standard Proctor, pH, sulfate content, chloride content, resistivity, redox potential and sulfide content. The laboratory tests were performed in accordance with the appropriate ASTM procedures. The results of the laboratory tests are shown on the boring logs opposite the samples upon which the tests were performed or on the data sheets included in the Appendix.

LIMITATIONS

The recommendations and professional opinions submitted in this report were based upon the data obtained through the sampling and testing program at the test boring locations. We wish to point out that because no exploration program can totally reveal the exact subsurface conditions for the entire site, conditions between test borings and between samples and at other times may differ from those described in our report. Our exploration program identified subsurface conditions only at those points where samples were retrieved or where water was observed. It is not standard engineering practice to continuously retrieve samples for the full depth of the borings. Therefore, strata boundaries and thicknesses must be inferred to some extent. Additionally, some soils layers present in the ground may not be observed between sampling intervals. If the subsurface conditions encountered at the time of construction differ from those represented by our test borings, it is necessary to contact us so that our recommendations can be reviewed. The variations may result in altering our conclusions or recommendations regarding site preparation or construction procedures, thus, potentially affecting construction costs.

This report is for the exclusive use of the addressee and its representatives for use in design of the proposed project described herein and preparation of construction documents. Without written approval, we assume no responsibility to other parties regarding this report. Our conclusions, opinions and recommendations may not be appropriate for other parties or projects.

STANDARD OF CARE

The recommendations submitted in this report represent our professional opinions. Our services for your project were performed in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering profession currently practicing at this time and area.

This report was prepared by:
GeoTek Engineering & Testing Services, Inc.

Jared Haskins, PE
Geotechnical Manager

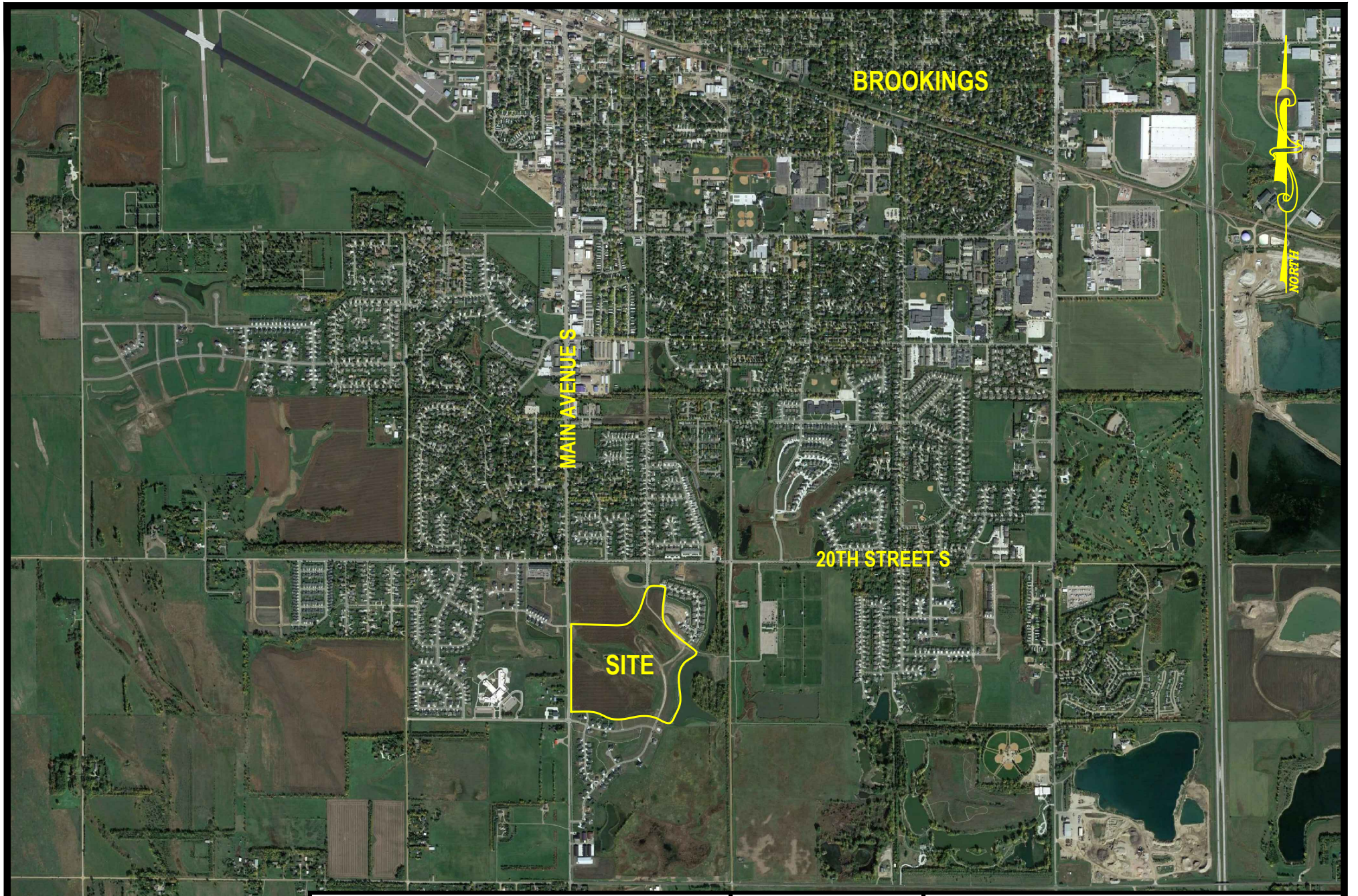


FIGURE 1
SITE LOCATION MAP
PROPOSED SITE DEVELOPMENT
20TH STREET S. & MAIN STREET S.
BROOKINGS, SD

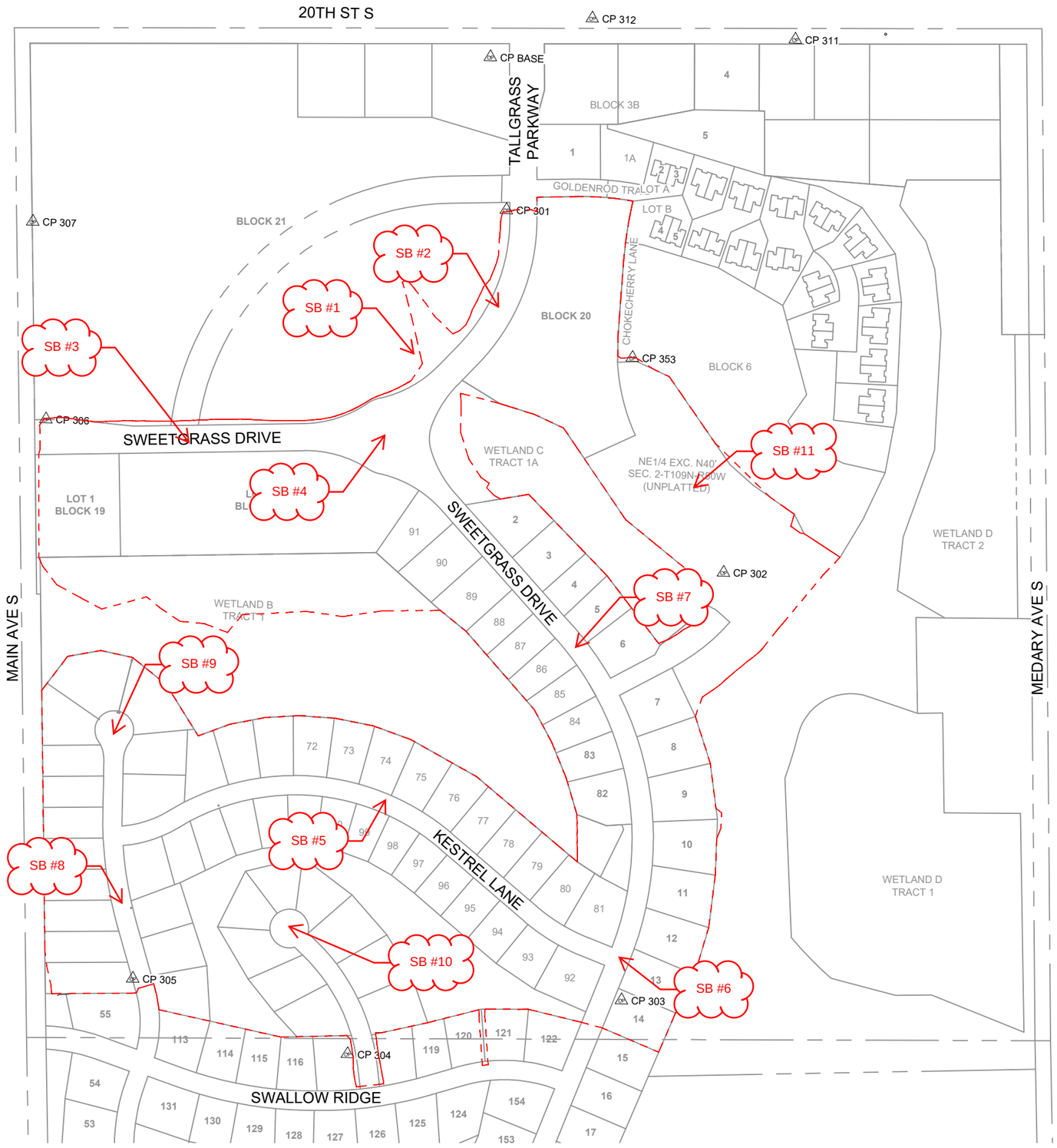
ACAD/GEOTEK/JARED/22-061

PROJECT#: 22-061

DRAWN BY: MAB

GEOTEK ENGINEERING & TESTING SERVICES, INC.
909 East 50th Street North
Sioux Falls, South Dakota 57104
605-335-5512 Fax 605-335-0773

Figure 2



CONTROL POINT TABLE				
POINT #	DESCRIPTION	NORTHING	EASTING	ELEVATION
300	CP BASE	180311.389	2807933.050	1616.873
301	CP 301	179918.783	2807987.941	1610.169
302	CP 302	179004.349	2808580.098	1603.585
303	CP 303	177893.561	2808355.625	1604.468
304	CP 304	177730.454	2807654.141	1614.510
305	CP 305	177905.444	2807094.044	1624.089
306	CP 306	179338.446	2806819.864	1619.398
307	CP 307	179846.300	2806768.354	1626.558
311	CP 311	180383.977	2808717.441	1607.733
312	CP 312	180420.457	2808192.199	1615.054
353	CP 353	179549.461	2808325.951	1608.274

BANNER
engineering a better community
www.bannerassociates.com - Toll Free: 1.855.323.6342

PROJECT / SHEET TITLE:
PRAIRIE HILLS ADDITION INFRASTRUCTURE IMPROVEMENTS
CONTROL POINT LAYOUT
BROOKINGS, SOUTH DAKOTA

REV.	DATE	DESCRIPTION

FOR REVIEW ONLY
NOT FOR CONSTRUCTION

JOB No.:	20977-01
DATE:	FEBRUARY 2022
ENG / ARCH:	JDB
DESIGNER:	JDB
TECHNICIAN:	JLU

0 1/2" 1"
SCALE REDUCTION BAR

SHEET No. :
A-4

F:\20977-01\Design Phase\CADD\Sheet File\Section A.dwg,1/9/2022 1:32 PM

FIGURE 3

Table A.1 Soil-test evaluation

Soil Characteristics Based on Samples Taken Down to Pipe Depth		
Resistivity—ohm-cm (based on water-saturated soil box):		Points*
	<1,500	10
	≥1,500–1,800	8
	>1,800–2,100	5
	>2,100–2,500	2
	>2,500–3,000	1
	>3,000	0
pH:		
	0–2	5
	2–4	3
	4–6.5	0
	6.5–7.5	0†
	7.5–8.5	0
	>8.5	3
Redox potential:		
	> +100 mV	0
	+50 to +100 mV	3.5
	0 to +50 mV	4
	Negative	5
Sulfides:		
	Positive	3.5
	Trace	2
	Negative	0
Moisture:		
	Poor drainage, continuously wet	2
	Fair drainage, generally moist	1
	Good drainage, generally dry	0

*Ten points or greater indicates that soil is corrosive to ductile-iron pipe; protection is needed. Refer to paragraph A.3 for a description of Uniquely Severe Environments and additional considerations.

†If sulfides are present and low (<100 mv) or negative redox-potential results are obtained, add three points for this range.

GEOTEK ENGINEERING
& TESTING SERVICES, INC.
909 E 50th St N
Sioux Falls, South Dakota, 57104
605-335-5512 Fax
jhaskins@geotekeng.com

GEOTECHNICAL TEST BORING LOG

-unsuitable material for trench backfill

GEOTEK # **22-061** BORING NO. **1 (1 of 1)**

PROJECT **Proposed Site Development, 20th Street South & Main Avenue South, Brookings, SD**

DEPTH in FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION 1610.5 ft)	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	LABORATORY TESTS WC	D	LL	PL	QU
	LEAN CLAY WITH SAND: very dark brown, frozen, (CL)	TOPSOIL			1	HSA					
2	**LEAN CLAY WITH SAND**: a little gravel, grayish brown, frozen to 4' then moist, stiff, (CL)	GLACIAL TILL			2	HSA					
			12		3	SPT	17	117	34	13	
			11		4	SPT	19				
			12		5	SPT	19				
			11		6	SPT	16				
			12		7	SPT	19				
16	Bottom of borehole at 16 feet.										

WATER LEVEL MEASUREMENTS

START 1-31-22 COMPLETE 1-31-22 4:10 pm

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL
1-31-22	4:10 pm	16	--	14	none
--	--	--	--	--	--
--	--	--	--	--	--
--	--	--	--	--	--

METHOD
3.25" ID Hollow Stem Auger

CREW CHIEF Roy Hanson

GEOTECHNICAL TEST BORING 22-061.GPJ GEOTEKENG.GDT 2/3/22

GEOTEK ENGINEERING
& TESTING SERVICES, INC.
909 E 50th St N
Sioux Falls, South Dakota, 57104
605-335-5512 Fax
jhaskins@geotekeng.com

GEOTECHNICAL TEST BORING LOG

GEOTEK # **22-061** BORING NO. **2 (1 of 1)**

PROJECT **Proposed Site Development, 20th Street South & Main Avenue South, Brookings, SD**

DEPTH in FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION 1610.4 ft)	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	LABORATORY TESTS WC	D	LL	PL	QU
	FILL, MOSTLY LEAN CLAY WITH SAND: a little gravel, brown and dark brown, frozen to 4' then moist	FILL			1	HSA					
			43		2	SPT					
4½	**FILL, MOSTLY LEAN CLAY WITH SAND**: a little gravel, dark brown, moist	FILL	17		3	SPT	15				
					4	BAG					
7	**LEAN CLAY WITH SAND**: a little gravel, grayish brown, moist, stiff, (CL)	GLACIAL TILL	10		5	SPT	18				
			10		6	SPT	19				
			12		7	SPT	19				
			15		8	SPT	19				
16	Bottom of borehole at 16 feet.										

WATER LEVEL MEASUREMENTS

START 1-31-22 COMPLETE 1-31-22 10:15 am

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL
1-31-22	10:15 am	16	--	14	none
1-31-22	4:56 pm	16	--	11	none
--	--	--	--	--	--
--	--	--	--	--	--

METHOD
3.25" ID Hollow Stem Auger

CREW CHIEF Roy Hanson

GEOTECHNICAL TEST BORING 22-061.GPJ GEOTEKENG.GDT 2/3/22

GEOTEK ENGINEERING
& TESTING SERVICES, INC.
909 E 50th St N
Sioux Falls, South Dakota, 57104
605-335-5512 Fax
jhaskins@geotekeng.com

GEOTECHNICAL TEST BORING LOG

-unsuitable material for trench backfill
-wet soils/excessive drying needed

GEOTEK # **22-061** BORING NO. **3 (1 of 1)**

PROJECT **Proposed Site Development, 20th Street South & Main Avenue South, Brookings, SD**

DEPTH in FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION 1615.0 ft)	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	LAB WC	LAB D	LAB LL	LAB PL	LAB QU
0½	**LEAN CLAY**: very dark brown, frozen, (CL)	TOPSOIL									
	LEAN CLAY: brown, frozen to 4' then moist, (CL)	FINE ALLUVIUM			1	HSA					
					2	HSA					
4½	**LEAN CLAY**: brown, moist to wet, stiff, (CL)	FINE ALLUVIUM	9		3	SPT	21				
			9		4	SPT	26	102			
				▼	5	BAG					
			10		6	SPT	26				
12	**LEAN CLAY WITH SAND**: a little gravel, brown, moist, stiff, (CL)	GLACIAL TILL	10		7	SPT	20				
			11		8	SPT	20				
16	Bottom of borehole at 16 feet.										

WATER LEVEL MEASUREMENTS

START 1-31-22 COMPLETE 1-31-22 4:50 pm

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL
1-31-22	4:50 pm	16	--	14	▼ 9
--	--	--	--	--	--
--	--	--	--	--	--
--	--	--	--	--	--

METHOD
3.25" ID Hollow Stem Auger

CREW CHIEF Roy Hanson

GEOTECHNICAL TEST BORING 22-061.GPJ GEOTEKENG.GDT 2/3/22

GEOTEK ENGINEERING
& TESTING SERVICES, INC.
909 E 50th St N
Sioux Falls, South Dakota, 57104
605-335-5512 Fax
jhaskins@geotekeng.com

GEOTECHNICAL TEST BORING LOG

-unsuitable material for trench backfill

GEOTEK # **22-061** BORING NO. **4 (1 of 1)**

PROJECT **Proposed Site Development, 20th Street South & Main Avenue South, Brookings, SD**

DEPTH in FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION 1610.7 ft)	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	LAB WC	LAB D	LAB LL	LAB PL	LAB QU
	LEAN CLAY: black, frozen, (CL)	TOPSOIL			1	HSA					
2	**LEAN CLAY**: brown and gray, frozen to 4' then moist, (CL)	FINE ALLUVIUM			2	HSA					
4½	**CLAYEY SAND**: a trace of gravel, fine to medium grained, brown, dry, medium dense, (SC)	COARSE ALLUVIUM	14		3	SPT	6				
6	**LEAN CLAY WITH SAND**: a little gravel, grayish brown and gray, moist, stiff, (CL)	GLACIAL TILL	9		4	SPT	20				
					5	BAG					
			11		6	SPT	19				
12	**LEAN CLAY WITH SAND**: a little gravel, brown, moist, stiff, (CL)	GLACIAL TILL	10		7	SPT	19				
			11		8	SPT	18				
16	Bottom of borehole at 16 feet.										

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL
1-31-22	3:35 pm	16	--	14	none
--	--	--	--	--	--
--	--	--	--	--	--
--	--	--	--	--	--

START 1-31-22 COMPLETE 1-31-22 3:35 pm

METHOD
3.25" ID Hollow Stem Auger

CREW CHIEF Roy Hanson

GEOTECHNICAL TEST BORING 22-061.GPJ GEOTEKENG.GDT 2/3/22

GEOTEK ENGINEERING & TESTING SERVICES, INC.
909 E 50th St N
Sioux Falls, South Dakota, 57104
605-335-5512 Fax
jhaskins@geotekeng.com

GEOTECHNICAL TEST BORING LOG

-unsuitable material for trench backfill

-wet soils/excessive drying needed

GEOTEK # **22-061** BORING NO. **5 (1 of 1)**

PROJECT **Proposed Site Development, 20th Street South & Main Avenue South, Brookings, SD**

DEPTH in FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION 1608.0 ft)	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	LAB WC	LAB D	LAB LL	LAB PL	LAB QU
	SANDY LEAN CLAY: black, frozen, (CL)	TOPSOIL			1	HSA					
2	**CLAYEY SAND**: fine to medium grained, brown, frozen to 4' then dry, (SC)	COARSE ALLUVIUM			2	HSA					
4½	**LEAN CLAY**: gray, moist, firm, (CL)	FINE ALLUVIUM	7	▼	3	SPT	25		38	17	
			6		4	SPT	21	111			
9½	**LEAN CLAY**: brown, moist to wet, firm, a few lenses of sand above 10' (CL)	FINE ALLUVIUM	6		5	SPT	25				
			7		6	SPT	29				
			8		7	SPT	29				
16	Bottom of borehole at 16 feet.										

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL
1-31-22	1:50 pm	16	--	14	7
1-31-22	4:51 pm	16	--	8	▼ 6.5
--	--	--	--	--	--
--	--	--	--	--	--

START 1-31-22 COMPLETE 1-31-22 1:50 pm

METHOD
3.25" ID Hollow Stem Auger

CREW CHIEF Roy Hanson

GEOTECHNICAL TEST BORING 22-061.GPJ GEOTEKENG.GDT 2/3/22

GEOTEK ENGINEERING
& TESTING SERVICES, INC.
909 E 50th St N
Sioux Falls, South Dakota, 57104
605-335-5512 Fax
jhaskins@geotekeng.com

GEOTECHNICAL TEST BORING LOG

GEOTEK # **22-061** BORING NO. **6 (1 of 1)**

PROJECT **Proposed Site Development, 20th Street South & Main Avenue South, Brookings, SD**

DEPTH in FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION 1601.5 ft)	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	LABORATORY TESTS WC	D	LL	PL	QU
	FILL, MOSTLY LEAN CLAY WITH SAND: a trace of gravel, brown and dark brown, frozen to 4' then moist	FILL			1	HSA					
					2	HSA					
4½	**CLAYEY SAND**: a little gravel, fine to medium grained, brown, dry, medium dense, (SC)	COARSE ALLUVIUM	10		3	SPT	9				
7	**SAND WITH SILT**: a trace of gravel, fine to medium grained, brown, moist to waterbearing, medium dense, (SP-SM)	COARSE ALLUVIUM	15	▼	4	SPT	24				
			13		5	SPT	21				
			13		6	SPT	21				
14½	**LEAN CLAY WITH SAND**: a little gravel, dark grayish brown, moist, stiff, (CL)	GLACIAL TILL	12		7	SPT	17				
16	Bottom of borehole at 16 feet.										

WATER LEVEL MEASUREMENTS

START 1-31-22 COMPLETE 1-31-22 12:45 pm

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL
1-31-22	12:45 pm	16	--	7	▼ 7
--	--	--	--	--	--
--	--	--	--	--	--
--	--	--	--	--	--

METHOD
3.25" ID Hollow Stem Auger

CREW CHIEF Roy Hanson

GEOTECHNICAL TEST BORING 22-061.GPJ GEOTEKENG.GDT 2/3/22

GEOTEK ENGINEERING
& TESTING SERVICES, INC.
909 E 50th St N
Sioux Falls, South Dakota, 57104
605-335-5512 Fax
jhaskins@geotekeng.com

GEOTECHNICAL TEST BORING LOG

-unsuitable material for trench backfill

GEOTEK # **22-061** BORING NO. **7 (1 of 1)**

PROJECT **Proposed Site Development, 20th Street South & Main Avenue South, Brookings, SD**

DEPTH in FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION 1607.8 ft)	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	LAB WC	LAB D	LAB LL	LAB PL	LAB QU
	FILL, MOSTLY LEAN CLAY: a trace of gravel, brown and dark brown, frozen to 4' then moist	FILL			1	HSA					
					2	HSA					
			12		3	SPT	12				
6	**LEAN CLAY WITH SAND**: black, moist, (CL)	TOPSOIL									
7	**SAND**: a little gravel, fine to medium grained, brown, dry, loose, (SP)	COARSE ALLUVIUM	8		4	SPT	5				
9½	**LEAN CLAY WITH SAND**: a little gravel, brown, moist, firm to stiff, (CL)	GLACIAL TILL	7		5	SPT	19				
			9		6	SPT	19				
			10		7	SPT	20				
16	Bottom of borehole at 16 feet.										

WATER LEVEL MEASUREMENTS

START 1-31-22 COMPLETE 1-31-22 11:35 am

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL
1-31-22	11:35 am	16	--	14	none
--	--	--	--	--	--
--	--	--	--	--	--
--	--	--	--	--	--

METHOD
3.25" ID Hollow Stem Auger

CREW CHIEF Roy Hanson

GEOTECHNICAL TEST BORING 22-061.GPJ GEOTEKENG.GDT 2/3/22

GEOTEK ENGINEERING
& TESTING SERVICES, INC.
909 E 50th St N
Sioux Falls, South Dakota, 57104
605-335-5512 Fax
jhaskins@geotekeng.com

GEOTECHNICAL TEST BORING LOG

GEOTEK # **22-061** BORING NO. **8 (1 of 1)**

PROJECT **Proposed Site Development, 20th Street South & Main Avenue South, Brookings, SD**

DEPTH in FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION 1625.2 ft)	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	LABORATORY TESTS WC	D	LL	PL	QU
	LEAN CLAY: brown, frozen to 4' then moist, (CL)	FINE ALLUVIUM			1	HSA					
					2	HSA					
4½	**LEAN CLAY WITH SAND**: a little gravel, grayish brown, moist, stiff, (CL)	GLACIAL TILL	12		3	SPT	17	114	33	15	
			14		4	SPT	14				
9½	**LEAN CLAY WITH SAND**: a little gravel, grayish brown, moist, stiff, (CL)	GLACIAL TILL	10		5	SPT	15				
			10		6	SPT	18				
			11		7	SPT	17				
16	Bottom of borehole at 16 feet.										

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL
1-31-22	2:55 pm	16	--	14	none
--	--	--	--	--	--
--	--	--	--	--	--
--	--	--	--	--	--

START 1-31-22 COMPLETE 1-31-22 2:55 pm

METHOD
3.25" ID Hollow Stem Auger

CREW CHIEF Roy Hanson

GEOTECHNICAL TEST BORING 22-061.GPJ GEOTEKENG.GDT 2/3/22

GEOTEK ENGINEERING
& TESTING SERVICES, INC.
909 E 50th St N
Sioux Falls, South Dakota, 57104
605-335-5512 Fax
jhaskins@geotekeng.com

GEOTECHNICAL TEST BORING LOG

-unsuitable material for trench backfill

GEOTEK # **22-061** BORING NO. **9 (1 of 1)**

PROJECT **Proposed Site Development, 20th Street South & Main Avenue South, Brookings, SD**

DEPTH in FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION 1615.4 ft)	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	LAB WC	LAB D	LAB LL	LAB PL	LAB QU
0½	**LEAN CLAY**: very dark brown, frozen	TOPSOIL									
	LEAN CLAY WITH SAND: a little gravel, brown, frozen to 4' then moist, stiff to very stiff, (CL)	GLACIAL TILL			1	HSA					
					2	HSA					
			14		3	SPT	17				
			14		4	SPT	18				
			15		5	SPT	17				
			16		6	SPT	17				
			20		7	SPT	17				
16	Bottom of borehole at 16 feet.										

WATER LEVEL MEASUREMENTS

START 1-31-22 COMPLETE 1-31-22 2:25 pm

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL
1-31-22	2:25 pm	16	--	14	none
--	--	--	--	--	--
--	--	--	--	--	--
--	--	--	--	--	--

METHOD
3.25" ID Hollow Stem Auger

CREW CHIEF Roy Hanson

GEOTECHNICAL TEST BORING 22-061.GPJ GEOTEKENG.GDT 2/3/22

GEOTEK ENGINEERING
& TESTING SERVICES, INC.
909 E 50th St N
Sioux Falls, South Dakota, 57104
605-335-5512 Fax
jhaskins@geotekeng.com

GEOTECHNICAL TEST BORING LOG

-unsuitable material for trench backfill

GEOTEK # **22-061** BORING NO. **10 (1 of 1)**

PROJECT **Proposed Site Development, 20th Street South & Main Avenue South, Brookings, SD**

DEPTH in FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION 1613.6 ft)	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	LABORATORY TESTS WC	D	LL	PL	QU
	LEAN CLAY: black, frozen, (CL)	TOPSOIL			1	HSA					
2	**LEAN CLAY**: grayish brown, frozen to 4' then moist, (CL)	FINE ALLUVIUM			2	HSA					
4½	**LEAN CLAY WITH SAND**: a little gravel, grayish brown, moist, stiff, (CL)	GLACIAL TILL	11		3	SPT	16	117	31	14	
			9		4	SPT	19				
			10		5	SPT	20				
					6	BAG					
			11		7	SPT	17				
			12		8	SPT	18				
16	Bottom of borehole at 16 feet.										

WATER LEVEL MEASUREMENTS

START 1-31-22 COMPLETE 1-31-22 1:25 pm

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL
1-31-22	1:25 pm	16	--	14	none
--	--	--	--	--	--
--	--	--	--	--	--
--	--	--	--	--	--

METHOD
3.25" ID Hollow Stem Auger

CREW CHIEF Roy Hanson

GEOTECHNICAL TEST BORING 22-061.GPJ GEOTEKENG.GDT 2/3/22

GEOTEK ENGINEERING
& TESTING SERVICES, INC.
909 E 50th St N
Sioux Falls, South Dakota, 57104
605-335-5512 Fax
jhaskins@geotekeng.com

GEOTECHNICAL TEST BORING LOG

-unsuitable material for trench backfill

GEOTEK # **22-061** BORING NO. **11 (1 of 1)**

PROJECT **Proposed Site Development, 20th Street South & Main Avenue South, Brookings, SD**

DEPTH in FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION 1605.9 ft)	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	LAB WC	LAB D	LAB LL	LAB PL	LAB QU
	FILL, MOSTLY CLAYEY SAND: a little gravel, fine to medium grained, brown, frozen	FILL			1	HSA					
3	**LEAN CLAY**: black, frozen to 4' then moist, (CL)	TOPSOIL			2	HSA					
4½	**LEAN CLAY WITH SAND**: a little gravel, grayish brown, frozen to 4' then moist, stiff, (CL)	GLACIAL TILL	13		3	SPT	18				
7	**LEAN CLAY WITH SAND**: a little gravel, brown and grayish brown, moist, stiff, (CL)	GLACIAL TILL	9		4	SPT	19				
			12		5	SPT	19				
			13		6	SPT	18				
			14		7	SPT	19				
16	Bottom of borehole at 16 feet.										

WATER LEVEL MEASUREMENTS

START 1-31-22 COMPLETE 1-31-22 11:00 am

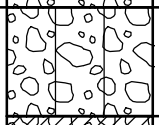
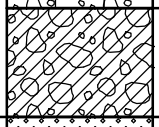
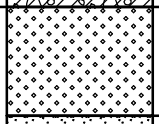
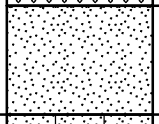
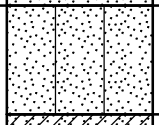
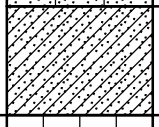
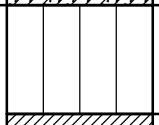
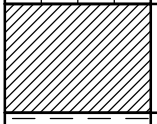
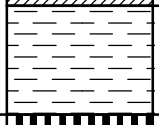
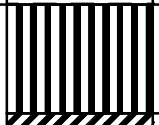
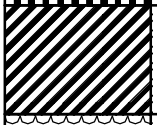
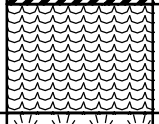
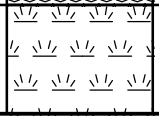
DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL
1-31-22	11:00 am	16	--	14	none
--	--	--	--	--	--
--	--	--	--	--	--
--	--	--	--	--	--

METHOD
3.25" ID Hollow Stem Auger

CREW CHIEF Roy Hanson

GEOTECHNICAL TEST BORING 22-061.GPJ GEOTEKENG.GDT 2/3/22

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTIONS
			GRAPH	LETTER	
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS LIQUID LIMIT LESS THAN 50			ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50			MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

BORING LOG SYMBOLS AND DESCRIPTIVE TERMINOLOGY

SYMBOLS FOR DRILLING AND SAMPLING

Symbol	Definition
Bag	Bag sample
CS	Continuous split-spoon sampling
DM	Drilling mud
FA	Flight auger; number indicates outside diameter in inches
HA	Hand auger; number indicates outside diameter in inches
HSA	Hollow stem auger; number indicates inside diameter in inches
LS	Liner sample; number indicates outside diameter of liner sample
N	Standard penetration resistance (N-value) in blows per foot
NMR	No water level measurement recorded, primarily due to presence of drilling fluid
NSR	No sample retrieved; classification is based on action of drilling equipment and/or material noted in drilling fluid or on sampling bit
SH	Shelby tube sample; 3-inch outside diameter
SPT	Standard penetration test (N-value) using standard split-spoon sampler
SS	Split-spoon sample; 2-inch outside diameter unless otherwise noted
WL	Water level directly measured in boring
▼	Water level symbol

SYMBOLS FOR LABORATORY TESTS

Symbol	Definition
WC	Water content, percent of dry weight; ASTM:D2216
D	Dry density, pounds per cubic foot
LL	Liquid limit; ASTM:D4318
PL	Plastic limit; ASTM:D4318
QU	Unconfined compressive strength, pounds per square foot; ASTM:D2166

DENSITY/CONSISTENCY TERMINOLOGY

Density		Consistency
Term	N-Value	Term
Very Loose	0-4	Soft
Loose	5-8	Firm
Medium Dense	9-15	Stiff
Dense	16-30	Very Stiff
Very Dense	Over 30	Hard

PARTICLE SIZES

Term	Particle Size
Boulder	Over 12”
Cobble	3” – 12”
Gravel	#4 – 3”
Coarse Sand	#10 – #4
Medium Sand	#40 – #10
Fine Sand	#200 – #40
Silt and Clay	passes #200 sieve

DESCRIPTIVE TERMINOLOGY

Term	Definition
Dry	Absence of moisture, powdery
Frozen	Frozen soil
Moist	Damp, below saturation
Waterbearing	Pervious soil below water
Wet	Saturated, above liquid limit
Lamination	Up to ½” thick stratum
Layer	½” to 6” thick stratum
Lens	½” to 6” discontinuous stratum

GRAVEL PERCENTAGES

Term	Range
A trace of gravel	2-4%
A little gravel	5-15%
With gravel	16-50%

GEOTEK ENGINEERING
& TESTING SERVICES, INC.
909 East 50th Street North
Sioux Falls, SD 57104
605-335-5512 Fax 605-335-0773
www.geotekeng.com

MOISTURE - DENSITY TEST REPORT

REPORTED TO:

Mills Development Corporation
Jacob Mills
1323 Main Avenue South
Brookings, SD 57006

PROJECT: 22-061

Proposed Site Development
20th Street South & Main
Avenue South
Brookings, SD

COPIES TO:

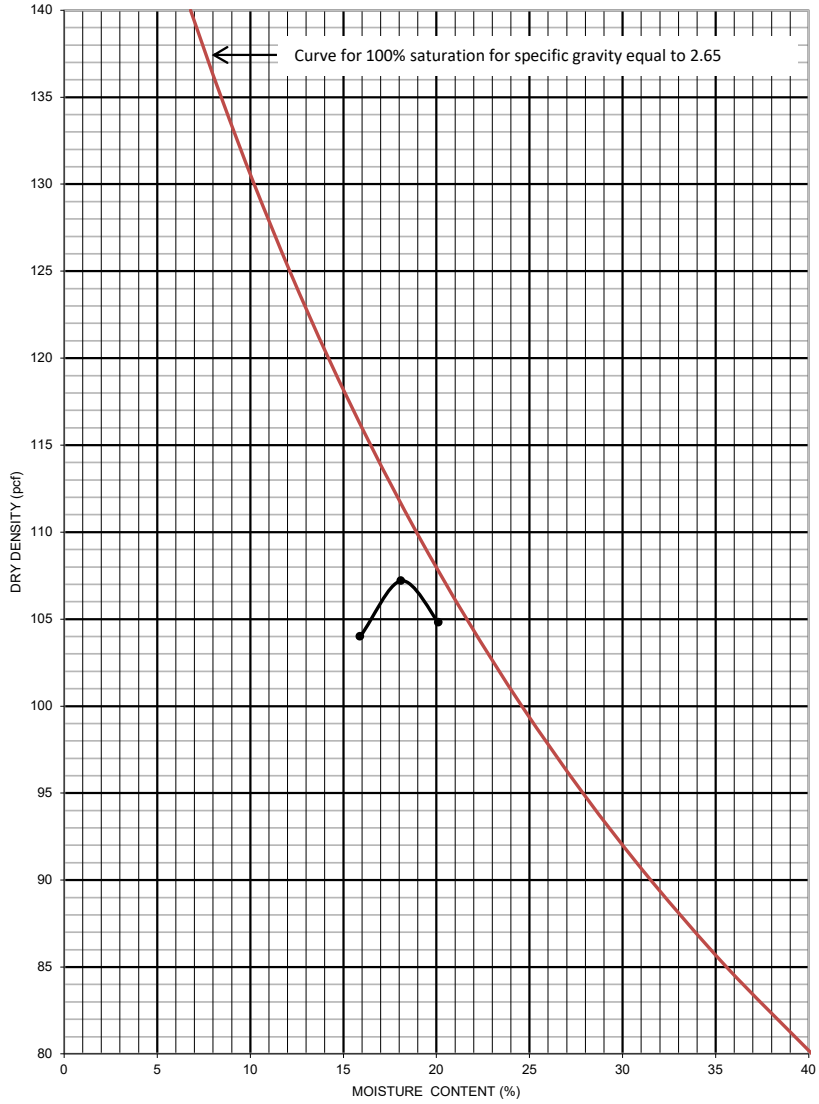
DATE REPORTED: 2/7/2022

SAMPLE DATA

Sample No.: 1
ASTM Test Method: D698B Manual
Soil Classification: Lean Clay, Brown (CL)
Remarks: SB 3 (4 1/2' to 12')

Date Received: 1/31/2022
Date Tested: 2/2/2022

TEST DATA



Maximum Density, pcf: 107.2

Optimum Moisture, %: 18.1

Percent Passing, %:
3/4": 100
3/8": 100
#4: 100
#200: 86

Atterberg Limits (ASTM: D4318):
Liquid Limit:
Plastic Limit:
Plasticity Index:

Nick Bierle, Staff Engineer/Materials Lab Super

GEOTEK ENGINEERING
& TESTING SERVICES, INC.
909 East 50th Street North
Sioux Falls, SD 57104
605-335-5512 Fax 605-335-0773
www.geotekeng.com

MOISTURE - DENSITY TEST REPORT

REPORTED TO:

Mills Development Corporation
Jacob Mills
1323 Main Avenue South
Brookings, SD 57006

PROJECT: 22-061

Proposed Site Development
20th Street South & Main
Avenue South
Brookings, SD

COPIES TO:

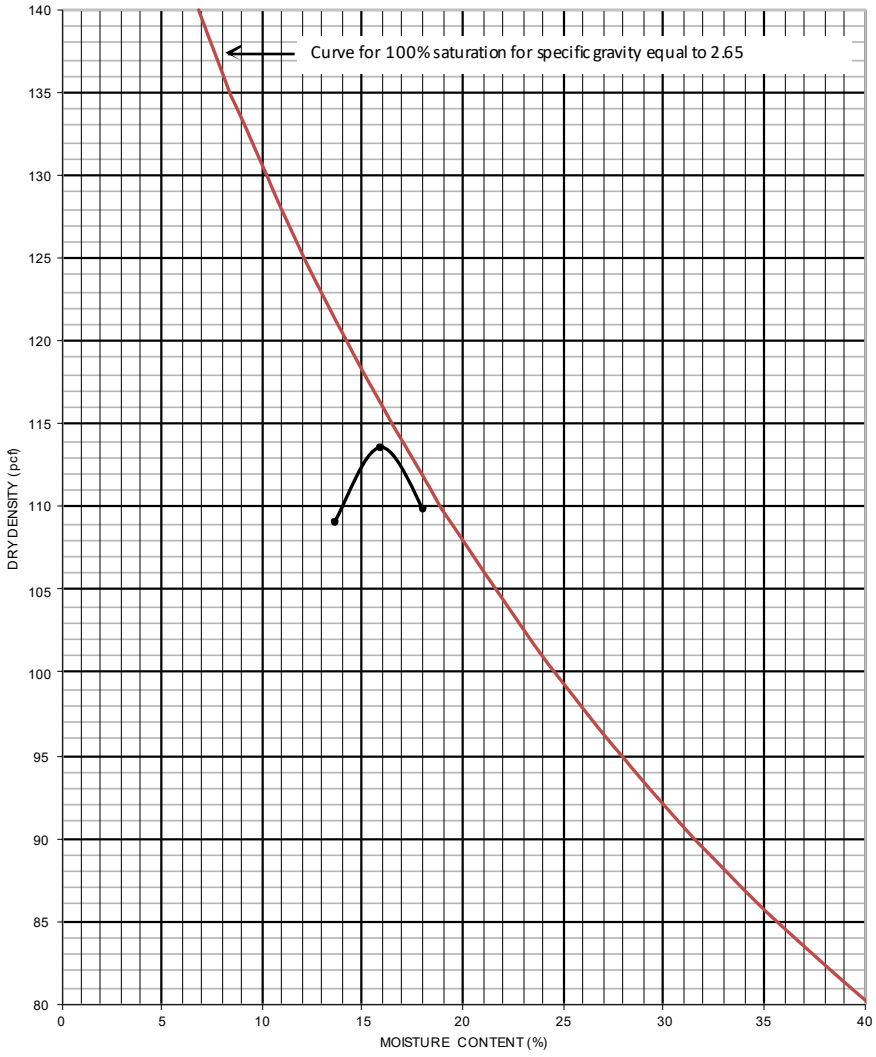
DATE REPORTED: 2/7/2022

SAMPLE DATA

Sample No.: 2
ASTM Test Method: D698B Manual
Soil Classification: Lean Clay with Sand, Brown (CL)
Remarks: SB 4 (6' to 12')

Date Received: 1/31/2022
Date Tested: 2/3/2022

TEST DATA



Maximum Density, pcf: 113.7
Optimum Moisture, %: 15.8

Percent Passing, %:
3/4": 100
3/8": 100
#4: 100
#200: 72

Atterberg Limits (ASTM: D4318):
Liquid Limit:
Plastic Limit:
Plasticity Index:

Nick Bierle, Staff Engineer/Materials Lab Supervisor