



**GEOTEK ENGINEERING  
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APR 05 2011

April 4, 2011

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

Attn: Mr. Tim Conner

Subj: Supplemental Test Boring  
River Crossing  
Proposed Treated Water Pipeline Iowa Segment 2  
Lewis and Clark Regional Water System  
SD Border to Sioux Center, Iowa  
BAI No. 20000.21.01  
GeoTek #10-B93

This correspondence presents our report of our recent supplemental test boring for the referenced project. We performed our work in accordance with the authorization of Dennis Odens.

The project site is generally located at the Big Sioux River Crossing that will connect the South Dakota Segment 12 and the Iowa Segment 2 treated water pipelines. We performed one (1) test boring for Iowa Segment 2 on March 12, 2011. The test boring was located on the Iowa side of the Big Sioux River in the vicinity of the proposed pipeline alignment. We placed a wood lathe next to the boring location for the survey crew to find. We also drilled one (1) test boring on the South Dakota side of the river and the results will be submitted in a separate report.

The subsurface conditions encountered at the test boring location are illustrated by means of the boring log attached to this report. The subsurface conditions encountered at the boring location consist of 3 ½ feet of topsoil overlying lean clay (fine alluvium) soils that extended to 5 ½ feet. Sand (coarse alluvium) soils were encountered beneath the lean clay soils and extended to 28 feet. We encountered shale (Carlisle Shale) beneath the 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 location.

We performed a measurement to record the groundwater level at the boring location at the time the boring was completed. The time and level of the groundwater reading is recorded on the boring log. We measured groundwater at a depth of 7 feet at the boring location.

It is our opinion that the groundwater measurement is likely an accurate indication of the groundwater level at the time the measurement was taken due to the permeable characteristics of the sand soils. 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 reading recorded at the boring. 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 boring was 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. The test results are shown on the attached data sheet.

We understand the project will consist of a river crossing for the South Dakota Segment 12 and the Iowa Segment 2 treated water pipelines. The purpose for the supplemental test borings is to provide subsurface information for potential construction methods for the river crossing.

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. – St. Peter, MN  
Attn: Dennis Odens, PE

**LABORATORY TEST RESULTS**

<b>Boring</b>	<b>Depth (ft)</b>	<b>Soil Type</b>	<b>Resistivity, ohm-cm (ASTM:G187)</b>	
			<b>As Received</b>	<b>Saturated</b>
25	14.5-16	Sand	5,500	Already Saturated
25	19.5-21	Sand	8,300	Already Saturated

<b>Boring</b>	<b>Depth (ft)</b>	<b>Soil Type</b>	<b>pH</b>	<b>Chloride (mg/kg)</b>	<b>Sulfate (mg/kg)</b>
25	5.5-6	Sand	9.1	10	11
25	24.5-26	Sand	9.1	11	26







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# GEOTECHNICAL TEST BORING LOG

GEOTEK # **10-B93**

BORING NO. **25 (2 of 2)**

PROJECT **Proposed TWP Iowa Segment 2, Lewis & Clark Regional Water System, SD Border to Sioux Center, IA**

DEPTH in FEET	DESCRIPTION OF MATERIAL	GEOLOGIC ORIGIN	N	WL	SAMPLE		LABORATORY TESTS								
					NO.	TYPE	WC	D	LL	PL	QU				
28	~ 1164 <b>SHALE: FAT CLAY:</b> dark gray, moist, hard, (CH)	CARLILE SHALE				8	X SPT								
			50/0.8'			9	HSA								
36	Bottom of borehole at 36 feet.														

**WATER LEVEL MEASUREMENTS**

START 3-12-11 COMPLETE 3-12-11 10:40 am

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL	METHOD
3-12-11	10:50 am	--	--	--	▼ 7	3.25" I.D. HOLLOW STEM AUGER
--	--	--	--	--	--	
--	--	--	--	--	--	
--	--	--	--	--	--	

CREW CHIEF **Dan Hanson**

GEOTECHNICAL TEST BORING 10-B93.GPJ GEOTEKENG.GDT 3/22/11

# SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTIONS	
			GRAPH	LETTER		
<b>COARSE GRAINED SOILS</b>  MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	<b>GRAVEL AND GRAVELLY SOILS</b>  MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	<b>CLEAN GRAVELS</b>  (LITTLE OR NO FINES)		<b>GW</b>	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES	
		<b>GRAVELS WITH FINES</b>  (APPRECIABLE AMOUNT OF FINES)		<b>GP</b>	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES	
		<b>CLEAN SANDS</b>  (LITTLE OR NO FINES)		<b>SW</b>	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	
		<b>SANDS WITH FINES</b>  (APPRECIABLE AMOUNT OF FINES)		<b>SP</b>	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES	
	<b>FINE GRAINED SOILS</b>  MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	<b>SILTS AND CLAYS</b>  LIQUID LIMIT LESS THAN 50	<b>CLEAN SANDS</b>  (LITTLE OR NO FINES)		<b>SM</b>	SILTY SANDS, SAND - SILT MIXTURES
			<b>SANDS WITH FINES</b>  (APPRECIABLE AMOUNT OF FINES)		<b>SC</b>	CLAYEY SANDS, SAND - CLAY MIXTURES
			<b>SILTS AND CLAYS</b>  LIQUID LIMIT LESS THAN 50		<b>ML</b>	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
		<b>SILTS AND CLAYS</b>  LIQUID LIMIT GREATER THAN 50	<b>SILTS AND CLAYS</b>  LIQUID LIMIT LESS THAN 50		<b>CL</b>	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			<b>SILTS AND CLAYS</b>  LIQUID LIMIT LESS THAN 50		<b>OL</b>	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
			<b>SILTS AND CLAYS</b>  LIQUID LIMIT GREATER THAN 50		<b>MH</b>	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
<b>HIGHLY ORGANIC SOILS</b>	<b>SILTS AND CLAYS</b>  LIQUID LIMIT GREATER THAN 50		<b>CH</b>	INORGANIC CLAYS OF HIGH PLASTICITY		
	<b>SILTS AND CLAYS</b>  LIQUID LIMIT GREATER THAN 50		<b>OH</b>	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS		
	<b>HIGHLY ORGANIC SOILS</b>		<b>PT</b>	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 Term</u>	<u>N-Value</u>	<u>Consistency 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%