

**GEOTECHNICAL EXPLORATION
TREATED WATER PIPELINE SEGMENT 12
LEWIS & CLARK
REGIONAL WATER SYSTEM
NEAR BERESFORD, SOUTH DAKOTA**

**BANNER NO. 2000.21.01
GEOTEK #10-870**





**GEOTEK ENGINEERING
& TESTING SERVICES, INC.**
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September 28, 2010

Banner Associates, Inc.
PO Box 298
409 22nd Avenue South
Brookings, SD 57006

Attn: Mr. Tim Conner

Subj: Geotechnical Exploration
Proposed Treated Water Pipeline Segment 12
Lewis and Clark Regional Water System
Near Beresford, South Dakota
BAI No. 20000.21.01
GeoTek #10-870

This correspondence presents our report of the geotechnical exploration program for the referenced project. We performed our work in accordance with the authorization of Carrie Buthe dated July 14, 2010. The project site is generally located along 298th Street between Beresford, South Dakota and the Iowa border. The locations for the test borings were staked in the field by Banner Associates, Inc.

We performed sixteen (16) test borings for the project on August 4, August 5, August 6 and August 30, 2010. We did not drill test boring #12-13 because it was staked very near boring #12-14 (both were staked on the east side of Finnie Creek). The subsurface conditions encountered at the test boring locations are illustrated by means of the boring logs attached to this report.

The subsurface conditions encountered at the boring locations consist of existing fill, topsoil and slope wash materials at the surface underlain by alluvium, loess and glacial till soils. The alluvium soils encountered at the borings consisted of lean clay, fat clay, clayey sand and sand. The loess soils encountered at the borings consisted of lean clay. The glacial till soils encountered at the borings consisted of lean clay with sand. 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 necessary that you contact us so that our recommendations can be reviewed.

The consistency of the clay soils varied from soft to stiff. The density of the sand soils varied from very loose to dense. The consistency and density of the soils are indicated by the standard penetration resistance ("N") values as shown on the boring logs.

We performed measurements to record the groundwater levels at the boring locations both at the time the borings were completed and just before being backfilled. The time and level of the groundwater readings are recorded on the boring logs. Groundwater was measured at depths varying from 1 ½ feet to 14 ½ feet at boring locations.

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 clay soils and the measurements may not be an accurate indication of subsurface groundwater levels. Long term groundwater monitoring was not included in our work scope.

Subsurface groundwater levels should be expected to fluctuate seasonally and yearly from the groundwater readings recorded at the 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 borings were performed.

Selected samples were submitted to the laboratory for testing to aid in the design of the corrosion protection system. The tests consisted of pH, chloride content, sulfate content and resistivity. In addition, some of the samples were tested for moisture content and dry density.

We understand the project will consist of constructing a treated water pipeline along 298th Street from Beresford to the Iowa border. The pipeline will have a typical cover depth of 6 feet to 10 feet.

The subgrade soils encountered in the test borings at the anticipated invert depths for the proposed pipeline will consist of either clay or sand soils. Areas of wet or soft soils will likely be encountered at the bottom of the pipeline trench excavations, requiring subexcavation and trench bottom stabilization methods and materials. Based on our groundwater readings, water will also likely enter the excavation as a result of subsurface water, precipitation and surface run off. Where clay soils are encountered, 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 clayey soils. However, where sand soils are encountered, more extensive dewatering techniques, such as a series of well points, will likely be required 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.

A portion of the materials encountered in the trench excavations may not be suitable for backfill material. These unsuitable materials would consist of organic soils and soils having high water contents such that the specified compaction level cannot be reasonably achieved. The unsuitable soil materials should be replaced with suitable material available at the project site or with suitable off-site borrow soils.

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

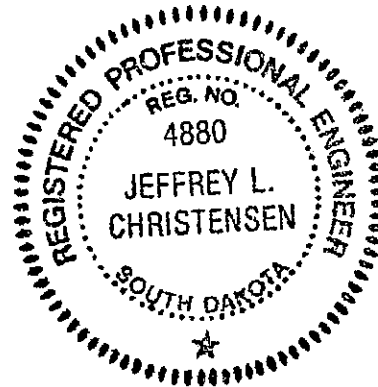
responsibility of the contractor. Reference to this OSHA requirement should be included in the project specifications.

We trust this report provides you with the initial information for the project. If you have any questions regarding this report, please contact our office at (605) 335-5512.

Respectfully Submitted,
GeoTek Engineering & Testing Services, Inc.



Jeff Christensen, PE
Geotechnical Manager



Cc: Banner Associates, Inc. – Sioux Falls
Attn: Scott Vander Meulen

Banner Associates, Inc. – Sioux Falls
Attn: Carrie Buthe

LABORATORY TEST RESULTS

Boring	Depth (ft)	Soil Type	Resistivity (ohm-cm)
12-1	8.5-10.5	Lean Clay with Sand	1,150
12-2	7-9	Lean Clay with Sand	1,300
12-3	7-9	Lean Clay with Sand	1,730
12-4	12-14	Lean Clay	1,720
12-5	7-9	Organic Lean Clay	1,400
12-6	7-9	Lean Clay	1,290
12-7	9-11	Lean Clay	880
12-8	7-9	Lean Clay	2,200
12-9	7-9	Lean Clay	1,330
12-10	7-9	Organic Lean Clay	1,550
12-11	7-9	Lean Clay	2,040
12-12	7-9	Organic Lean Clay	820
12-14	7-9	Lean Clay	580

Boring	Depth (ft)	Soil Type	pH	Chloride (mg/kg)	Sulfate (mg/kg)
12-1	10.5-12	Lean Clay with Sand	8.0	7	85
12-2	9.5-11	Lean Clay with Sand	8.0	5	440
12-3	4.5-6	Lean Clay with Sand	8.0	3	7
12-4	9.5-11	Clayey Sand	8.3	41	12
12-4	14.5-16	Lean Clay	8.0	32	10
12-5	9.5-11	Organic Lean Clay	8.1	4	68
12-6	9.5-11	Lean Clay	8.3	1	36
12-7	7-8.5	Organic Lean Clay	7.1	29	32
12-8	9.5-11	Lean Clay	8.1	2	6
12-9	9.5-11	Lean Clay	8.1	4	27
12-10	9.5-11	Organic Lean Clay	7.4	4	131
12-11	9.5-11	Lean Clay	8.2	2	62
12-12	9.5-11	Organic Lean Clay	7.7	3	73
12-14	9.5-11	Lean Clay	7.8	2	345
12-15	9.5-11	Sand, medium grained	8.6	23	18
12-16	7-8.5	Sand, medium grained	8.6	3	7
12-17	7-8.5	Sand, medium grained	8.1	2	4



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GEOTECHNICAL TEST BORING LOG

GEOTEK # **10-870**

BORING NO. **12-1 (1 of 1)**

PROJECT **Proposed TWS Segment 12, Lewis & Clark Regional Water System, Near Beresford, SD**

DEPTH in FEET	DESCRIPTION OF MATERIAL	GEOLOGIC ORIGIN	N	WL	SAMPLE		LABORATORY TESTS				
					NO.	TYPE	WC	D	LL	PL	QU
4 1/2	FILL, MOSTLY CLAY: brown and black, moist	FILL			1	HSA					
			4		2	SPT					
7	LEAN CLAY: dark brown, moist, firm, (CL)	FINE ALLUVIUM	5		3	SPT					
14	LEAN CLAY WITH SAND: a little gravel, brown and gray mottled, moist, firm, (CL)	GLACIAL TILL	7		4	SPT					
					5	SH	21	107			
			7		6	SPT					
			7		7	SPT					
21	LEAN CLAY WITH SAND: a little gravel, brown, moist, stiff, (CL)	GLACIAL TILL	9		8	SPT					
			10		9	SPT					
Bottom of borehole at 21 feet.											

WATER LEVEL MEASUREMENTS

START 8-4-10 COMPLETE 8-4-10 1:45 pm

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL	METHOD
8-4-10	1:45 pm	21	--	17	3.5	3.25" ID Hollow Stem Auger
8-25-10	10:35 am	21	--	9	4.5	
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GEOTECHNICAL TEST BORING 10-870.GPJ GEOTEKENG.GDT 9/24/10



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GEOTECHNICAL TEST BORING LOG

GEOTEK # <u>10-870</u>						BORING NO. <u>12-2 (1 of 1)</u>					
PROJECT <u>Proposed TWS Segment 12, Lewis & Clark Regional Water System, Near Beresford, SD</u>											
DEPTH in FEET	DESCRIPTION OF MATERIAL	GEOLOGIC ORIGIN	N	WL	SAMPLE		LABORATORY TESTS				
					NO.	TYPE	WC	D	LL	PL	QU
	<u>LEAN CLAY</u> : black, moist, (CL)	TOPSOIL			1	HSA					
2	<u>LEAN CLAY</u> : brown, moist, soft, (CL)	FINE ALLUVIUM	4		2	SPT					
4	<u>LEAN CLAY WITH SAND</u> : a little gravel, brown and gray mottled, moist, firm, (CL)	GLACIAL TILL	6		3	SPT					
9	<u>LEAN CLAY WITH SAND</u> : a little gravel, brown, moist, stiff to firm, (CL)	GLACIAL TILL	9		4	SH	23	100			
	<u>LEAN CLAY WITH SAND</u> : a little gravel, brown, moist, stiff to firm, (CL)	GLACIAL TILL	8		5	SPT					
			7		6	SPT					
			8		7	SPT					
19	<u>LEAN CLAY WITH SAND</u> : a little gravel, dark gray, moist, firm, (CL)	GLACIAL TILL	8		8	SPT					
21	Bottom of borehole at 21 feet.										
WATER LEVEL MEASUREMENTS						START	<u>8-4-10</u>	COMPLETE	<u>8-4-10 2:55 pm</u>		
DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL	METHOD					
8-4-10	2:55 pm	21	--	17	4	3.25" ID Hollow Stem Auger					
8-25-10	10:30 am	21	--	9	3.5						
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--	--	--	--	--	--	CREW CHIEF Roy Hanson					

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GEOTECHNICAL TEST BORING LOG

GEOTEK # 10-870

BORING NO. 12-3 (1 of 1)

PROJECT Proposed TWS Segment 12, Lewis & Clark Regional Water System, Near Beresford, SD

DEPTH in FEET	DESCRIPTION OF MATERIAL	GEOLOGIC ORIGIN	N	WL	SAMPLE		LABORATORY TESTS					
					NO.	TYPE	WC	D	LL	PL	QU	
	<u>LEAN CLAY</u> : black, moist, (CL)	TOPSOIL			1	HSA						
2	<u>LEAN CLAY</u> : brown and gray mottled, moist, soft, (CL)	FINE ALLUVIUM	4		2	SPT						
4	<u>LEAN CLAY WITH SAND</u> : a little gravel, brown, moist, stiff to firm, (CL)	GLACIAL TILL	9	▼	3	SPT						
					4	SH	18	110				
			8		5	SPT						
			8		6	SPT						
			9		7	SPT						
			13		8	SPT						
21	Bottom of borehole at 21 feet.											

WATER LEVEL MEASUREMENTS

START 8-4-10 COMPLETE 8-4-10 3:55 pm

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL	METHOD
8-4-10	3:55 pm	21	--	19	none	3.25" ID Hollow Stem Auger
8-25-10	10:25 am	21	--	5.5	▼ 5	
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GEOTECHNICAL TEST BORING LOG

GEOTEK # 10-870

BORING NO. 12-4 (1 of 1)

PROJECT Proposed TWS Segment 12, Lewis & Clark Regional Water System, Near Beresford, SD

DEPTH in FEET	DESCRIPTION OF MATERIAL	GEOLOGIC ORIGIN	N	WL	SAMPLE		LABORATORY TESTS					
					NO.	TYPE	WC	D	LL	PL	QU	
0	FILL, MOSTLY CLAY: brown and black, moist	FILL			1	HSA						
4 1/2	LEAN CLAY: dark brown, moist, firm, (CL)	FINE ALLUVIUM	3		2	SPT						
7	CLAYEY SAND: fine grained, brown, moist, very loose, (SC)	MIXED ALLUVIUM	6		3	SPT						
			3		4	SPT						
			3		5	SPT						
12	LEAN CLAY: brown, moist, soft, (CL)	FINE ALLUVIUM			6	SH	23	98				
			3		7	SPT						
19	LEAN CLAY: grayish brown, moist, firm, (CL)	FINE ALLUVIUM			8	SPT						
24	FAT CLAY: grayish brown, moist, stiff, (CH)	FINE ALLUVIUM			9	SPT						
26	Bottom of borehole at 26 feet.											

WATER LEVEL MEASUREMENTS

START 8-5-10 COMPLETE 8-5-10 10:05 am

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL	METHOD
8-5-10	10:05 am	26	--	24	19	3.25" ID Hollow Stem Auger
8-25-10	10:20 am	26	--	16	14.5	
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--	--	--	--	--	--	CREW CHIEF Roy Hanson

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GEOTECHNICAL TEST BORING LOG

DEPTH in FEET		DESCRIPTION OF MATERIAL	GEOLOGIC ORIGIN	N	WL	SAMPLE		LABORATORY TESTS								
						NO.	TYPE	WC	D	LL	PL	QU				
		ORGANIC LEAN CLAY: black, moist to wet, soft, (OL)	SLOPE WASH			1	HSA									
				2	▼	2	SPT									
				3		3	SPT									
				4		4	SH	41	79							
				2		5	SPT									
				2		6	SPT									
14		LEAN CLAY: dark brownish gray, moist, soft, (CL)	FINE ALLUVIUM			7	SPT									
19		LEAN CLAY: brownish gray, moist, soft, (CL)		FINE ALLUVIUM	3		8	SPT								
21		Bottom of borehole at 21 feet.														
WATER LEVEL MEASUREMENTS						START	8-5-10	COMPLETE	8-5-10 11:10 am							
DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL	METHOD										
8-5-10	11:10 am	21	--	18	▼ 3	3.25" ID Hollow Stem Auger										
8-25-10	10:10 am	21	--	15	▼ 3											
--	--	--	--	--	--											
--	--	--	--	--	--	CREW CHIEF Roy Hanson										

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GEOTECHNICAL TEST BORING LOG

GEOTEK # 10-870

BORING NO. 12-6 (1 of 1)

PROJECT Proposed TWS Segment 12, Lewis & Clark Regional Water System, Near Beresford, SD

DEPTH in FEET	DESCRIPTION OF MATERIAL	GEOLOGIC ORIGIN	N	WL	SAMPLE		LABORATORY TESTS					
					NO.	TYPE	WC	D	LL	PL	QU	
0	ORGANIC LEAN CLAY: black, moist, soft, (OL)	SLOPE WASH			1	HSA						
4	LEAN CLAY: grayish brown, moist, soft, (CL)	FINE ALLUVIUM	4		2	SPT						
7	LEAN CLAY: brownish gray, moist to wet, soft, (CL)	FINE ALLUVIUM	3		3	SPT						
					4	SH	31	94				
			3		5	SPT						
			2		6	SPT						
			2		7	SPT						
21	Bottom of borehole at 21 feet.		4		8	SPT						

WATER LEVEL MEASUREMENTS

START 8-30-10 COMPLETE 8-30-10 1:20 pm

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL	METHOD
8-30-10	1:20 pm	21	--	16	7	3.25" ID Hollow Stem Auger
--	--	--	--	--	--	
--	--	--	--	--	--	
--	--	--	--	--	--	CREW CHIEF Roy Hanson

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GEOTECHNICAL TEST BORING LOG

GEOTEK # 10-870

BORING NO. 12-7 (1 of 1)

PROJECT Proposed TWS Segment 12, Lewis & Clark Regional Water System, Near Beresford, SD

DEPTH in FEET	DESCRIPTION OF MATERIAL	GEOLOGIC ORIGIN	N	WL	SAMPLE		LABORATORY TESTS					
					NO.	TYPE	WC	D	LL	PL	QU	
0	FILL, MOSTLY CLAY: brown and black, moist	FILL			1	HSA						
5			5		2	SPT						
6			5		3	SPT						
6	ORGANIC LEAN CLAY: black, moist, soft, (OL)	TOPSOIL			4	SPT						
9	LEAN CLAY: dark brownish gray, moist, soft, (CL)	FINE ALLUVIUM			5	SH	28	92				
14			3		6	SPT						
14	SAND: fine to medium grained, brown, waterbearing, medium dense, (SP)	COARSE ALLUVIUM			7	SPT						
21			10		8	SPT						
21	Bottom of borehole at 21 feet.											

WATER LEVEL MEASUREMENTS

START 8-5-10 COMPLETE 8-5-10 12:20 pm

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL	METHOD
8-5-10	12:20 pm	21	--	12	4	3.25" ID Hollow Stem Auger
8-25-10	10:00 am	21	--	7	4	
--	--	--	--	--	--	
--	--	--	--	--	--	CREW CHIEF Roy Hanson

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GEOTECHNICAL TEST BORING LOG

GEOTEK # 10-870

BORING NO. 12-8 (1 of 1)

PROJECT Proposed TWS Segment 12, Lewis & Clark Regional Water System, Near Beresford, SD

DEPTH in FEET	DESCRIPTION OF MATERIAL	GEOLOGIC ORIGIN	N	WL	SAMPLE		LABORATORY TESTS					
					NO.	TYPE	WC	D	LL	PL	QU	
0	<u>LEAN CLAY</u> : black, moist, (CL)	TOPSOIL			1	HSA						
2	<u>LEAN CLAY</u> : dark brown, moist, soft, (CL)	FINE ALLUVIUM	3		2	SPT						
3 1/2	<u>LEAN CLAY</u> : brown, moist, soft, (CL)	FINE ALLUVIUM	2		3	SPT						
					4	SH	31	90				
					5	SPT						
12	<u>LEAN CLAY</u> : grayish brown, moist, soft, (CL)	FINE ALLUVIUM	2	▼	6	SPT						
					7	SPT						
19	<u>LEAN CLAY</u> : brown, moist, soft, (CL)	FINE ALLUVIUM	3		8	SPT						
21	Bottom of borehole at 21 feet.											

WATER LEVEL MEASUREMENTS

START 8-5-10 COMPLETE 8-5-10 2:00 pm

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL	METHOD
8-5-10	2:00 pm	21	--	18	15	3.25" ID Hollow Stem Auger
8-25-10	9:55 am	21	--	13	▼ 13	
--	--	--	--	--	--	
--	--	--	--	--	--	CREW CHIEF Roy Hanson

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BORING NO. 12-9 (1 of 1)

PROJECT Proposed TWS Segment 12, Lewis & Clark Regional Water System, Near Beresford, SD

DEPTH in FEET	DESCRIPTION OF MATERIAL	GEOLOGIC ORIGIN	N	WL	SAMPLE		LABORATORY TESTS				
					NO.	TYPE	WC	D	LL	PL	QU
4 1/2	ORGANIC LEAN CLAY: black, moist, soft, (OL)	SLOPE WASH	3	▼	1	HSA					
	2				SPT						
7	LEAN CLAY: brown, moist, firm, (CL)	FINE ALLUVIUM	6		3	SPT					
12	LEAN CLAY: brown and gray mottled, moist, soft, (CL)	FINE ALLUVIUM	2		4	SH	28	96			
13 1/2	LEAN CLAY: grayish brown, moist, firm, (CL)	FINE ALLUVIUM	5		6	SPT					
19	SAND: a trace of gravel, medium grained, brownish brown, waterbearing, dense, (SP)	COARSE ALLUVIUM	23		7	SPT					
21	LEAN CLAY WITH SAND: a little gravel, brown, moist, stiff, (CL)	GLACIAL TILL	11		8	SPT					
Bottom of borehole at 21 feet.											

WATER LEVEL MEASUREMENTS

START 8-30-10 COMPLETE 8-30-10 2:40 pm

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL	METHOD
8-30-10	2:40 pm	21	--	14	▼ 4	3.25" ID Hollow Stem Auger
--	--	--	--	--	--	
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--	--	--	--	--	--	CREW CHIEF Roy Hanson

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BORING NO. 12-10 (1 of 1)

PROJECT Proposed TWS Segment 12, Lewis & Clark Regional Water System, Near Beresford, SD

DEPTH in FEET	DESCRIPTION OF MATERIAL	GEOLOGIC ORIGIN	N	WL	SAMPLE		LABORATORY TESTS					
					NO.	TYPE	WC	D	LL	PL	QU	
0	FILL, MOSTLY CLAY: brown and black, moist	FILL			1	HSA						
5			5		2	SPT						
6			6		3	SPT						
7	ORGANIC LEAN CLAY: black, moist, soft, (OL)	SLOPE WASH		▼	4	SH	32	89				
11			3		5	SPT						
11	LEAN CLAY: grayish brown, moist, firm to soft, (CL)	FINE ALLUVIUM			6	SPT						
19			5		7	SPT						
19	LEAN CLAY: brown, moist, soft, (CL)	FINE ALLUVIUM			8	SPT						
21	Bottom of borehole at 21 feet.		3									

WATER LEVEL MEASUREMENTS

START 8-5-10 COMPLETE 8-5-10 3:10 pm

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL	METHOD
8-5-10	3:10 pm	21	--	18	▼ 8	3.25" ID Hollow Stem Auger
8-25-10	9:45 am	21	--	12.5	▼ 8	
--	--	--	--	--	--	
--	--	--	--	--	--	

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GEOTECHNICAL TEST BORING 10-870.GPJ GEOTEKENG.GDT 9/24/10



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GEOTECHNICAL TEST BORING LOG

GEOTEK # **10-870**

BORING NO. **12-11 (1 of 1)**

PROJECT **Proposed TWS Segment 12, Lewis & Clark Regional Water System, Near Beresford, SD**

DEPTH in FEET	DESCRIPTION OF MATERIAL	GEOLOGIC ORIGIN	N	WL	SAMPLE		LABORATORY TESTS					
					NO.	TYPE	WC	D	LL	PL	QU	
1	LEAN CLAY: black, moist, (CL)	TOPSOIL			1	HSA						
	LEAN CLAY: grayish brown, moist to wet, soft, (CL)	LOESS	3		2	SPT						
			3		3	SPT						
					4	SH	30	96				
			3		5	SPT						
12	LEAN CLAY WITH SAND: a little gravel, brown, moist, firm to stiff, (CL)	GLACIAL TILL	5		6	SPT						
			8		7	SPT						
21	Bottom of borehole at 21 feet.		11		8	SPT						

WATER LEVEL MEASUREMENTS

START 8-5-10 COMPLETE 8-5-10 4:20 pm

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL	METHOD
8-5-10	4:20 pm	21	--	12	12	3.25" ID Hollow Stem Auger
8-25-10	9:40 am	21	--	8.5	▼ 8.5	
--	--	--	--	--	--	
--	--	--	--	--	--	CREW CHIEF Roy Hanson

GEOTECHNICAL TEST BORING 10-870.GPJ GEOTEKENG.GDT 9/28/10



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 909 E. 50th Street North
 Sioux Falls, SD 57104
 605-335-5512 Fax 605-335-0773
 www.geotekeng.com

GEOTECHNICAL TEST BORING LOG

GEOTEK # 10-870

BORING NO. 12-12 (1 of 1)

PROJECT Proposed TWS Segment 12, Lewis & Clark Regional Water System, Near Beresford, SD

DEPTH in FEET	DESCRIPTION OF MATERIAL	GEOLOGIC ORIGIN	N	WL	SAMPLE		LABORATORY TESTS					
					NO.	TYPE	WC	D	LL	PL	QU	
0	FILL, MOSTLY CLAY: brown and black, moist	FILL			1	HSA						
5			5		2	SPT						
6			3		3	SPT						
6	ORGANIC LEAN CLAY: black, moist, firm, (OL)	SLOPE WASH			4	SH	40	77				
12			5		5	SPT						
12	FAT CLAY: dark grayish brown, moist, soft, (CH)	FINE ALLUVIUM	3		6	SPT						
14	LEAN CLAY: grayish brown, moist, soft, (CL)	FINE ALLUVIUM	2		7	SPT						
19	SAND: a trace of gravel, fine to medium grained, brown, waterbearing, loose, (SP)	COARSE ALLUVIUM	6		8	SPT						
21	Bottom of borehole at 21 feet.											

WATER LEVEL MEASUREMENTS

START 8-6-10 COMPLETE 8-6-10 10:25 am

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL	METHOD
8-6-10	10:25 am	21	--	15	10	3.25" ID Hollow Stem Auger
8-25-10	9:30 am	21	--	11.5	11	
--	--	--	--	--	--	
--	--	--	--	--	--	CREW CHIEF Roy Hanson

GEOTECHNICAL TEST BORING 10-870.GPJ GEOTEKENG.GDT 9/28/10



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GEOTECHNICAL TEST BORING LOG

GEOTEK # 10-870

BORING NO. 12-14 (1 of 1)

PROJECT Proposed TWS Segment 12, Lewis & Clark Regional Water System, Near Beresford, SD

DEPTH in FEET	DESCRIPTION OF MATERIAL	GEOLOGIC ORIGIN	N	WL	SAMPLE		LABORATORY TESTS					
					NO.	TYPE	WC	D	LL	PL	QU	
	ORGANIC LEAN CLAY: black, moist, soft to firm, (OL)	SLOPE WASH			1	HSA						
			3		2	SPT						
			6		3	SPT						
7	LEAN CLAY: dark grayish brown, moist, soft, (CL)	FINE ALLUVIUM			4	SH	26	95				
			4	▼	5	SPT						
			3		6	SPT						
14	LEAN CLAY: grayish brown, moist, soft, (CL)	FINE ALLUVIUM			7	SPT						
16	LEAN CLAY: brownish gray, moist, soft, (CL)	FINE ALLUVIUM										
			4		8	SPT						
21	Bottom of borehole at 21 feet.											

WATER LEVEL MEASUREMENTS

START 8-6-10 COMPLETE 8-6-10 11:35 am

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL	METHOD
8-6-10	11:35 am	21	--	18	10	3.25" ID Hollow Stem Auger
8-25-10	9:25 am	21	--	14.5	▼ 10.5	
--	--	--	--	--	--	
--	--	--	--	--	--	

CREW CHIEF Roy Hanson

GEOTECHNICAL TEST BORING 10-870.GPJ GEOTEKENG.GDT 9/24/10



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GEOTECHNICAL TEST BORING LOG

DEPTH in FEET		DESCRIPTION OF MATERIAL	GEOLOGIC ORIGIN	N	WL	SAMPLE		LABORATORY TESTS										
						NO.	TYPE	WC	D	LL	PL	QU						
		FILL, MOSTLY CLAY: brown and black, moist	FILL			1	HSA											
4 1/2		ORGANIC LEAN CLAY: black, moist, soft, (OL)	TOPSOIL	7		2	SPT											
7		LEAN CLAY: brownish gray, moist, soft, (CL)	FINE ALLUVIUM	4		3	SPT											
9		SAND: a trace of gravel, medium grained, brown, waterbearing, dense, (SP)	COARSE ALLUVIUM	4		4	SPT											
12		SAND: medium grained, brown, waterbearing, medium dense, (SP)	COARSE ALLUVIUM	17		5	SPT											
14		SAND: a little gravel, medium grained, brown, waterbearing, dense to medium dense, (SP)	COARSE ALLUVIUM	12		6	SPT											
21		Bottom of borehole at 21 feet.		16		7	SPT											
				13		8	SPT											
WATER LEVEL MEASUREMENTS					START	8-6-10	COMPLETE	8-6-10 1:05 pm										
DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL	METHOD												
8-6-10	1:05 pm	21	--	9	3.5	3.25" ID Hollow Stem Auger												
8-25-10	9:20 am	21	--	4.5	3.5													
--	--	--	--	--	--													
--	--	--	--	--	--	CREW CHIEF Roy Hanson												

GEOTECHNICAL TEST BORING 10-870.GPJ GEOTEKENG.GDT 9/24/10



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GEOTECHNICAL TEST BORING LOG

GEOTEK # 10-870

BORING NO. 12-16 (1 of 1)

PROJECT Proposed TWS Segment 12, Lewis & Clark Regional Water System, Near Beresford, SD

DEPTH in FEET	DESCRIPTION OF MATERIAL	GEOLOGIC ORIGIN	N	WL	SAMPLE		LABORATORY TESTS								
					NO.	TYPE	WC	D	LL	PL	QU				
2	LEAN CLAY: black, moist, (CL)	TOPSOIL			1	HSA									
3 1/2	LEAN CLAY: brown, moist, firm, (CL)	FINE ALLUVIUM	5		2	SPT									
	SAND: a trace of gravel, medium grained, brown, waterbearing, very loose to medium dense, (SP)	COARSE ALLUVIUM	3		3	SPT									
			11		4	SPT									
9	SAND: a little gravel, medium grained, brown, waterbearing, dense to medium dense, (SP)	COARSE ALLUVIUM	20		5	SPT									
			13		6	SPT									
14	SAND: a little gravel, medium to coarse grained, brown, waterbearing, medium dense to loose, (SP)	COARSE ALLUVIUM	12		7	SPT									
			8		8	SPT									
21	Bottom of borehole at 21 feet.														

WATER LEVEL MEASUREMENTS

START 8-6-10 COMPLETE 8-6-10 2:05 pm

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL	METHOD
8-6-10	2:05 pm	21	--	3	1	3.25" ID Hollow Stem Auger
8-25-10	9:15 am	21	--	2.5	1.5	
--	--	--	--	--	--	
--	--	--	--	--	--	CREW CHIEF Roy Hanson

GEOTECHNICAL TEST BORING 10-870.GPJ GEOTEKENG.GDT 9/28/10



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GEOTECHNICAL TEST BORING LOG

GEOTEK # 10-870

BORING NO. 12-17 (1 of 1)

PROJECT Proposed TWS Segment 12, Lewis & Clark Regional Water System, Near Beresford, SD

DEPTH in FEET	DESCRIPTION OF MATERIAL	GEOLOGIC ORIGIN	N	WL	SAMPLE		LABORATORY TESTS							
					NO.	TYPE	WC	D	LL	PL	QU			
0	<u>LEAN CLAY</u> : black, moist, (CL)	TOPSOIL				1	HSA							
2	<u>LEAN CLAY</u> : dark brown, moist, firm, (CL)	FINE ALLUVIUM	5			2	SPT							
4	<u>SAND</u> : a trace of gravel, fine to medium grained, brown, moist, very loose to loose, (SP)	COARSE ALLUVIUM	4			3	SPT							
			5			4	SPT							
9	<u>SAND</u> : a trace of gravel, medium grained, brown, waterbearing, dense, (SP)	COARSE ALLUVIUM	16		▼	5	SPT							
			16			6	SPT							
14	<u>SAND</u> : a little gravel, medium to coarse grained, brown, waterbearing, dense, (SP)	COARSE ALLUVIUM	22			7	SPT							
			26			8	SPT							
21	Bottom of borehole at 21 feet.													


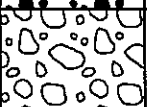

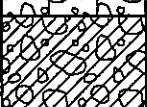

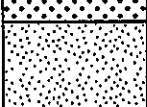
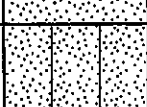

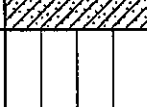

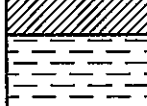




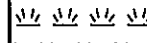
WATER LEVEL MEASUREMENTS

START 8-6-10 COMPLETE 8-6-10 3:00 pm

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL	METHOD
8-6-10	3:00 pm	21	--	10	10	3.25" ID Hollow Stem Auger
8-25-10	9:10 am	21	--	9.5	▼ 9.5	
--	--	--	--	--	--	
--	--	--	--	--	--	CREW CHIEF Roy Hanson

GEOTECHNICAL TEST BORING 10-870.GPJ GEOTEKENG.GDT 8/28/10

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 CLEAN GRAVELS (LITTLE OR NO FINES)	(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	
				GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES	
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)	(LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
					SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
					SM	SILTY SANDS, SAND - SILT MIXTURES
SANDS WITH FINES MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	(APPRECIABLE AMOUNT OF FINES)		SC	CLAYEY SANDS, SAND - CLAY MIXTURES		
			GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES		
			GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES		
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS LIQUID LIMIT LESS THAN 50	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	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

<u>Symbol</u>	<u>Definition</u>
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

<u>Symbol</u>	<u>Definition</u>
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

<u>Density</u>	<u>N-Value</u>	<u>Consistency</u>
<u>Term</u>		<u>Term</u>
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

<u>Term</u>	<u>Particle Size</u>
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

<u>Term</u>	<u>Definition</u>
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 1/2" thick stratum
Layer	1/2" to 6" thick stratum
Lens	1/2" to 6" discontinuous stratum

GRAVEL PERCENTAGES

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