GEOTEK ENGINEERING
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May 19, 2015

Lake Poinsett Sanitary District
19553 US Highway 81, Suite 3
Arlington, South Dakota 57212

Attn: Larry Furney

Subj: Geotechnical Exploration
Proposed Sewer Stabilization Pond
Lake Poinsett Sanitary District
Near Estelline, South Dakota
GeoTek #15-295

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 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, Inc., Attn: Pat Carey

TABLE OF CONTENTS

GEOTECHNICAL EXPLORATION
PROPOSED SEWER STABILIZATION POND
LAKE POINSETT SANITARY DISTRICT
NEAR ESTELLINE, SOUTH DAKOTA
GEOTEK #15-295

INTRODUCTION

Project Information

This report presents the results of the recent geotechnical exploration program for the proposed sewer stabilization pond for the Lake Poinsett Sanitary District near Estelline, South Dakota.

Scope of Services

Our work was performed in accordance with the authorization of Larry Furney with the Lake Poinsett Sanitary District. The scope of work as presented in this report is limited to the following:

1. To perform five (5) standard penetration test (SPT) borings to gather data on the subsurface conditions at the project site.
2. To perform laboratory tests that include moisture content, Atterberg limits (liquid and plastic limits), standard Proctor and permeability.
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.

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.

FIELD DATA

Site Location & Description

The project site is located approximately 2,200 feet north of 194th Street and approximately 1,500 feet west of 459th Avenue, which is approximately seven (7) miles west of Estelline, South Dakota. Lake Poinsett is located west of the site. The site was previously used for agricultural proposes. An aerial image is attached at the conclusion of this report showing the location of the site.

Ground Surface Elevations & Test Boring Locations

The ground surface elevations at the test boring locations were furnished by Banner Associates, Inc. and varied from 1,686.6 feet at test boring 1 to 1,703.9 feet at test boring 4. A test boring location map is attached at the conclusion of this report showing the relative location of the test borings. The test boring locations were established by Banner Associates, Inc.

Subsurface Conditions

Five (5) test borings were performed at the site on April 17, 2015. The subsurface conditions encountered at the test boring locations are illustrated by means of the boring logs included in Appendix A.

The subsurface conditions encountered at the test boring locations consisted of 1 foot to 4 ½ feet of topsoil materials overlying fine alluvium soils, mixed alluvium soils, coarse alluvium soils and glacial till soils. The glacial till soils were the predominant soil type encountered.

The topsoil materials and fine alluvium soils consisted of lean clay soils. The mixed alluvium soils consisted of clayey sand soils. The coarse alluvium soils consisted of sand soils. The glacial till soils consisted of lean clay with sand soils.

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, 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. A summary of the groundwater levels is shown in Table 1.

Table 1. Groundwater Levels

Test Boring Number	Date of Observation (2015)	Ground Surface Elevation, ft	Groundwater Level Below Existing Grade, ft	Elevation of Groundwater, ft
1	April 17	1,686.6	-----	-----
2	April 17	1,697.7	19	1,678.7
3	April 17	1,689.1	12	1,677.1
4	April 17	1,703.9	-----	-----
5	April 17	1,689.6	13	1,676.6

The water levels shown above may or may not be an accurate indication of the depth or lack of subsurface groundwater. Subsurface groundwater levels should be expected to fluctuate seasonally and yearly from the groundwater readings recorded at the test boring locations.

ENGINEERING REVIEW & RECOMMENDATIONS

Project Design Data

We understand that the project will consist of constructing a new sewer stabilization pond for the Lake Poinsett Sanitary District near Estelline, South Dakota. The project is currently in the preliminary design phase. Preliminary discussions indicate that the bottom-of-pond elevation

will be near 1,682 feet. Based on the bottom-of-pond elevation, grading within the pond will involve a cut varying from 5 feet to 22 feet. We assume that the pond will be required to have a maximum seepage rate of 1/16 inch per day.

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

Discussion

The test borings encountered 1 foot to 4 ½ feet of topsoil materials. It is our opinion that the topsoil materials should not be used as liner material or embankment fill for the pond. In addition, the coarse alluvium soils and mixed alluvium soils should not be used as liner material or embankment fill.

The majority of the cut materials will consist of glacial till soils. It is our opinion that the glacial till soils could be considered for use as liner material and embankment fill. Also, the fine alluvium soils could be considered for use as liner material and embankment fill.

Sewer Stabilization Pond

As stated above, the test borings encountered 1 foot to 4 ½ feet of topsoil materials. We recommend that the site preparation for the sewer stabilization pond, which includes the embankment areas, consist of removing the topsoil materials. Following the removals, we recommend achieving the design elevations.

Pond Dikes

Based upon the results of the test borings and laboratory tests, it is our opinion that the glacial till soils and fine alluvium soils are suitable for construction of the dike embankments. We recommend that the embankment fill be placed in uniform lifts (6-inch maximum). The moisture content of the embankment fill should be maintained within a range of 3 percent below to 3

percent above the optimum moisture content. The optimum moisture content should be determined by using a standard Proctor (ASTM: D698) test.

The results of the laboratory moisture contents indicate that the glacial till soils have in-situ moisture content levels that vary from 3 percent below to 3 percent above the optimum moisture content determined by the Proctor test. Therefore, the glacial till soils have suitable moisture content levels; however, some moisture conditioning should be expected. Regarding the fine alluvium soils, we estimate that the fine alluvium soils have in-situ moisture content levels that are 5 percent and 6 percent above the optimum moisture content. With that said, the fine alluvium soils will require drying prior to their use. Once the moisture content of the embankment fill is within the recommended range, the embankment fill should be compacted to a minimum of 95 percent of standard Proctor density (ASTM:D698).

A portion of the on-site soils may not be suitable for use as embankment fill. These unsuitable materials would consist of organic soils, sandy soils and soils having high moisture content levels such that the specified compaction level cannot be reasonably achieved. The organic materials and sandy soils should be replaced with suitable material available at the site or with suitable off-site borrow soils. The wet soils will require significant drying in order to adjust the moisture content of the soils to a level that will facilitate the specified compaction requirement. Alternatively, the wet soils could be replaced with suitable material available at the project site or with suitable off-site borrow soils.

We recommend that the side slopes of the new embankment dike sections be sloped no steeper than 3:1 (horizontal:vertical).

Pond Liner

Based upon the results of the permeability test, it is our opinion that the glacial till soils are suitable for liner construction. The fine alluvium soils could also be considered for liner construction. A total liner thickness of at least 12 inches is recommended. We recommend that the liner soils be placed in uniform lifts (6-inch maximum). The moisture content of the liner soils should be maintained within a range of the optimum moisture content to 3 percent above the optimum moisture content. The optimum moisture content should be determined by using a

standard Proctor (ASTM: D698) test. Once the moisture content of the liner soils is within the recommended range, the liner soils should be compacted to a minimum of 97 percent of standard Proctor density (ASTM:D698). If the liner material is naturally present at the bottom-of-pond elevation, a minimum of 6 inches of material should be removed and the exposed subgrade should be scarified to a minimum depth of 6 inches. This should only occur if glacial till soils or fine alluvium soils are exposed. If mixed alluvium soils or coarse alluvium soils are exposed, a removal depth of 12 inches would be needed and 12 inches of suitable liner material should be placed. The subgrade should be closely observed for any sand veins or pockets that would require an overexcavation. The scarified layer should be adjusted to the required moisture content range, followed by the necessary compaction.

The glacial till soils may randomly contain "pockets" of sand soils. We recommend the bottom of the pond excavation be observed by a geotechnical engineer or technician to help identify sand pockets that will require removal and replacement with suitable clay liner material.

The pond should be pre-filled as soon as possible to minimize drying and shrinkage cracking of the completed liner. Consideration should be given to protecting the liner on slopes of the embankment from erosion. A suitable riprap layer or shallow root vegetation could be used. Alternatively, the liner thickness could be increased so that some erosion could occur without compromising the required liner thickness.

After the pond liner has been completed, we recommend that Shelby tube samples of the liner be collected for laboratory permeability testing to document the permeability characteristics of the completed liner.

Earthwork Activities

The glacial till soils and fine alluvium soils are susceptible to disturbance caused by construction traffic and/or additional moisture. Precautions will be required during earthwork activities in order to reduce the risk of soil disturbance. Conventional scrapers should not be used within 1 foot of the bottom-of-pond elevation, unless conditions allow such equipment. Low-ground-pressure construction equipment or excavators with smooth-edged buckets should be used in areas where soft/wet soils are encountered.

Groundwater

Based on our groundwater measurements, groundwater is not likely to be encountered during construction. However, if groundwater is encountered, we recommend dewatering methods be used prior to and during construction to cut off and/or remove groundwater from the soils in the proposed pond and embankment areas. The contractor would need to provide appropriate dewatering methods and equipment.

CONSTRUCTION CONSIDERATIONS

Groundwater & Surface Water

Water may enter the excavation due to subsurface water, precipitation or surface run off. The clayey soils encountered at the test boring locations are relatively poor draining. As a result, water that enters the excavation will likely become trapped or "perched". It will likely be possible to remove and control water entering the excavation using normal sump pumping techniques due to the low permeable characteristics of the predominant clayey soils encountered at the test boring locations. However, lenses and layers of sand may be encountered, requiring more extensive dewatering techniques depending upon the subsurface water levels present during construction and the required excavation depths. 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 filling is performed during freezing temperatures, 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. 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 and 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 the pond. 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 the proposed construction. These observations should be performed prior to placement of embankment fill or liner construction.

Testing

After the subgrade is observed by a geotechnical engineer or technician and approved, we recommend that a representative number of moisture content tests and compaction tests be taken during the placement of the embankment fill and liner construction. The tests should be performed to determine if the moisture content of the soils is within the recommended range and the required compaction has been achieved. As a general guideline, we recommend at least one (1) test be taken for every 2,000 square feet of embankment fill placed in dike areas for every 2-foot thickness of embankment fill and at least one (1) test be taken for every 4,000 square feet of liner material placed for every 6-inch thickness. The actual number of tests should be left to the discretion of the geotechnical engineer. Samples of proposed embankment fill and liner materials should be submitted to our laboratory for testing to determine their compliance with our recommendations and project specifications.

Again, after the pond liner has been completed, Shelby tube samples of the liner should be collected from the bottom and slopes of the pond. The samples should be submitted to the laboratory for permeability testing to document the permeability characteristics of the completed liner.

SUBSURFACE EXPLORATION PROCEDURES

Test Borings

We performed five (5) SPT borings on April 17, 2015 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 bentonite chips.

The soil samples collected from the test boring locations will be retained in our office for a period of one (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 borings. 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 selected samples to aid in determining the index properties of the soils. The index tests consisted of moisture content, Atterberg limits (liquid limit and plastic limit), standard Proctor and permeability. 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 Appendix A.

LIMITATIONS

The recommendations and professional opinions submitted in this report were based upon the data obtained through the sampling and testing program at the 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 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 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
AERIAL IMAGE
PROPOSED SEWER STABILIZATION POND
LAKE POINSETT SANITARY DISTRICT
NEAR ESTELLINE, SD
ACAD\GEOTEK\JARED\15-295

PROJECT#: 15-295

DRAWN BY: CSP CHECKED BY:

GEOTEK ENGINEERING & TESTING SERVICES, INC.

FIGURE 2
TEST BORING LOCATION MAP
PROPOSED SEWER STABILIZATION POND
LAKE POINSETT SANITARY DISTRICT
NEAR ESTELLINE, SD
ACAD\GEOTEK\JARED\15-295

PROJECT#: 15-295

DRAWN BY: CSP CHECKED BY:

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GEOTECHNICAL TEST BORING LOG

GEOTEK # **15-295** BORING NO. **1 (1 of 1)**

PROJECT **Proposed Sewer Stabilization Pond, Near Estelline, SD**

DEPTH in FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION 1686.6 ft)	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	LABORATORY TESTS WC	D	LL	PL	QU
	LEAN CLAY: black, moist, soft, (CL)	TOPSOIL			1	HSA					
			4		2	SPT					
4½	**LEAN CLAY WITH SAND**: a little gravel, brown and gray, moist, firm to stiff, (CL)	GLACIAL TILL	8		3	SPT	17				
			7		4	SPT	20				
			9		5	SPT					
12	**LEAN CLAY WITH SAND**: a little gravel, brown, moist, stiff, (CL)	GLACIAL TILL	12		6	SPT					
14½	**LEAN CLAY WITH SAND**: a little gravel, brown and dark brown, moist, very stiff, (CL)	GLACIAL TILL	18		7	SPT					
19	**LEAN CLAY WITH SAND**: a little gravel, dark brown and dark gray, moist, very stiff, (CL)	GLACIAL TILL	17		8	SPT					
21	Bottom of borehole at 21 feet.										

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL
4-17-15	10:20 am	21	--	19	none
4-17-15	12:35 pm	21	--	16	none
--	--	--	--	--	--
--	--	--	--	--	--

START 4-17-15 COMPLETE 4-17-15 10:20 am

METHOD
3.25" ID Hollow Stem Auger

CREW CHIEF Roy Hanson

GEOTECHNICAL TEST BORING 15-295.GPJ GEOTEKENG.GDT 5/6/15

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GEOTECHNICAL TEST BORING LOG

GEOTEK # **15-295** BORING NO. **2 (1 of 1)**

PROJECT **Proposed Sewer Stabilization Pond, Near Estelline, SD**

DEPTH in FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION 1697.7 ft)	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	LABORATORY TESTS WC	D	LL	PL	QU
	LEAN CLAY: black, moist, (CL)	TOPSOIL			1	HSA					
2											
	LEAN CLAY: dark brown, moist, soft, (CL)	FINE ALLUVIUM	4		2	SPT					
3½	**LEAN CLAY WITH SAND**: a little gravel, brown, moist, stiff, (CL)	GLACIAL TILL	11		3	SPT					
			15		4	SPT	18				
			11		5	SPT					
			13		6	SPT	19		38	17	
			15		7	SPT	19				
				▼							
			15		8	SPT	19				
24											
	LEAN CLAY: brown, moist, stiff, (CL)	FINE ALLUVIUM	9		9	SPT					
26	Bottom of borehole at 26 feet.										

WATER LEVEL MEASUREMENTS

START 4-17-15 COMPLETE 4-17-15 11:20 am

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL
4-17-15	11:20 am	26	--	24	21
4-17-15	12:40 pm	26	--	22	▼ 19
--	--	--	--	--	--
--	--	--	--	--	--

METHOD
3.25" ID Hollow Stem Auger

CREW CHIEF Roy Hanson

GEOTECHNICAL TEST BORING 15-295.GPJ GEOTEKENG.GDT 5/6/15

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GEOTECHNICAL TEST BORING LOG

GEOTEK # **15-295** BORING NO. **3 (1 of 1)**

PROJECT **Proposed Sewer Stabilization Pond, Near Estelline, SD**

DEPTH in FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION 1689.1 ft)	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	LABORATORY TESTS WC	D	LL	PL	QU
	LEAN CLAY: black, moist, (CL)	TOPSOIL			1	HSA					
2	**LEAN CLAY WITH SAND**: a little gravel, brown, moist, firm to stiff, (CL)	GLACIAL TILL	8		2	SPT					
			10		3	SPT	17				
					4	BAG					
			12		5	SPT	18				
			9		6	SPT					
				▼							
			11		7	SPT					
			10		8	SPT					
19	**CLAYEY SAND**: a little gravel, medium grained, brown, wet, dense, (SC)	MIXED ALLUVIUM	23		9	SPT					
21	Bottom of borehole at 21 feet.										

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL
4-17-15	9:40 am	21	--	19	18
4-17-15	12:30 pm	21	--	18	▼ 12
--	--	--	--	--	--
--	--	--	--	--	--

START 4-17-15 COMPLETE 4-17-15 9:40 am

METHOD
3.25" ID Hollow Stem Auger

CREW CHIEF Roy Hanson

GEOTECHNICAL TEST BORING 15-295.GPJ GEOTEKENG.GDT 5/6/15

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GEOTECHNICAL TEST BORING LOG

GEOTEK # **15-295** BORING NO. **4 (1 of 1)**

PROJECT **Proposed Sewer Stabilization Pond, Near Estelline, SD**

DEPTH in FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION 1703.9 ft)	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	LABORATORY TESTS WC	D	LL	PL	QU
1	**LEAN CLAY**: black, moist, (CL)	TOPSOIL			1	HSA					
	LEAN CLAY WITH SAND: a little gravel, brown, moist, stiff, (CL)	GLACIAL TILL	11		2	SPT	14				
			13		3	SPT	16		40	17	
			14		4	SPT	17				
					5	BAG					
			11		6	SPT	18				
			15		7	SPT	17				
			12		8	SPT	15				
			16		9	SPT	15				
24	**LEAN CLAY**: brown, moist, stiff, (CL)	FINE ALLUVIUM	10		10	SPT					
29	**LEAN CLAY WITH SAND**: a little gravel, brown and dark brown, moist, stiff, (CL)	GLACIAL TILL	13		11	SPT					
31	Bottom of borehole at 31 feet.										

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL
4-17-15	12:20 pm	31	--	29	none
--	--	--	--	--	--
--	--	--	--	--	--
--	--	--	--	--	--

START 4-17-15 COMPLETE 4-17-15 12:20 pm

METHOD
3.25" ID Hollow Stem Auger

CREW CHIEF Roy Hanson

GEOTECHNICAL TEST BORING 15-295.GPJ GEOTEKENG.GDT 5/6/15

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GEOTECHNICAL TEST BORING LOG

GEOTEK # **15-295** BORING NO. **5 (1 of 1)**

PROJECT **Proposed Sewer Stabilization Pond, Near Estelline, SD**

DEPTH in FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION 1689.6 ft)	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	LABORATORY TESTS WC	D	LL	PL	QU
2	**LEAN CLAY**: black, moist, (CL)	TOPSOIL			1	HSA					
	LEAN CLAY: brown and gray, moist, firm, (CL)	FINE ALLUVIUM	6		2	SPT	24				
			8		3	SPT	25				
7	**SAND**: a little gravel, medium grained, brown, dry, medium dense, (SP)	COARSE ALLUVIUM	12		4	SPT					
9½	**LEAN CLAY WITH SAND**: a little gravel, brown, moist, stiff, (CL)	GLACIAL TILL	11		5	SPT					
			11	▼	6	SPT					
			10		7	SPT					
19	**CLAYEY SAND**: a little gravel, medium grained, brown, wet, dense, (SC)	MIXED ALLUVIUM	20		8	SPT					
21	Bottom of borehole at 21 feet.										

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL
4-17-15	9:00 am	21	--	19	17
4-17-15	12:25 pm	21	--	17	▼ 13
--	--	--	--	--	--
--	--	--	--	--	--

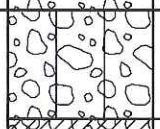
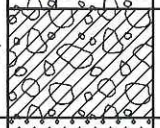
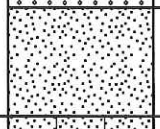
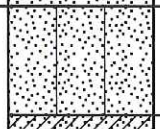
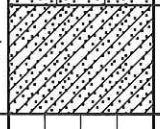
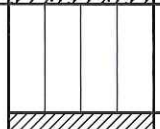
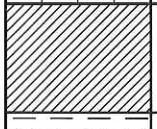
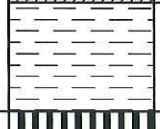
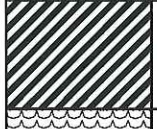
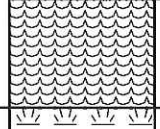
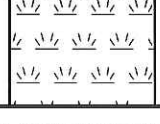
START 4-17-15 COMPLETE 4-17-15 9:00 am

METHOD
3.25" ID Hollow Stem Auger

CREW CHIEF Roy Hanson

GEOTECHNICAL TEST BORING 15-295.GPJ GEOTEKENG.GDT 5/6/15

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 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

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 E. 50th St. N.
Sioux Falls SD 57104
605-335-5512 Fax 605-335-0773
info@geotekeng.com

MOISTURE-DENSITY CURVE

PROJECT:
Proposed Sewer Stabilization Pond

Near Estelline, SD

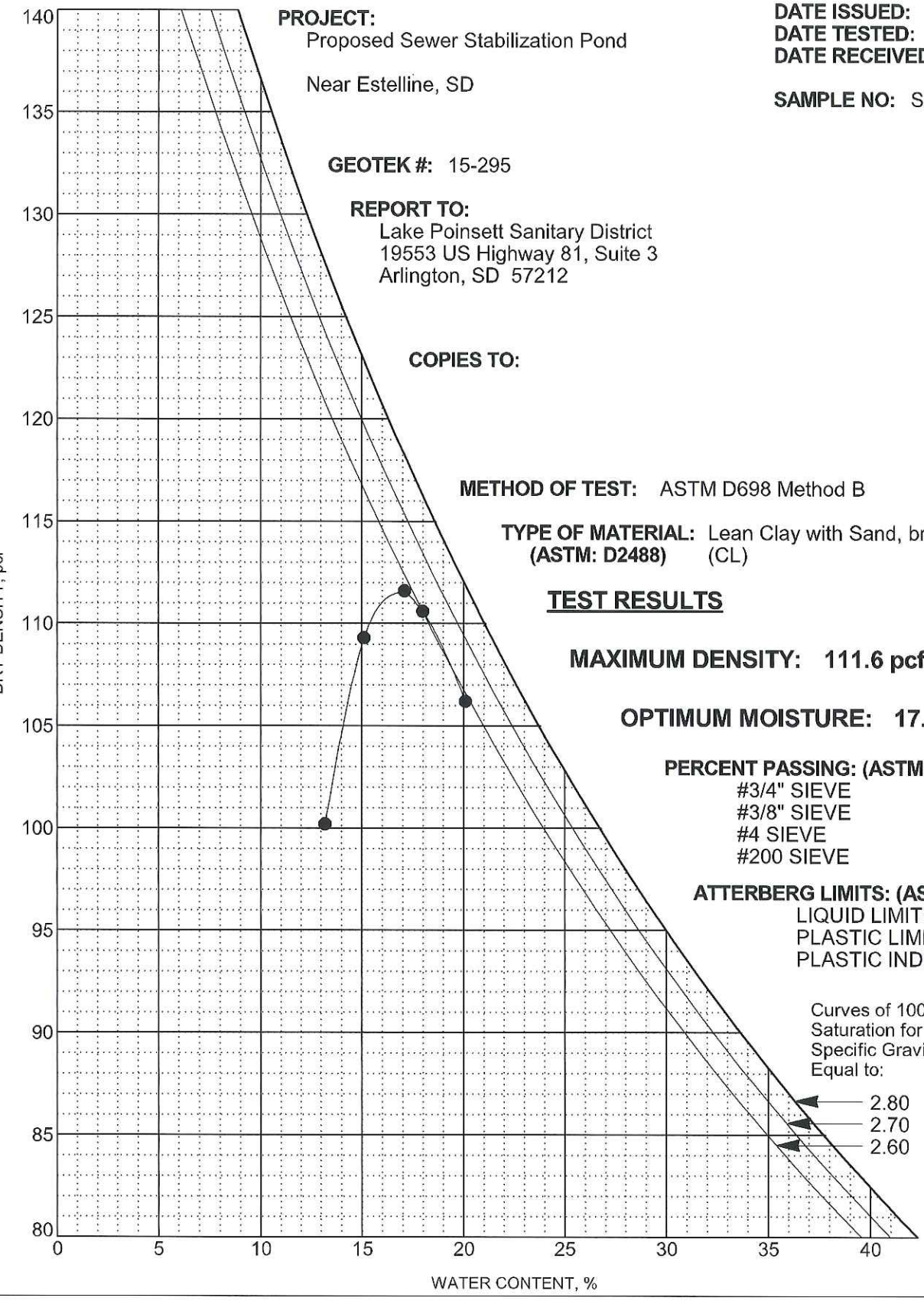
DATE ISSUED: 4-27-15
DATE TESTED: 4-23-15
DATE RECEIVED: 4-17-15

SAMPLE NO: SB 3 - 3' to 10'

GEOTEK #: 15-295

REPORT TO:
Lake Poinsett Sanitary District
19553 US Highway 81, Suite 3
Arlington, SD 57212

COPIES TO:



METHOD OF TEST: ASTM D698 Method B

TYPE OF MATERIAL: Lean Clay with Sand, brown
(ASTM: D2488) (CL)

TEST RESULTS

MAXIMUM DENSITY: 111.6 pcf

OPTIMUM MOISTURE: 17.1 %

PERCENT PASSING: (ASTM: D698)

#3/4" SIEVE	--
#3/8" SIEVE	--
#4 SIEVE	--
#200 SIEVE	71%

ATTERBERG LIMITS: (ASTM: D4318)
LIQUID LIMIT:
PLASTIC LIMIT:
PLASTIC INDEX:

Curves of 100% Saturation for Specific Gravity Equal to:
2.80
2.70
2.60

MOISTURE-DENSITY 15-295 - PROPOSED POND - NEAR ESTELLINE, SD.GPJ GEOTEKENG.GDT 4/30/15

Matthew Thompson, PE; Project Manager

TR #402

Hydraulic Conductivity Test Data ASTM D5084

Project: Proposed Sewer Stabilization Pond - Near Estelline, SD Date: 5/18/2015

Reported To: Geotek Engineering & Testing Services, Inc. Job No.: 9844

Boring No.:	SB-3						
Sample No.:							
Depth (ft):	3-10						
Location:							
Sample Type:	Cylinder						
Soil Type:	Lean Clay w/ sand (CL)						
Atterberg Limits							
LL							
PL							
PI							
Permeability Test	Reconstituted						
Before Test Conditions: Saturation %:							
Porosity:							
Ht. (in):	3.00						
Dia. (in):	2.85						
Dry Density (pcf):	108.2						
Water Content:	19.1%						
Test Type:	Falling						
Max Head (ft.):	5.0						
Confining press. (Effective-psi):	2.0						
Trial No.:	9-13						
Water Temp °C:	22.0						
% Compaction	97.0%						
% Saturation (After Test)	95.1%						
Coefficient of Permeability							
K @ 20 °C (cm/sec)	**4.0×10^{-9}**						
K @ 20 °C (ft/min)	**7.9×10^{-9}**						
Notes:							

2401 W 66th Street SOIL ENGINEERING TESTING, INC. Richfield, Minnesota 55423-2031