GEOTEK ENGINEERING
& TESTING SERVICES, INC.
909 East 50th Street North
Sioux Falls, South Dakota 57104
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December 10, 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 MCWC East
Lewis and Clark Regional Water System
Near Sioux Falls, South Dakota
BAI No. 20000.14.01
GeoTek #10-D99

This correspondence presents our report of the geotechnical exploration program for the referenced project. We performed our work in accordance with the authorization of Keith Winter dated October 27, 2010. The project site is generally located along Six Mile Road from 269th Street (69th Street) to just north of SD Highway 42, about one mile east of Sioux Falls, South Dakota. The locations for the test borings were provided by Banner Associates and are shown on the attached site maps.

We performed six (6) test borings for the project on November 16 and November 17, 2010. 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 2 feet to 14 feet of existing fill and topsoil materials at the surface overlying mostly lean clay with sand (glacial till) soils that extended to the termination depth of the borings. Lean clay (fine alluvium) soils were encountered above the glacial till at boring #4. Lean clay (loess) soils were encountered above the glacial till at borings #5 and #6. 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 very stiff. 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 2 ½ feet to 12 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 Six Mile Road from 269th Street (69th Street) to just north of SD Highway 42, about one mile east of Sioux Falls, South Dakota. 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 clay soils. Areas of wet or soft soils may 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 likey 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 organic soil materials should be replaced with suitable material available at the project site or with suitable off-site borrow soils. The wet soils should either be dried to a water content that facilitates compaction or 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.

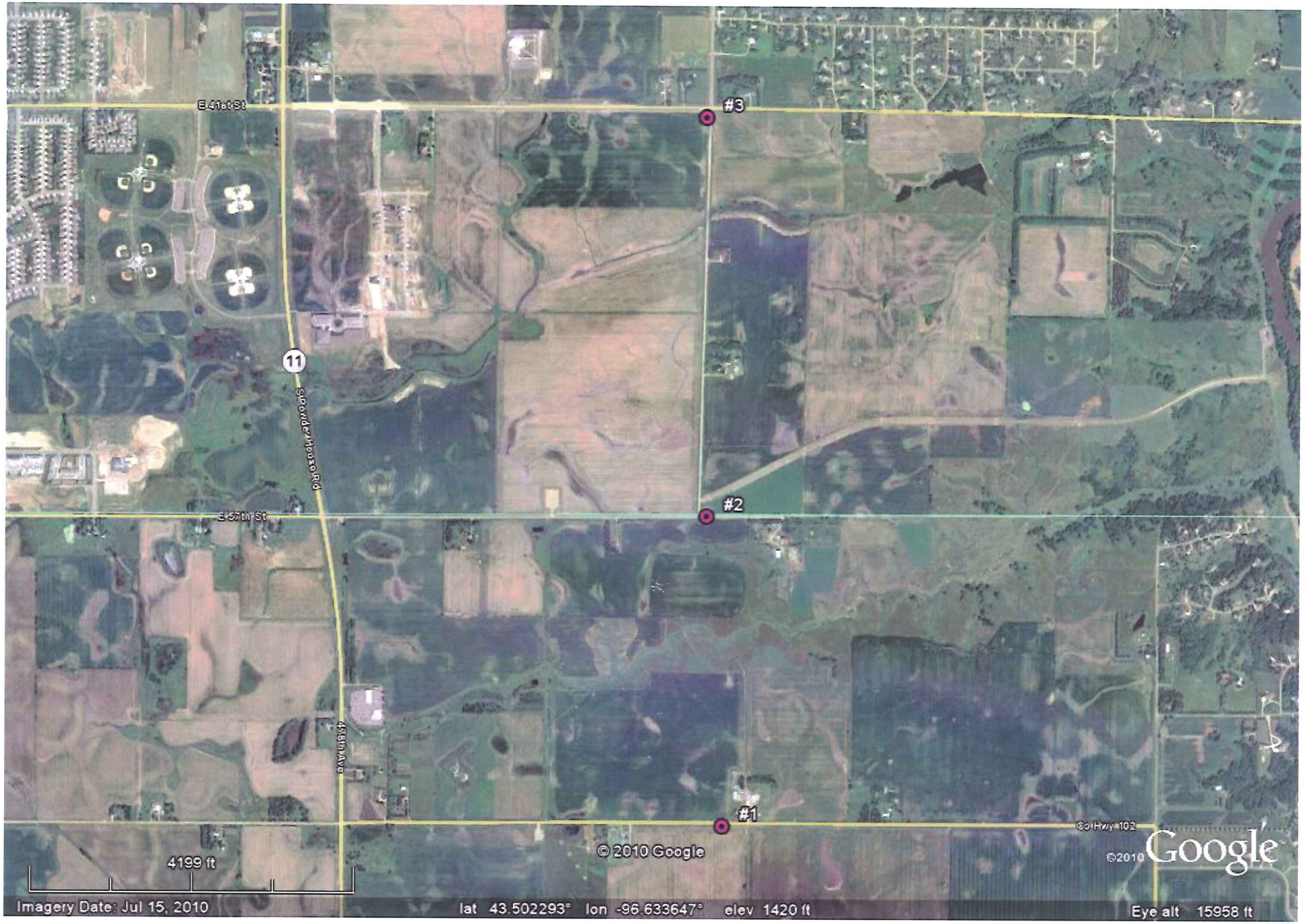
Jeff Christensen, PE
Geotechnical Manager

Cc: Banner Associates, Inc. – Rapid City
Attn: Keith Winter

LABORATORY TEST RESULTS

Boring	Depth (ft)	Soil Type	pH	Chloride (mg/kg)	Sulfate (mg/kg)	Resistivity (ohm-cm)
1	7'-8.5'	Lean Clay with Sand	8.5	9	15	6290
2	7'-8.5'	Lean Clay with Sand	8.3	7	180	3180
3	7'-8.5'	Lean Clay with Sand	8.1	263	17	1880
4	7'-8.5'	Fill, Mostly Clay	8.3	32	23	4570
5	4.5'-6'	Lean Clay	7.4	220	31	2410
6	7'-8.5'	Lean Clay	8.3	204	13	2380


#6
#5
#4
#3
#2
#1
Arrowhead Pkwy
E 18th St
E 29th St
E 41st St
E 49th St
E 57th St
County Rd 148
East Sioux Fa
S Cleveland Ave
S Bahnson Ave
S Southeastern Ave
S Sycamore Ave
S Riverview Ave
Southeastern Cir
476th Ave
229
11
42
7631 ft
© 2010 Google
©2010 Google
Imagery Date: Jul 15, 2010
lat 43.515096° lon -96.649340° elev 1502 ft
Eye alt 27879 ft


E 41st St
#3
11
S Sioux Prairie Rd
E 57th St
#2
485th Ave
#1
Co Hwy 102
4199 ft
© 2010 Google
©2010 Google
Imagery Date: Jul 15, 2010
lat 43.502293° lon -96.633647° elev 1420 ft
Eye alt 15958 ft


#6
#5
#4
42
County Rd 148
E 96th St
S Powderhorn Rd
2275 ft
© 2010 Google
©2010 Google
Imagery Date: Jul 15, 2010
lat 43.533743° lon -96.637487° elev 1410 ft
Eye alt 9398 ft

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GEOTECHNICAL TEST BORING LOG

GEOTEK # **10-D99** BORING NO. **1 (1 of 1)**

PROJECT **Proposed MCWC East, Lewis & Clark Regional Water System, Near Sioux Falls, SD**

DEPTH in FEET	DESCRIPTION OF MATERIAL	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	LAB WC	LAB D	LAB LL	LAB PL	LAB QU
	FILL, MOSTLY CLAY: brown and black, moist	FILL			1	HSA					
			8		2	SPT					
4½	**LEAN CLAY WITH SAND**: a trace of gravel, brown and gray mottled, moist, soft, (CL)	GLACIAL TILL	3	▼	3	SPT	27	97			
7	**LEAN CLAY WITH SAND**: a little gravel, brown, moist, stiff, (CL)	GLACIAL TILL	10		4	SPT					
			9		5	SPT					
			10		6	SPT					
			14		7	SPT					
			12		8	SPT					
26	Bottom of borehole at 26 feet.		15		9	SPT					

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL
11-16-10	10:05 am	26	--	23	17
11-24-10	12:10 pm	26	--	12	▼ 6
--	--	--	--	--	--
--	--	--	--	--	--

START 11-16-10 COMPLETE 11-16-10 10:05 am

METHOD
3.25" ID Hollow Stem Auger

CREW CHIEF Roy Hanson

GEOTECHNICAL TEST BORING 10-D99.GPJ GEOTEKENG.GDT 11/24/10

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GEOTECHNICAL TEST BORING LOG

GEOTEK # 10-D99 BORING NO. 2 (1 of 1)

PROJECT Proposed MCWC East, Lewis & Clark Regional Water System, Near Sioux Falls, SD

DEPTH in FEET	DESCRIPTION OF MATERIAL	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	LABORATORY TESTS WC	D	LL	PL	QU
	FILL, MOSTLY CLAY: black, moist, 7" layer of gravel at the surface	FILL			1	HSA					
			6	▼	2	SPT					
4	LEAN CLAY WITH SAND: a trace of gravel, grayish brown, moist, firm, a lens of sand below 5' (CL)	GLACIAL TILL	7		3	SPT	23				
7	LEAN CLAY WITH SAND: a little gravel, brown, moist, firm, a lens of sand below 7' (CL)	GLACIAL TILL	6		4	SPT					
			8		5	SPT					
12	LEAN CLAY WITH SAND: a little gravel, dark brown, moist, stiff, (CL)	GLACIAL TILL	11		6	SPT					
			14		7	SPT					
			13		8	SPT					
24	LEAN CLAY WITH SAND: a little gravel, dark gray, moist, stiff, (CL)	GLACIAL TILL	14		9	SPT					
26	Bottom of borehole at 26 feet.										

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL
11-16-10	11:05 am	26	--	24	5.5
11-24-10	12:30 pm	26	--	7	▼ 3.5
--	--	--	--	--	--
--	--	--	--	--	--

START 11-16-10 COMPLETE 11-16-10 11:05 am

METHOD
3.25" ID Hollow Stem Auger

CREW CHIEF Roy Hanson

GEOTECHNICAL TEST BORING 10-D99.GPJ GEOTEKENG.GDT 11/24/10

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GEOTECHNICAL TEST BORING LOG

GEOTEK # 10-D99 BORING NO. 3 (1 of 1)

PROJECT Proposed MCWC East, Lewis & Clark Regional Water System, Near Sioux Falls, SD

DEPTH in FEET	DESCRIPTION OF MATERIAL	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	LABORATORY TESTS WC	D	LL	PL	QU
	FILL, MIXTURE OF CLAY AND GRAVEL: black and pink, moist	FILL			1	HSA					
2	**LEAN CLAY WITH SAND**: a trace of gravel, brown, moist, soft, (CL)	GLACIAL TILL	4	▼	2	SPT	26				
4	**LEAN CLAY WITH SAND**: a little gravel, brown, moist, firm to stiff, (CL)	GLACIAL TILL	7		3	SPT	22	105			
			9		4	SPT					
			11		5	SPT					
			12		6	SPT					
			11		7	SPT					
			18		8	SPT					
24	**LEAN CLAY**: brown, wet, soft, (CL)	GLACIAL TILL	4		9	SPT					
26	Bottom of borehole at 26 feet.										

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL
11-16-10	1:15 pm	26	--	24	23
11-24-10	12:35 pm	26	--	7.5	▼ 2.5
--	--	--	--	--	--
--	--	--	--	--	--

START 11-16-10 COMPLETE 11-16-10 1:15 pm

METHOD
3.25" ID Hollow Stem Auger

CREW CHIEF Roy Hanson

GEOTECHNICAL TEST BORING 10-D99.GPJ GEOTEKENG.GDT 11/24/10

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GEOTECHNICAL TEST BORING LOG

GEOTEK # 10-D99 BORING NO. 4 (1 of 1)

PROJECT Proposed MCWC East, Lewis & Clark Regional Water System, Near Sioux Falls, SD

DEPTH in FEET	DESCRIPTION OF MATERIAL	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	LABORATORY TESTS WC	D	LL	PL	QU
	FILL, MOSTLY CLAY: brown and black, moist	FILL			1	HSA					
			7		2	SPT					
			3		3	SPT	28				
			5		4	SPT					
			5		5	SPT					
			6	▼	6	SPT					
14	LEAN CLAY WITH SAND: a little gravel, brown, moist, firm to stiff, (CL)	GLACIAL TILL	7		7	SPT					
			13		8	SPT					
			22		9	SPT					
26	Bottom of borehole at 26 feet.										

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL
11-16-10	3:20 pm	26	--	24	18
11-24-10	12:45 pm	26	--	17	▼ 12
--	--	--	--	--	--
--	--	--	--	--	--

START 11-16-10 COMPLETE 11-16-10 3:20 pm

METHOD
3.25" ID Hollow Stem Auger

CREW CHIEF Roy Hanson

GEOTECHNICAL TEST BORING 10-D99.GPJ GEOTEKENG.GDT 11/24/10

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GEOTECHNICAL TEST BORING LOG

GEOTEK # 10-D99 BORING NO. 5 (1 of 1)

PROJECT Proposed MCWC East, Lewis & Clark Regional Water System, Near Sioux Falls, SD

DEPTH in FEET	DESCRIPTION OF MATERIAL	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	LABORATORY TESTS WC	D	LL	PL	QU
	FILL, MOSTLY CLAY: brown and black, moist	FILL			1	HSA					
			14		2	SPT					
4½	LEAN CLAY: dark brown, moist, stiff to firm, (CL)	LOESS	11		3	SPT					
7	LEAN CLAY: brown, moist, firm, (CL)	LOESS	5		4	SPT	22				
			6		5	SPT					
			7		6	SPT					
			7		7	SPT					
			4		8	SPT					
24	LEAN CLAY WITH SAND: a little gravel, brown, wet, very stiff, (CL)	GLACIAL TILL	25		9	SPT					
26	Bottom of borehole at 26 feet.										

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL
11-17-10	9:15 am	26	--	24	none
11-24-10	12:50 pm	26	--	24	none
--	--	--	--	--	--
--	--	--	--	--	--

START 11-17-10 COMPLETE 11-17-10 9:15 am

METHOD
3.25" ID Hollow Stem Auger

CREW CHIEF Roy Hanson

GEOTECHNICAL TEST BORING 10-D99.GPJ GEOTEKENG.GDT 11/24/10

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GEOTECHNICAL TEST BORING LOG

GEOTEK # 10-D99 BORING NO. 6 (1 of 1)

PROJECT Proposed MCWC East, Lewis & Clark Regional Water System, Near Sioux Falls, SD

DEPTH in FEET	DESCRIPTION OF MATERIAL	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	LABORATORY TESTS WC	D	LL	PL	QU
	FILL, MOSTLY CLAY: brown and black, moist	FILL			1	HSA					
			11		2	SPT					
3½	LEAN CLAY: brown, moist, firm, (CL)	LOESS									
			6		3	SPT	24				
			5		4	SPT					
9	LEAN CLAY WITH SAND: a trace of gravel, grayish brown, moist, firm to stiff, a few lenses of sand below 10' (CL)	GLACIAL TILL	6	▼	5	SPT					
			8		6	SPT					
			11		7	SPT					
19	LEAN CLAY WITH SAND: a little gravel, brown, moist, very stiff, (CL)	GLACIAL TILL	17		8	SPT					
			27		9	SPT					
26	Bottom of borehole at 26 feet.										

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL
11-17-10	10:15 am	26	--	23	19
11-24-10	12:55 pm	26	--	13	▼ 12
--	--	--	--	--	--
--	--	--	--	--	--

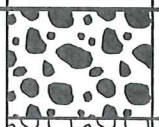
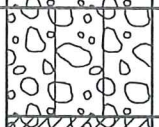
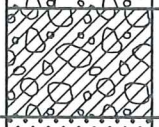
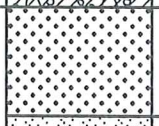
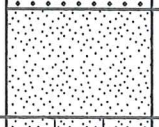
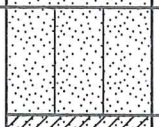
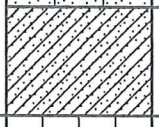
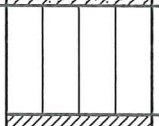
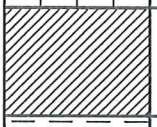
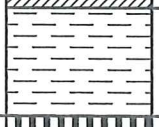
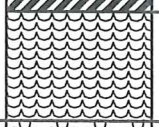
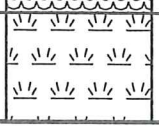
START 11-17-10 COMPLETE 11-17-10 10:15 am

METHOD
3.25" ID Hollow Stem Auger

CREW CHIEF Roy Hanson

GEOTECHNICAL TEST BORING 10-D99.GPJ GEOTEKENG.GDT 11/24/10

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

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

BORING LOG SYMBOLS AND DESCRIPTIVE TERMINOLOGY

SYMBOLS FOR DRILLING AND SAMPLING

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

SYMBOLS FOR LABORATORY TESTS

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

DENSITY/CONSISTENCY TERMINOLOGY

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

PARTICLE SIZES

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

DESCRIPTIVE TERMINOLOGY

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

GRAVEL PERCENTAGES

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