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January 7, 2021

City of Tea
600 E. 1st Street
PO Box 128
Tea, South Dakota 57064

Attn: Dan Zulkosky

Subj: Geotechnical Exploration
Proposed Law Enforcement Center
Figzel Court
Tea, South Dakota
GeoTek #20-M45

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.

Brennen Ahlers

Brennen Ahlers, PE
Project Manager

Cc: Banner Associates, Inc., Attn: Dave Lorang, AIA

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GEOTECHNICAL EXPLORATION
PROPOSED LAW ENFORCEMENT CENTER
FIGZEL COURT
TEA, SOUTH DAKOTA
GEOTEK #20-M45

INTRODUCTION

Project Information

This report presents the results of the recent geotechnical exploration program for the proposed law enforcement center in Tea, South Dakota.

Scope of Services

Our work was performed in accordance with the authorization of Dan Zulkosky with the City of Tea. The scope of work as presented in this report is limited to the following:

1. To perform 8 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 and unconfined compressive strength.

3. To prepare an engineering report that includes the results of the field and laboratory tests as well as our earthwork and foundation recommendations for design and construction.

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 Figzel Court in Tea, South Dakota. A Site Location Map (Figure 1) is attached showing the location of the site. The site is currently vacant and snow-covered.

Ground Surface Elevations & Test Boring Locations

The ground surface elevations at the test boring locations were determined by using the top of a wooden lath located southwest of the site (southwest of Figzel Court) as a benchmark. The benchmark elevation was provided to us by Banner Associates, Inc. An elevation of 1,479.35 feet was provided for the benchmark. Based on the benchmark datum, the ground surface elevations at the test boring locations varied from 1,476.4 feet at test boring 5 to 1,479.1 feet at test boring 1. A site layout plan (Figure 2) is attached showing the relative location of the test borings and the benchmark.

Subsurface Conditions

Eight (8) test borings were performed at the site on December 29, 2020. Test borings 1 through 5 were performed for the building and test borings 6 through 8 were performed in the pavement areas. The subsurface conditions encountered at the test boring locations are illustrated by means of the boring logs included in the appendix.

The subsurface profile at the test boring locations consisted of the following soil types: existing fill materials, fine alluvium soils, glacial till soils and glacial fluvial soils. The existing fill materials were encountered at all of the test borings and extended to a depth of 4 ½ feet. The fine alluvium soils, glacial till soils and glacial fluvial soils were encountered beneath the existing fill materials. The fine alluvium soils were not encountered at test borings 2, 3 and 8. The glacial fluvial soils were only encountered at test boring 2. The glacial till soils were not encountered at test borings 6, 7 and 8.

The existing fill materials consisted of fat clay soils and fat clay with sand soils. Some organic material was encountered within the existing fill materials. The fine alluvium soils and glacial fluvial soils consisted of fat clay soils. The glacial till soils consisted of fat clay with sand soils.

The consistency/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/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.

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. Groundwater did not enter the boreholes at the test boring locations at the time of our measurements.

The water levels indicated on the boring logs may or may not be an accurate indication of the depth or lack of subsurface groundwater. A long period of time is generally required for subsurface water to stabilize in the low permeable soils encountered at the test boring locations. Long term groundwater monitoring was not included in our work scope.

ENGINEERING REVIEW & RECOMMENDATIONS

Project Design Data

We understand that the project will consist of constructing a new law enforcement center. The law enforcement center will consist of a 10,850 square foot one-story slab-on-grade building. The north portion of the law enforcement building will be a garage and the south portion of the building will be administration. A mezzanine may be constructed within the garage in the future. The walls of the garage will consist of pre-cast panels. We anticipate heavier footing loads within the garage portion of the building and light to moderate footing loads for the administration portion of the building. We assume that foundation support for the building will be provided by perimeter footings resting below frost depth and interior footings resting at or slightly below the floor slab. At the time of this report, a finished floor elevation had not been determined; however, we assume that the finished floor elevation of the building will be near 1,480 feet. We do not anticipate below-grade walls or retaining walls being constructed as part of the project. Based on the assumed finished floor elevation, filling is expected in the majority of the building footprint in order to achieve the design elevation. The project will also consist of

constructing pavement areas. We expect that the vehicle traffic will consist of automobiles and occasional garbage trucks and snow removal equipment.

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.

Law Enforcement Center Building

Discussion

In our opinion, a spread footing foundation system can be used for support of the proposed building after the recommended site preparation has been performed.

The existing fill materials at the site are considered "undocumented" meaning it is unknown how the existing fill materials were placed and compacted. The existing fill materials also contained some organic material. With that said, it is our opinion that the existing fill materials are not suitable for support of the footings of the building.

Regarding the fine alluvium soils and the upper portion of the glacial till soils, these soils have limited strength characteristics. In our opinion, the fine alluvium soils and upper portion of the glacial till soils would be considered suitable for indirect support of the footings. In addition, the fine alluvium soils, glacial fluvial soils and glacial till soils consist of fat clay soils and fat clay with sand soils. In our opinion, fat clay soils and fat clay with sand soils may exhibit some expansive soil pressures. In order to control or minimize the potential effects of the fat clay soils and fat clay with sand soils, we recommend providing a buffer of non-expansive soil (granular material) between the fat clay soils and fat clay with sand soils and the footings of the building. With all of this said, in order to provide uniform support and to limit the potential for movement due to the expansive soils, we recommend that additional site preparation (overexcavation and backfill with granular structural fill) be performed beneath the footings.

Regarding the floor slab, the existing fill materials could be considered suitable for indirect support of the floor slab after the recommended site preparation is performed.

Site Preparation – Footings

The initial site preparation in the footing areas (interior and exterior) of the building should consist of removing the vegetation/organic materials and the existing fill materials in order to expose the fine alluvium soils and/or glacial till soils. Following the removals, we recommend that an overexcavation be performed below the footings. The overexcavation depths are based on the type of footing (continuous footing or column pads) and the magnitude of the foundation loads. Please see Table 1 for the minimum overexcavation depths.

Table 1. Minimum Overexcavation Depths – Footing Areas

Footing	Minimum Overexcavation Depth, ft
Continuous Footings (0 klf to 6 klf)	2
Continuous Footing (6 klf to 12 klf)	3
Column Pad (0 kips to 75 kips)	2
Column Pad (75 kips to 125 kips)	3

Note: Klf – Kips per lineal foot

Following the overexcavation, granular structural fill should be placed and compacted up to the design elevation. The thickness of the granular structural fill beneath the footings will exceed the minimum overexcavation depths where the vegetation/organic materials and existing fill materials extend to depths greater than the minimum overexcavation depths.

Site Preparation – Floor Slab

The site preparation for the floor slab should consist of excavating to a minimum depth of 2 feet below the bottom-of-slab elevation. In addition, the vegetation/organic materials should be removed. Following the removals, we recommend compacting the exposed subgrade with a large sheepsfoot roller. We also recommend that observations and testing be performed on the materials exposed at the bottom of the excavation to determine the suitability of the existing fill materials. Unstable areas, areas of fill containing significant organic materials or areas having low density will likely require further excavation. Once the subgrade is approved, granular structural fill should be placed and compacted up to the design grade. The final 6 inches of granular structural fill beneath the floor slab should consist of select granular fill.

Excavation & Soil Disturbance – Building

All excavations within the footprint of the building should be performed with a track backhoe with a smooth edge bucket. The subgrade within the footprint of the building should not be exposed to heavy construction traffic from rubber tire vehicles. The soils are vulnerable to disturbance and can experience strength loss caused by construction traffic and/or additional moisture. If any soils become disturbed during construction, then the disturbed soils will likely need to be removed.

Groundwater & Saturated Soils

If groundwater or saturated soils are encountered at the bottom of an excavation, then we recommend placing a layer (6 inches to 12 inches) of crushed drainage rock at the bottom of the excavation prior to the placement of the granular structural fill, select granular fill or footings.

Laterally Oversized Excavations

Where granular structural fill or crushed drainage rock is needed below the footings, the bottom of the excavation should be laterally oversized 1 foot beyond the edges of the footings for each vertical foot of granular structural fill or crushed drainage rock required below the footings (1 horizontal : 1 vertical).

Foundation Loads & Settlement

If our recommendations are followed during site preparations, then it is our opinion that the footings of the building can be sized for a net allowable soil bearing pressure of up to 2,500 pounds per square foot (psf). If a higher net allowable soil bearing pressure is desired or the foundation loads shown in Table 1 are exceeded, then we recommend that we be contacted to provide additional recommendations.

With the recommended site preparation, load limits and net allowable soil bearing pressure, total settlement of the footings should be less than 1 inch and differential settlement should be less than ½ inch over 50 feet. Unknown soil conditions at the site that are different from those depicted at the test boring locations could increase the amount of expected settlement.

Soil Modulus of Subgrade Reaction – Floor Slab

If our recommendations are followed during site preparations, then it is our opinion that the floor slab of the building can be designed using a soil modulus of subgrade reaction (k value) of 100 psi/inch.

Dewatering

Dewatering will likely not be needed during construction. However, if dewatering is needed, then the contractor should provide appropriate dewatering methods and equipment. In areas where clay soils are encountered, it will likely be possible to remove and control water entering the excavations using normal sump pumping techniques. If waterbearing sand soils are encountered, then an extensive dewatering system will likely be needed.

Coefficient of Friction

It is our opinion that a friction factor of 0.35 can be used between the natural clay soils and the bottom of the concrete. A friction factor of 0.45 can be used between the granular structural fill or drainage rock and the bottom of the concrete. The friction values are considered ultimate values. We recommend applying a theoretical safety factor of at least 2.0.

Drain Tile Recommendations

Since the building will be slab-on-grade, it is our opinion that drain tile is not needed along the perimeter of the building. If any below-grade slabs are constructed, we recommend placing drainage pipes beneath the elevator pit. We recommend placing the drainage pipes approximately 12 inches below the elevator pit slab (at the bottom of the granular structural fill). The drainage pipes should be surrounded by a properly graded filter that is wrapped in a geotextile filter fabric to minimize clogging. The drainage pipes should be connected to a suitable means of discharge (sump pump).

Seismic Site Classification

Based on the 2018 International Building Code (IBC), it is our opinion that the site, as a whole, corresponds to a Site Class D (stiff soil). Also, the ground acceleration values are as follows: S_S

= 0.093 g, S_1 = 0.036 g, S_{MS} = 0.149 g, S_{M1} = 0.086 g, S_{DS} = 0.099 g, S_{D1} = 0.057 g. Therefore, the seismic design category is "A". The ground acceleration values are based on the ASCE 7-16 (referenced standard for 2018 IBC) with Risk Category IV. If needed, we can provide ground acceleration values for a different design code.

Pavement Areas

Discussion

Fair subgrade conditions were encountered at test borings 6 through 8. In our opinion, normal subgrade preparation (scarification and compaction) could be used in the pavement areas, assuming that the site work will be performed during drier periods of the year.

Subgrade Preparation

We recommend that the subgrade preparation in the pavement areas consist of removing any vegetation and highly organic materials. A minimum removal depth of 6 inches should be expected. Following the removals, the subgrade should be prepared by cutting or placing subgrade fill to the design subgrade elevations. We recommend that the subgrade be scarified (with a disc harrow) to a minimum depth of 8 inches and adjusted to a moisture level that is 1 percent to 4 percent below the optimum moisture content as determined by standard Proctor (ASTM:D698). The moisture-conditioned soils should then be compacted.

Prior to the placement of the aggregate base course materials, we recommend that a proof roll be performed on the exposed subgrade with a truck weighing 20 tons to 30 tons. During the proof roll, 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, the placement of a woven geotextile fabric at the subgrade surface, and/or the placement of granular subbase at the subgrade surface. The type of correction performed should be determined after observing the performance of the subgrade during the proof roll test. We expect that stable

conditions will be encountered during drier periods of the year, while some unstable conditions could be encountered during wetter periods of the year (late fall and the spring thaw).

Pavement Section Thicknesses

Table 2 shows the recommended pavement section thicknesses based on the subsurface conditions and anticipated traffic loads. Again, we expect that the vehicle traffic will consist of automobiles and occasional garbage trucks and snow removal equipment.

Table 2. Recommended Pavement Section Thicknesses

Pavement Description	Pavement Surfacing, in	Aggregate Base Course, in
Car Only Areas		
Asphalt:	4	8
PC Concrete:	5	6
Heavy Duty Areas		
Asphalt:	5	9
PC Concrete:	7	6

Notes: The pavement sections are based on the assumption that a stable subgrade condition is achieved during construction. A geotextile fabric would be beneficial if installed beneath the aggregate base course material to extend the life of the pavement.

The asphalt pavement should meet the requirements of sections 320 and 321 for Class G. We recommend the concrete pavement meet the requirements of Section 380 of the SDDOT Standard Specifications. The geotextile fabric should consist of Mirafi HP 370, Propex Geotex 3x3 HF, Huesker Comtrac P 45/45, or an approved alternative.

It should be noted that routine maintenance such as crack filling, localized patching, and seal coating should be expected with all pavements in our recommendations. The design sections could be reduced if the owner is willing to assume additional maintenance costs or potentially shorter pavement life.

Excavation – Pavement Areas

If soils with high moisture content levels are encountered, then low-ground pressure construction equipment should be used.

Frost Protection

Footings

We recommend that all footings be placed at a sufficient depth for frost protection. The perimeter footings for heated buildings should be placed such that the bottom of the footing is a minimum of 4 feet below the finished exterior grade. Interior footings in heated buildings can be placed beneath the floor slab. Footings for unheated areas and canopies, or footings that are not protected from frost during freezing temperatures, should be placed such that the bottom of the footing is a minimum of 5 feet below the finished exterior grade.

Surface Improvements

It is our opinion that clay soils have a moderate frost susceptibility. Surface improvements, such as pavements, patios and sidewalks, constructed on clay soils are potentially subject to both cosmetic and structural damage caused by frost heaving. We anticipate the heave for the clay soils to potentially be on the order of 0.1 inch to 0.3 inch for each foot of frost penetration within the soil, which would translate to ½ inch to 1 ½ inches of total movement. The heave could be even greater if free water is available, resulting in a buildup of ice lenses. The surface improvements should be designed to accommodate the potential frost movements, or non-frost susceptible drainage fill should be placed beneath the surface improvements. If movement cannot be tolerated, then we recommend placing non-frost susceptible drainage fill beneath the surface improvements. The non-frost susceptible drainage fill should extend to a depth of 4 feet below the finished exterior grade. If it is desired to reduce (but not eliminate) the amount of potential frost heave, then we recommend consideration be given to placing 2 feet of non-frost susceptible drainage fill beneath the surface improvements.

Material Types & Compaction Levels

Granular Structural Fill – The granular structural fill should consist of a pit-run or processed sand or gravel having a maximum particle size of 3 inches with less than 15 percent by weight passing the #200 sieve. The granular structural fill should be placed in lifts of up to 1 foot in thickness.

Crushed Drainage Rock – The crushed drainage rock should be washed and meet the gradation specifications shown in Table 3.

Table 3. Crushed Drainage Rock Gradation Specifications

Sieve Size	Percent Passing
1 1/2-inch	100
1-inch	70 – 90
3/4-inch	25 – 50
3/8-inch	0 – 5

Select Granular Fill – The select granular fill should consist of a medium to coarse grained, free-draining sand or rock having a maximum particle size of 1 inch with less than 5 percent by weight passing the #200 sieve. The select granular fill should be placed in lifts of up to 1 foot in thickness.

Exterior Foundation Wall Backfill for Slab-on-Grade Structures – We recommend either clay or granular soils be used. Debris, organic material, or over-sized material should not be used as backfill. If granular soils are used in areas that will not have asphalt or concrete surfacing, then we recommend capping the granular soils with at least 1 foot to 2 feet of clay soils to minimize infiltration of surface water. The exterior backfill should be placed in lifts of up to 1 foot in thickness. The majority of the on-site soils could be used as backfill.

Interior Foundation Wall Backfill for Slab-on-Grade Structures – We recommend that granular structural fill be used to backfill the interior side of the foundation walls. The interior backfill should be placed in lifts of up to 1 foot in thickness.

Non-Frost Susceptible Drainage Fill – The non-frost susceptible drainage fill should have a maximum particle size of 1 inch, less than 40 percent by weight passing the #40 sieve and less than 5 percent by weight passing the #200 sieve. The non-frost susceptible drainage fill should be placed in lifts of up to 1 foot in thickness.

Subgrade Fill – The subgrade fill should consist of either a granular or clay material. Debris, organic material, or over-sized material should not be used as subgrade fill. 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 3 inches. The granular material can be placed in lifts of up to 1 foot in thickness. If a clay material is selected, then it should consist of a non-organic clay. Scrutiny on the clay material's moisture content should be made prior to the acceptance and use. The clay fill should be placed in lifts of up to 6 inches in thickness. The majority of the on-site soils could be used as subgrade fill. Organic materials should not be used as subgrade fill.

Granular Subbase – The granular subbase should consist of crushed quartzite, recycled concrete or a crushed pit-run material meeting the gradation specifications shown in Table 4.

Table 4. Granular Subbase Gradation Specifications

Sieve Size	Percent Passing
4-inch	100
3-inch	70 – 90
2-inch	60 – 80
1-inch	40 – 70
#4	10 – 50
#40	5 – 20
#200	0 – 8

Aggregate Base Course Material – We recommend that the aggregate base course materials meet the requirements of Sections 260 and 882 of the SDDOT Standard Specifications.

Recommended Compaction Levels – The recommended compaction levels listed in Table 5 are based on a material's maximum dry density value, as determined by a standard Proctor (ASTM: D698) test.

Table 5. Recommended Compaction Levels

Placement Location	Compaction Specifications
Below Footings	97%
Below Floor Slabs	95%
Exterior Foundation Wall Backfill for Slab-on-Grade Structures	95%
Subgrade Fill in Pavement Areas	95%
Aggregate Base Course in Pavement Areas	97%
Granular Subbase in Pavement Areas	97%
Non-Structural Areas	90%

Notes: Compaction specifications are not applicable with the drainage rock. Compaction testing may not be practical for the granular subbase due to the large aggregate.

Recommended Moisture Levels – The moisture content of the clay backfill materials, when used as backfill around the exterior of a foundation should be maintained within a range of plus 1 percent to minus 4 percent of the materials' optimum moisture content. When the clay backfill materials are used below a pavement area, or as site grading, the materials' moisture content should be maintained within a range of minus 1 percent to minus 4 percent of the materials' optimum moisture content. The moisture content of the trench backfill soils should be adjusted to a moisture level that is within plus or minus 2 percent of the optimum moisture content. The optimum moisture content should be determined using a standard Proctor (ASTM: D698) test.

The moisture content of the granular backfill materials should be maintained at a level that will be conducive for vibratory compaction.

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 structure should be sloped such that positive drainage away from the structure is provided. Also, a system to collect and channel roof run-off waters away from the structure is suggested.

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 and asphalt 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 8 standard penetration test (SPT) borings on December 29, 2020 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 the appendix. Charts illustrating the soil classification procedures,

the descriptive terminology and the symbols used on the boring logs are also attached in the appendix.

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 and strength properties of the soils. The index tests consisted of moisture content, dry density, standard Proctor and Atterberg limits (liquid and plastic limits). The strength tests consisted of unconfined compressive strength. 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.

Brennen Ahlers, PE
Project Manager

FIGURE 1
SITE LOCATION MAP
PROPOSED LAW ENFORCEMENT CENTER
FIGZEL COURT
TEA, SD

ACAD/GEOTEK/BRENNEN/20-M45

PROJECT#: 20-M45

DRAWN BY: DHP

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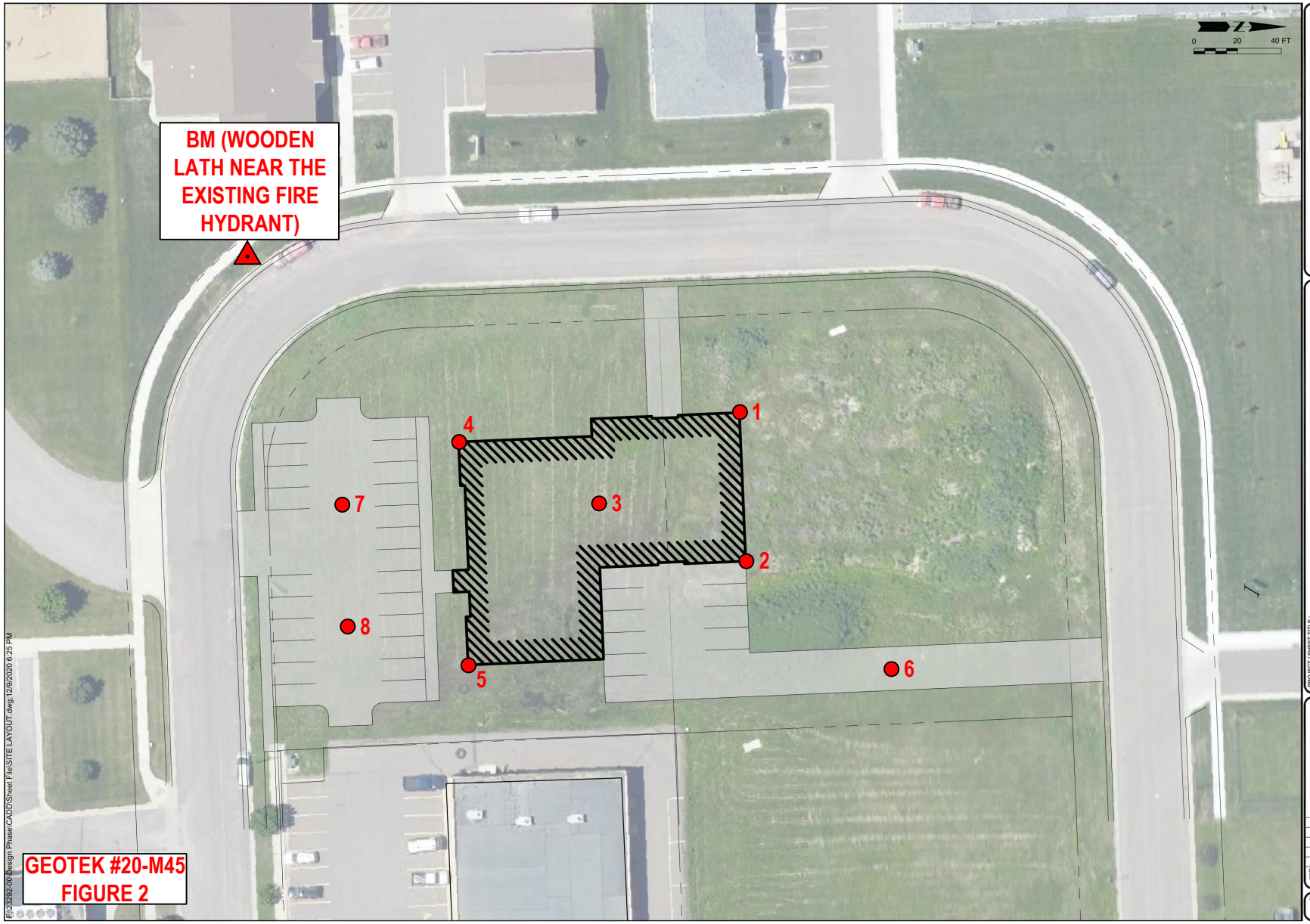

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PROJECT / SHEET TITLE :
TEA LAW ENFORCEMENT CENTER
SITE LAYOUT - OPTION 2
TEA, SOUTH DAKOTA

REV	DATE	DESCRIPTION

FOR REVIEW ONLY
NOT FOR CONSTRUCTION

JOB No.:	###
DATE:	###
DESIGNED BY:	###
CHECKED BY:	###
DRAWN BY:	###

0 1/2" 1"
SCALE REDUCTION BAR

SHEET No. :
2

F:\23292-00\Design Phase\CADD\Sheet Files\SITE LAYOUT.dwg:12/9/2020 6:25 PM

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GEOTECHNICAL TEST BORING LOG

GEOTEK # **20-M45** BORING NO. **1 (1 of 1)**

PROJECT **Proposed Law Enforcement Center, Figzel Court, Tea, SD**

DEPTH in FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION 1479.1 ft)	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	LABORATORY TESTS WC	D	LL	PL	QU
	FILL, MOSTLY FAT CLAY WITH SAND: a trace of gravel, very dark brown, frozen to moist, very stiff, 6" of vegetation/organics at the surface, with some organic material	FILL			1	HSA					
			18		2	SPT	15	116			
4½	**FAT CLAY**: brown to dark brown, moist, firm, (CH)	FINE ALLUVIUM	7		3	SPT	27	95	60	21	
7	**FAT CLAY WITH SAND**: a little gravel, brown and dark brown, moist, stiff, (CH)	GLACIAL TILL	9		4	SPT	25	99	56	19	
			9		5	SPT					
			11		6	SPT					
			11		7	SPT					
16	Bottom of borehole at 16 feet.										

WATER LEVEL MEASUREMENTS

START 12-29-20 COMPLETE 12-29-20 9:50 am

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL
12-29-20	9:50 am	16	--	14.5	none
--	--	--	--	--	--
--	--	--	--	--	--
--	--	--	--	--	--

METHOD
3.25" ID Hollow Stem Auger

CREW CHIEF Wyatt Schumacher

GEOTECHNICAL TEST BORING 20-M45.GPJ GEOTEKENG.GDT 1/6/21

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

GEOTECHNICAL TEST BORING LOG

GEOTEK # **20-M45** BORING NO. **2 (1 of 1)**

PROJECT **Proposed Law Enforcement Center, Figzel Court, Tea, SD**

DEPTH in FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION 1478.1 ft)	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	LAB WC	LAB D	LAB LL	LAB PL	LAB QU
	FILL, MOSTLY FAT CLAY: dark brown and very dark brown, frozen to moist, 6" of vegetation/organics at the surface, with some organic material	FILL			1	HSA					
			11		2	SPT	28	93			
4½	**FAT CLAY WITH SAND**: a little gravel, brown, moist, firm, (CH)	GLACIAL TILL	8		3	SPT	26	96			
			8		4	SPT					
9½	**FAT CLAY WITH SAND**: a little gravel, brown and gray, moist, firm, (CH)	GLACIAL TILL	8		5	SPT					
11	**FAT CLAY**: a little gravel, brown and gray, moist, stiff, (CH)	GLACIAL FLUVIAL	10		6	SPT					
			10		7	SPT					
16	Bottom of borehole at 16 feet.										

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL
12-29-20	10:25 am	16	--	14.5	none
--	--	--	--	--	--
--	--	--	--	--	--
--	--	--	--	--	--

START 12-29-20 COMPLETE 12-29-20 10:25 am

METHOD
3.25" ID Hollow Stem Auger

CREW CHIEF Wyatt Schumacher

GEOTECHNICAL TEST BORING 20-M45.GPJ GEOTEKENG.GDT 1/6/21

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GEOTECHNICAL TEST BORING LOG

GEOTEK # **20-M45** BORING NO. **3 (1 of 1)**

PROJECT **Proposed Law Enforcement Center, Figzel Court, Tea, SD**

DEPTH in FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION 1477.6 ft)	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	LAB WC	LAB D	LAB LL	LAB PL	LAB QU
	FILL, MOSTLY FAT CLAY WITH SAND: a trace of gravel, very dark brown, frozen to moist, 6" of vegetation/organics at the surface, with some organic material	FILL			1	HSA					
			7		2	SPT	20	105			
4½	**FAT CLAY WITH SAND**: a little gravel, brown, moist, firm to stiff, (CH)	GLACIAL TILL	6		3	SPT	22	103	50	16	
			6		4	SPT					
			8		5	SPT					
			9		6	SPT					
			10		7	SPT					
16	Bottom of borehole at 16 feet.										

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL
12-29-20	11:05 am	16	--	14.5	none
--	--	--	--	--	--
--	--	--	--	--	--
--	--	--	--	--	--

START 12-29-20 COMPLETE 12-29-20 11:05 am

METHOD
3.25" ID Hollow Stem Auger

CREW CHIEF Wyatt Schumacher

GEOTECHNICAL TEST BORING 20-M45.GPJ GEOTEKENG.GDT 1/6/21

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GEOTECHNICAL TEST BORING LOG

GEOTEK # **20-M45** BORING NO. **4 (1 of 1)**

PROJECT **Proposed Law Enforcement Center, Figzel Court, Tea, SD**

DEPTH in FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION 1478.3 ft)	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	LABORATORY TESTS WC	D	LL	PL	QU
	FILL, MOSTLY FAT CLAY WITH SAND: a trace of gravel, very dark brown, frozen to moist, 6" of vegetation/organics at the surface, with some organic material	FILL			1	HSA					
			5		2	SPT	18	105			
4½	**FAT CLAY**: dark brown, moist, firm, (CH)	FINE ALLUVIUM	9		3	SPT	29	92	58	20	
7	**FAT CLAY**: brown and gray, wet, soft, (CH)	FINE ALLUVIUM	4		4	SPT	30	93			
9½	**FAT CLAY WITH SAND**: a little gravel, brown, moist, firm to stiff, (CH)	GLACIAL TILL	8		5	SPT					
			9		6	SPT					
14½	**FAT CLAY WITH SAND**: a little gravel, brown and gray, moist, firm, (CH)	GLACIAL TILL	8		7	SPT					
16	Bottom of borehole at 16 feet.										

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL
12-29-20	12:00 pm	16	--	14.5	none
--	--	--	--	--	--
--	--	--	--	--	--
--	--	--	--	--	--

START 12-29-20 COMPLETE 12-29-20 12:00 pm

METHOD
3.25" ID Hollow Stem Auger

CREW CHIEF Wyatt Schumacher

GEOTECHNICAL TEST BORING 20-M45.GPJ GEOTEKENG.GDT 1/6/21

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GEOTECHNICAL TEST BORING LOG

GEOTEK # **20-M45** BORING NO. **5 (1 of 1)**

PROJECT **Proposed Law Enforcement Center, Figzel Court, Tea, SD**

DEPTH in FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION 1476.4 ft)	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	LABORATORY TESTS WC	D	LL	PL	QU
	FILL, MOSTLY FAT CLAY: a trace of gravel, dark brown, frozen to moist, 6" of vegetation/organics at the surface, with some organic material	FILL			1	HSA					
			11		2	SPT	29	95			
4½	**FAT CLAY**: brown and gray, moist, firm, (CH)	FINE ALLUVIUM	7		3	SPT	25	99			
7	**FAT CLAY WITH SAND**: a little gravel, brown, moist, firm to stiff, (CH)	GLACIAL TILL	7		4	SPT	26	99	54	19	3100
			7		5	SPT					
			9		6	SPT					
14½	**FAT CLAY WITH SAND**: a little gravel, brown and gray, moist, stiff, (CH)	GLACIAL TILL	12		7	SPT					
16	Bottom of borehole at 16 feet.										

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL
12-29-20	1:25 pm	16	--	14.5	none
--	--	--	--	--	--
--	--	--	--	--	--
--	--	--	--	--	--

START 12-29-20 COMPLETE 12-29-20 1:25 pm

METHOD
3.25" ID Hollow Stem Auger

CREW CHIEF Wyatt Schumacher

GEOTECHNICAL TEST BORING 20-M45.GPJ GEOTEKENG.GDT 1/6/21

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GEOTECHNICAL TEST BORING LOG

GEOTEK # **20-M45** BORING NO. **6 (1 of 1)**

PROJECT **Proposed Law Enforcement Center, Figzel Court, Tea, SD**

DEPTH in FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION 1478.8 ft)	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	LAB WC	LAB D	LAB LL	LAB PL	LAB QU
	FILL, MOSTLY FAT CLAY: very dark brown, frozen to moist, 6" of vegetation/organics at the surface, with some organic material	FILL	6		1	SPT	25	95			
			13		2	SPT	22	101			
4½	**FAT CLAY**: dark brown, moist, stiff, (CH)	FINE ALLUVIUM	11		3	SPT	23				
6	Bottom of borehole at 6 feet.										

WATER LEVEL MEASUREMENTS

START 12-29-20 COMPLETE 12-29-20 2:15 pm

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL
12-29-20	2:15 pm	6	--	6	none
--	--	--	--	--	--
--	--	--	--	--	--
--	--	--	--	--	--

METHOD
6" Flight Auger

CREW CHIEF Wyatt Schumacher

GEOTECHNICAL TEST BORING 20-M45.GPJ GEOTEKENG.GDT 1/6/21

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GEOTECHNICAL TEST BORING LOG

GEOTEK # **20-M45** BORING NO. **7 (1 of 1)**

PROJECT **Proposed Law Enforcement Center, Figzel Court, Tea, SD**

DEPTH in FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION 1477.9 ft)	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	LAB WC	LAB D	LAB LL	LAB PL	LAB QU
	FILL, MOSTLY FAT CLAY WITH SAND: a trace of gravel, very dark brown, frozen to moist, 6" of vegetation/organics at the surface, with some organic material	FILL	15		1	SPT	18	108			
			7		2	SPT	16	111			
4½	**FAT CLAY**: dark brown, moist, stiff, (CH)	FINE ALLUVIUM	10		3	SPT	26				
6	Bottom of borehole at 6 feet.										

WATER LEVEL MEASUREMENTS

START 12-29-20 COMPLETE 12-29-20 1:40 pm

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL
12-29-20	1:40 pm	6	--	6	none
--	--	--	--	--	--
--	--	--	--	--	--
--	--	--	--	--	--

METHOD
6" Flight Auger

CREW CHIEF Wyatt Schumacher

GEOTECHNICAL TEST BORING 20-M45.GPJ GEOTEKENG.GDT 1/6/21

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GEOTECHNICAL TEST BORING LOG

GEOTEK # **20-M45** BORING NO. **8 (1 of 1)**

PROJECT **Proposed Law Enforcement Center, Figzel Court, Tea, SD**

DEPTH in FEET	DESCRIPTION OF MATERIAL SURFACE ELEVATION 1477.0 ft	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	LABORATORY TESTS WC	D	LL	PL	QU
	FILL, MOSTLY FAT CLAY WITH SAND: a trace of gravel, very dark brown, frozen to moist, 6" of vegetation/organics at the surface, with some organic material	FILL	9		1	SPT	16				
			9		2	SPT	13				
			11		3	SPT	23				
6	Bottom of borehole at 6 feet.										

WATER LEVEL MEASUREMENTS

START 12-29-20 COMPLETE 12-29-20 2:00 pm

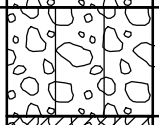
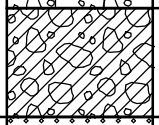
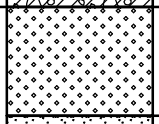
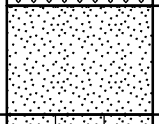
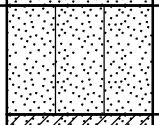
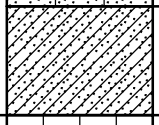
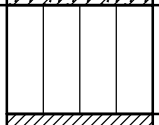
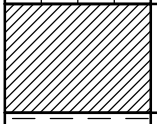
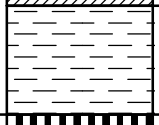
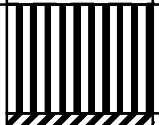
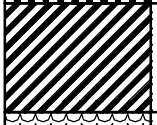
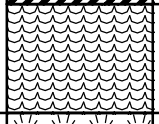
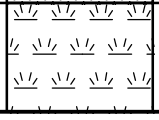
DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL
12-29-20	2:00 pm	6	--	6	none
--	--	--	--	--	--
--	--	--	--	--	--
--	--	--	--	--	--

METHOD
6" Flight Auger

CREW CHIEF Wyatt Schumacher

GEOTECHNICAL TEST BORING 20-M45.GPJ GEOTEKENG.GDT 1/6/21

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%

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MOISTURE - DENSITY TEST REPORT

REPORTED TO:

City of Tea
Dan Zulkosky
600 E. 1st Street
PO Box 128
Tea, SD 57064

PROJECT: 20-M45

Proposed Law Enforcement Center
Figzel Court
Tea, SD

COPIES TO:

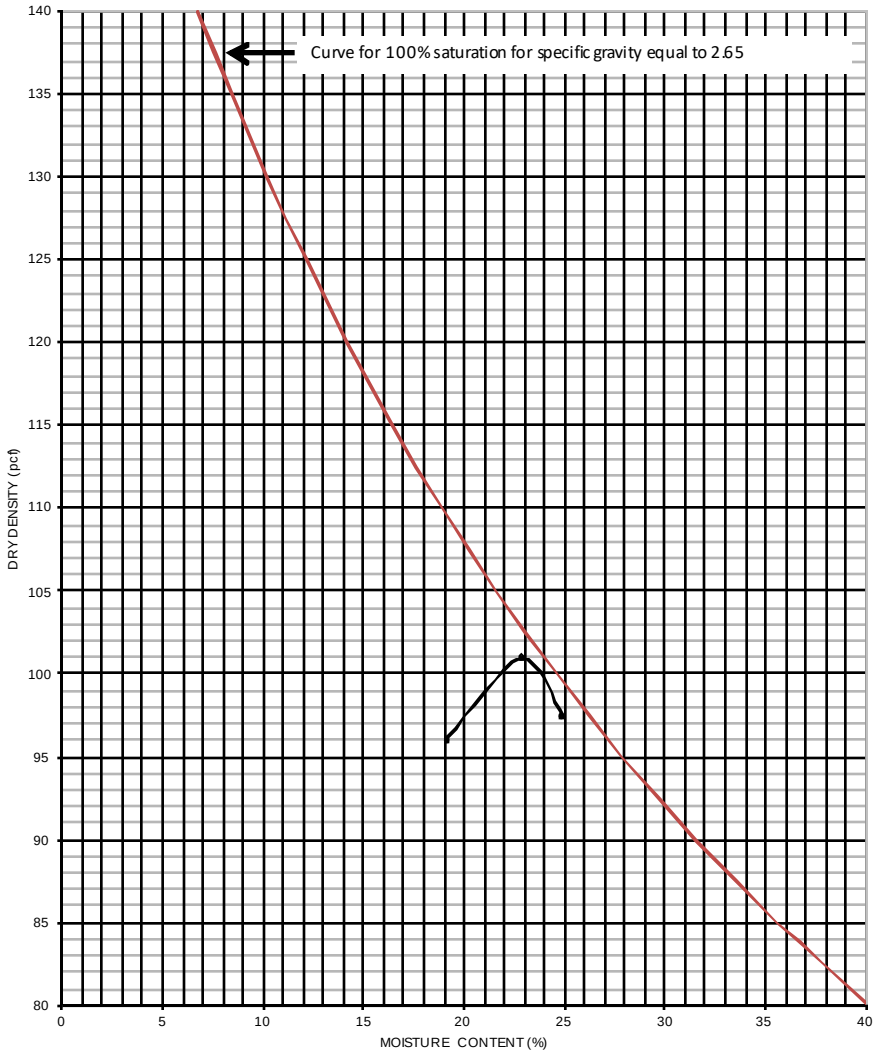
DATE REPORTED: 1/6/2021

SAMPLE DATA

Sample No.: 1
ASTM Test Method: D698B Manual
Soil Classification: Fat Clay with Sand, Very Dark Brown (CH)
Remarks: SB 2 (0' to 7')

Date Received: 12/30/2020
Date Tested: 12/31/2020

TEST DATA



Maximum Density, pcf: 100.9
Optimum Moisture, %: 22.8

Percent Passing, %:
3/4": 100
3/8": 100
#4: 100
#200: 82

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

Nick Bierle, Staff Engineer