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

November 17, 2021

Office of State Engineer
Foss Building
523 E. Capitol Avenue
Pierre, South Dakota 57501

Attn: Jennifer Walz, PE

Subj: Geotechnical Exploration
Proposed West Gate Parking Lot Improvements
South Dakota State Penitentiary
Sioux Falls, South Dakota
OSE #C1221- -16X/SWMR
GeoTek #21-K12

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.

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.

Daniel R Hanson

Daniel R Hanson, PE
General Manager

CC: Banner Associates, Inc.; Attn: Weston Blasius

TABLE OF CONTENTS

APPENDIX A

GEOTECHNICAL EXPLORATION
PROPOSED WEST GATE PARKING LOT IMPROVEMENTS
SOUTH DAKOTA STATE PENITENTIARY
SIOUX FALLS, SOUTH DAKOTA
OSE #C1221- -16X/SWMR
GEOTEK #21-K12

INTRODUCTION

Project Information

This report presents the results of the recent geotechnical exploration program for the proposed parking lot improvements of the west gate parking lot at the South Dakota State Penitentiary in Sioux Falls, South Dakota (see Figure 1).

Scope of Services

Our work was performed in accordance with the October 21, 2021 agreement. The scope of work as presented in this report is limited to the following:

1. To perform 3 standard penetration test (SPT) borings to gather data on the subsurface conditions within the existing parking lots.

2. To perform laboratory tests that include moisture content, dry density and sieve analysis.

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:

    - Existing pavement conditions;
    - Earthwork and grading for the reconstruction of the parking lots;
    - Subgrade strength and pavement support characteristics and potential corrective measures;
    - Pavement section thicknesses;
    - Comments regarding factors that may impact the constructability and final performance of the project;
    - Quality control observations and testing.

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 project site or to characterize the project site relative to wetlands status.

SITE & SUBSURFACE CONDITIONS

Site Location & Description

The site is located at 1600 N. Drive in Sioux Falls, South Dakota (see Figure 1). The existing parking lot is located south of the penitentiary and west of the main entrance. The existing parking lot is asphalt surfaced and generally slopes to the south and west.

Test Boring Locations & Ground Surface Elevations

The test borings were performed on October 29, 2021. Figure 2 is attached showing the relative location of the test borings.

The ground surface elevations at the test boring locations were determined by using the top of a fire hydrant located north of boring #2. An arbitrary elevation of 100.0 feet was used for this benchmark. The ground surface elevations at the test boring locations varied from 95.7 feet at test boring 2 to 86.3 at test boring 2.

Existing Pavement & Gravel Base Thicknesses

Table 1 summarizes the thicknesses of the existing pavement and gravel base encountered at the respective test boring locations. Note that borings 1 and 2 encountered asphalt over concrete pavement.

Table 1. Thicknesses of the Existing Asphalt Pavement & Gravel Base

Test Boring	Asphalt/Concrete Thickness, in	Gravel Base, in
1	2/6	-
2	3/6.5	-
3	6/0	24

Subsurface Conditions

The subsurface conditions encountered at the test boring locations are illustrated by means of the boring logs included in Appendix A.

At the test boring locations, the subgrade soils consisted of existing fill materials, fine alluvium soils, mixed alluvium soils, coarse alluvium soils and glacial till soils.

The existing fill materials consisted of lean clay (CL) and sand (SP). The fine alluvium soils consisted of lean clay (CL). The mixed alluvium soils consisted of clayey sand (SC). The coarse alluvium soils consisted of sand (SP). The glacial till soils consisted of lean clay with sand (CL).

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 project 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 was measured at a depth of 5 feet at boring 3. Groundwater did not enter the other 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. 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 improving the existing parking lot. We assume the pavement surfacing will be asphalt or concrete. Minimum grade changes are expected for the project. The vehicle traffic will likely consist of automobiles (light duty) and truck traffic (heavy duty).

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.

Subgrade Conditions

Based on the test borings, existing fill materials are expected to be encountered as subgrade soils. On the east portion of the lot (borings 1 and 2) the fill materials consisted of lean clay soils while sand fill materials were encountered on the west portion (boring 3). The existing fill materials soils have Unified Soils Classification System symbols of SP and CL and AASHTO classifications of A-2, A-6 and A-7.

Based on the test borings and laboratory data the subgrade is considered a fair (borings 1 and 3) to favorable (boring 3) subgrade for pavement support. We estimate California Bearing Ratio (CBR) values of 2.5 to 4.0 for the variable subgrade conditions encountered. 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.

In our opinion, 3 subgrade preparation options could be considered for the project. Option 1 would consist of normal subgrade preparation (scarification and recompaction). In our judgement Option 1 would work well for the subgrade conditions encountered at the boring 3 location and the subgrade preparation could be limited to re-densification of the sand subgrade soils (no scarification necessary). However, for option 1 to be successful in the area of borings 1 and 2, there may need to be an extended period of dry weather during construction. Option 2 would consist of subgrade reinforcement (geotextile fabric). Option 3 would consist of cement stabilization. Option 3 would not appear necessary in the area of boring 3. If Option 3 will be performed where sand soils are exposed, a higher percentage of cement will likely be needed or the area should be subcut 12 inches and replaced with a clayey subgrade fill material. With that said, Options 2 and 3 will help provide a more uniform subgrade condition once the subgrade preparation is performed as well as provide a longer pavement life than Option 1. However, Option 2 may encounter some unstable areas due to construction disturbance, potential groundwater and/or weather events (prior to paving). Furthermore, it is our opinion that Option 3 will provide a reduction in construction delays and the longest pavement life (of the provided options).

Stripping & Removals

We recommend removing the existing pavement section and any vegetation/organic materials in order to achieve the design subgrade elevations. 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 materials should consist of non-organic lean clay or sandy lean clay soils having a liquid limit less than 50 and a plasticity index between 15 and 35. The moisture content of the fill soils should be 1 percent to 4 percent below the optimum moisture content. 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. Alternatively, a granular material could be used as backfill. If used, we recommend protecting/capping the granular materials with a sufficient layer of clay material to minimize infiltration of water and to prevent erosion of the granular materials. It may be better suited to only use the granular materials within the roadway section as the side slopes will provide protection to the granular materials.

Subgrade Preparation Option 1 – Scarification & Recompaction

For subgrade preparation option 1, the upper 8 inches of the subgrade should be scarified, moisture conditioned and recompacted. The soils should be moisture conditioned to a moisture level that is 1 percent to 4 percent below the optimum moisture content as determined by standard Proctor (ASTM:D698). The scarification should be performed by a disc harrow and not a road grader with teeth. The scarification will not be needed in areas where sand soils are encountered. Following the subgrade preparation (scarification and recompaction) and prior to the placement of the aggregate base course material, 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 in order to provide a uniform and stable subgrade condition. See the section entitled *Unstable Subgrade with Subgrade Preparation Option 1* for detailed information regarding the additional corrections.

We would like to point out that unstable areas may be encountered with this option, especially during the spring thaw, wetter periods of the year, when it is difficult to dry wet soils (late fall), areas of high groundwater or due to construction disturbance. Additionally, for Option 1 to be successful, there would likely need to be an extended period of dry weather. With all that said, Option 1 will likely take the most amount of construction time and is the most weather dependent.

Unstable Subgrade with Subgrade Preparation Option 1

Areas of unstable subgrade may be encountered during construction with subgrade preparation option 1. The soils within the unstable area should be removed, and either moisture-conditioned and recompacted, or replaced with suitable subgrade soils. If the unstable area will not stabilize using this method, then alternative stabilization methods may be used such as a modified cross-section involving a geotextile fabric. With the geotextile fabric, a thicker aggregate base course section will likely be needed (thickness would be based on field conditions). For very poor subgrade conditions, granular subbase will likely be needed with the geotextile fabric. The granular subbase should consist of crushed quartzite, recycled concrete or a crushed pit-run material meeting the gradation specifications shown in Table 2.

Table 2. 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

Regarding the geotextile fabric, we recommend using Mirafi HP 370, Propex Geotex 3x3 HF, Huesker Comtrac P 45/45 or an approved alternative. The granular subbase should be compacted to a minimum of 97 percent of standard Proctor density (ASTM:D698). It should be noted that compaction testing may not be practical for the granular subbase due to the large aggregate.

Subgrade Preparation Option 2 – Subgrade Reinforcement

Subgrade preparation option 2 would consist of subgrade preparation option 1 with the addition of a geotextile fabric beneath the aggregate base course material.

We would like to point out that Option 2 will provide more uniform support and a longer pavement life than Option 1; however, unstable areas may still be encountered during construction (prior to and following subgrade preparation) due to construction disturbance, groundwater and/or weather events.

Subgrade Preparation Option 3 – Cement Stabilization

The cement stabilization should consist of blending the subgrade soils with cement to a minimum depth of 12 inches. The percentage of cement used typically ranges from 5 percent to 7 percent and should be based on a site specific mix design. For bidding purposes, the percentage of cement used should be 6 percent (example: if the in-place dry density equals 105 pounds per cubic foot (pcf), then 6.3 pounds of cement should be applied to the subgrade, per square foot). We recommend that the percentage of cement used during the blending process be determined by a mix design that should be performed when the subgrade soils are exposed during construction. The mix design typically takes about 2 weeks to complete.

Once the percentage of cement is determined, the cement should be placed uniformly over the subgrade surface at the specified percentage with a truck-mounted cement spreader. In addition to the cement being placed uniformly, the truck-mounted spreader will help control the spread of cement dust. Then, a self-propelled pulvimixer/reclaimer should be used to reclaim the upper 12 inches of the subgrade along with the cement. Due to the plasticity of the subgrade soils, we recommend that the self-propelled pulvimixer/reclaimer have at least 400 horsepower. Within 30 minutes, the reclaimed mixture of soil and cement should be initially compacted with a large (60-inch to 72-inch diameter) vibratory sheepsfoot roller to a minimum of 95 percent of the maximum dry density as determined by Moisture-Density Relations of Soil-Cement Mixtures (ASTM:D558). The moisture content of the material should be adjusted to a moisture level that is within 3 percent below to 3 percent above the optimum moisture content determined by Moisture-Density Relations of Soil-Cement Mixtures (ASTM:D558). After initial compaction, the subgrade should be graded to design elevations, rolled with a pneumatic tire roller and watered with a commercial water truck. Construction traffic should not be allowed on the subgrade for 48 hours after the final watering. This delay allows for the cement to properly hydrate without being disturbed. If at any time during or after the cement stabilization process it is determined that the subgrade is not performing as expected, then the problem should be assessed to determine the best course of action. This may include an additional application of cement.

We would like to point out that Option 3 will perform better than Option’s 1 and 2 as well as provide a more stable working surface during construction/weather events and a reduction of construction delays once the subgrade is prepared. Again, if this option is chosen in areas where the sand soils are exposed, a higher percentage of cement will likely be needed or the area should be subcut 12 inches and replaced with a clayey subgrade fill material.

Pavement Section Thicknesses

Tables 3 and 4 show the recommended pavement section thicknesses based on the subsurface conditions, subgrade preparation and anticipated traffic loads.

Table 3. Asphalt Pavement Section Thicknesses

Area	Asphalt Pavement Thickness, in	Aggregate Base Course Thickness, in	Granular Subbase Thickness, in	Subgrade Reinforcement	Cement Stabilization
Light Duty (1)	4	8	-	-	-
Light Duty (2)	4	10	-	Geotextile Fabric	-
Light Duty (3)	4	4	-	-	Yes
Heavy Duty (1)	5	9	-	-	-
Heavy Duty (2)	5	12	-	Geotextile Fabric	-
Heavy Duty (3)	5	4	-	-	Yes

Notes: The numbers are for the following sections: (1) normal subgrade preparation, (2) subgrade reinforcement and (3) cement stabilization. Subgrade reinforcement or cement stabilization may be needed in areas where normal subgrade preparation is performed. The thickness of the granular subbase may need to be increased if very poor subgrade conditions are encountered. Also, the percentage of cement may need to be increased if very poor subgrade conditions are encountered.

Table 4. Concrete Pavement Section Thicknesses

Area	Concrete Pavement Thickness, in	Aggregate Base Course Thickness, in	Granular Subbase Thickness, in	Subgrade Reinforcement	Cement Stabilization
Light Duty (1)	5	6	-	-	-
Light Duty (2)	5	8	-	Geotextile Fabric	-
Light Duty (3)	5	4	-	-	Yes
Heavy Duty (1)	7	6	-	-	-
Heavy Duty (2)	6	10	-	Geotextile Fabric	-
Heavy Duty (3)	6	4	-	-	Yes

Notes: The numbers are for the following sections: (1) normal subgrade preparation, (2) subgrade reinforcement and (3) cement stabilization. Subgrade reinforcement or cement stabilization may be needed in areas where normal subgrade preparation is performed. The thickness of the granular subbase may need to be increased if very poor subgrade conditions are encountered. Also, the percentage of cement may need to be increased if very poor subgrade conditions are encountered.

Asphalt & Aggregate Base Course Materials

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

Existing Gravel Base

As shown in Table 1, the thicknesses of the existing gravel base varied from 0 inches to 24 inches. In our opinion, reclaiming of the existing gravel base for use as aggregate base course material could be considered in some areas of the project. Samples of the reclaimed material should be collected for analysis during construction in order to approve the material for use as aggregate base course material.

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 excavations should be immediately removed and surface drainage away from the excavations 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. Where soft/wet soils are encountered, the excavations should be performed with low-ground-pressure construction equipment or an excavator (backhoe) having a smooth cutting edge on the bucket.

Cold Weather Precautions

If site preparation and construction is anticipated during cold weather, then we recommend all subgrades, 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. If subgrades freeze, then we recommend that the frozen soils be removed and replaced, or completely thawed. The subgrade soils will likely require reworking and recompacting due to the loss of density caused by the freeze/thaw process.

Excavation Sideslopes

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.

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 utilities, 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.

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 backfill placed below slabs and pavements. 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 10,000 square feet of embankment fill placed, at least 1 test for every 500 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 3 SPT borings on October 29, 2021 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

We performed laboratory tests on select samples to aid in determining the index properties of the soils. The tests consisted of moisture content, dry density, Atterberg limits (liquid and plastic limits) and sieve analysis (#200 wash). 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 attached data sheets.

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 test 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.

REGISTERED PROFESSIONAL ENGINEER
REG. NO. 4829
DANIEL R. HANSON
SOUTH DAKOTA
11-17-21

Daniel R Hanson, PE
General Manager

FIGURE 1
SITE LOCATION MAP
PROPOSED PARKING LOT IMPROVEMENTS
SD STATE PENITENTIARY - WEST GATE
SIOUX FALLS, SD

ACAD/GEOTEK/DAN/21-K12

PROJECT#: 21-K12

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

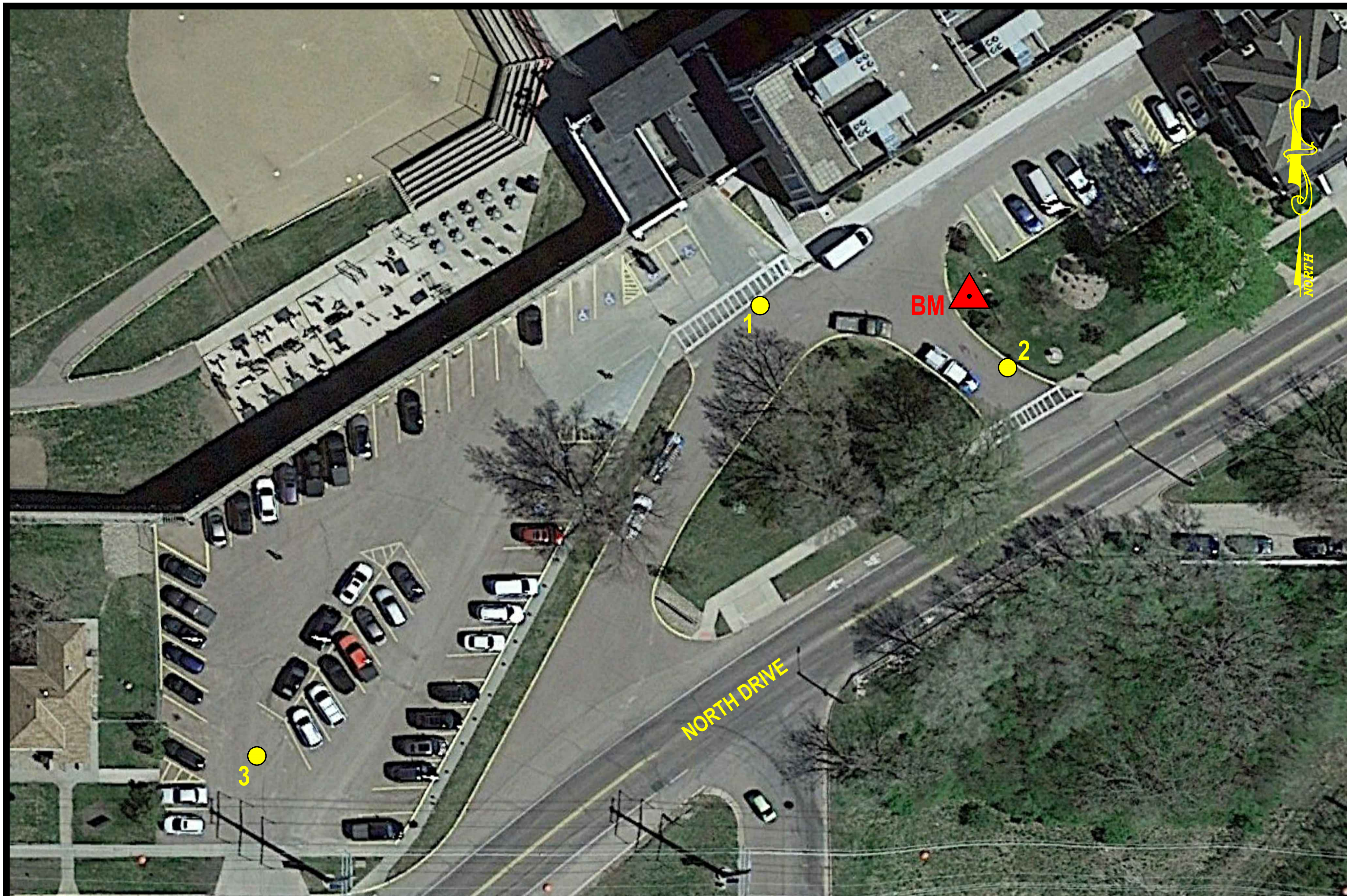

FIGURE 2
BORING LOCATION MAP
PROPOSED PARKING LOT IMPROVEMENTS
SD STATE PENITENTIARY - WEST GATE
SIOUX FALLS, SD

ACAD/GEOTEK/DAN/21-K12

PROJECT#: 21-K12

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

GEOTEK ENGINEERING
& TESTING SERVICES, INC.
909 E 50th St N
SIOUX FALLS, SD 57104
(605) 335-5512 Fax (605) 335-0773
info@geotekeng.com

GEOTECHNICAL TEST BORING LOG

GEOTEK # **21-K12**

BORING NO. **1 (1 of 1)**

PROJECT **Proposed West Gate Parking Lot Improvements, South Dakota State Penitentiary, Sioux Falls, SD**

SURFACE ELEVATION 94.9 ft

DEPTH in FEET	DESCRIPTION OF MATERIAL	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	WC	D	LL	PL	QU
	FILL, MOSTLY LEAN CLAY: a trace of gravel, brown and black, moist, a 2" layer of asphalt and 6" of concrete at the surface	FILL	5		1	SPT	11	121			
2	**CLAYEY SAND**: fine grained, brown, dry, loose, 27% passing #200 sieve (SC)	MIXED ALLUVIUM	6		2	SPT					
3½	**SAND**: a little gravel, medium grained, brown, dry, medium dense to dense, (SP)	COARSE ALLUVIUM	13		3	SPT					
			16		4	SPT					
8½	Bottom of borehole at 8½ feet.										

START 10-29-21 COMPLETE 10-29-21 3:30 pm

METHOD
6" Flight Auger

CREW CHIEF Roy Hanson

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL
10-29-21	3:30 pm	8.5	--	7	None
--	--	--	--	--	--
--	--	--	--	--	--
--	--	--	--	--	--

GEOTEK ENGINEERING
& TESTING SERVICES, INC.
909 E 50th St N
SIOUX FALLS, SD 57104
(605) 335-5512 Fax (605) 335-0773
info@geotekeng.com

GEOTECHNICAL TEST BORING LOG

GEOTEK # **21-K12** BORING NO. **2 (1 of 1)**

PROJECT **Proposed West Gate Parking Lot Improvements, South Dakota State Penitentiary, Sioux Falls, SD**

SURFACE ELEVATION 95.7 ft

DEPTH in FEET	DESCRIPTION OF MATERIAL	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	WC	D	LL	PL	QU
0–2	**FILL, MOSTLY LEAN CLAY**: a trace of gravel, brown and black, moist, a 3" of asphalt and 6.5" of concrete at the surface	FILL	4		1	SPT	15	115			
2–4½	**CLAYEY SAND**: fine grained, brown, dry, very loose, 37% passing #200 sieve (SC)	MIXED ALLUVIUM	3		2	SPT					
4½–7	**SAND**: fine grained, brown, dry, loose, (SP)	COARSE ALLUVIUM	5		3	SPT					
7–8½	**SAND**: a little gravel, medium grained, brown, dry, dense, (SP)	COARSE ALLUVIUM	17		4	SPT					
8½	Bottom of borehole at 8½ feet.										

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL
10-29-21	3:00 pm	8.5	--	7	None
--	--	--	--	--	--
--	--	--	--	--	--
--	--	--	--	--	--

START 10-29-21 COMPLETE 10-29-21 3:00 pm

METHOD
6" Flight Auger

CREW CHIEF Roy Hanson

GEOTEK ENGINEERING
& TESTING SERVICES, INC.
909 E 50th St N
SIOUX FALLS, SD 57104
(605) 335-5512 Fax (605) 335-0773
info@geotekeng.com

GEOTECHNICAL TEST BORING LOG

GEOTEK # **21-K12** BORING NO. **3 (1 of 1)**

PROJECT **Proposed West Gate Parking Lot Improvements, South Dakota State Penitentiary, Sioux Falls, SD**

DEPTH in FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION 86.3 ft)	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	WC	D	LL	PL	QU
	FILL, MOSTLY SAND: a little gravel, fine to medium grained, brown and dark brown, dry, a 6" layer of asphalt at the surface, 5% passing the #200 sieve	FILL	12		1	SPT					
2	**LEAN CLAY**: brown, moist, soft, (CL)	FINE ALLUVIUM	4		2	SPT	23	102			
4½	**LEAN CLAY WITH SAND**: a little gravel, brown, moist, firm to stiff, (CL)	GLACIAL TILL	9	▼	3	SPT	18	119			
			7		4	SPT					
8½	Bottom of borehole at 8½ feet.										

START 10-29-21 COMPLETE 10-29-21 4:00 pm

METHOD
6" Flight Auger

CREW CHIEF Roy Hanson

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL
10-29-21	4:00 pm	8.5	--	7	▼ 5.0
--	--	--	--	--	--
--	--	--	--	--	--
--	--	--	--	--	--

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTIONS
			GRAPH	LETTER	
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		(LITTLE OR NO FINES)		GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
		(APPRECIABLE AMOUNT OF FINES)		GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	SAND AND SANDY SOILS	CLEAN SANDS		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
		(LITTLE OR NO FINES)		SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	SANDS WITH FINES		SM	SILTY SANDS, SAND - SILT MIXTURES
		(APPRECIABLE AMOUNT OF FINES)		SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS	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
MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	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 Term	N-Value	Consistency 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

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

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

GRAVEL PERCENTAGES

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