TEST BORINGS & LABORATORY TESTS PROPOSED TREATED WATER PIPELINE IOWA SEGMENTS 4 & 5 LEWIS & CLARK REGIONAL WATER SYSTEM HULL TO SHELDON, IOWA GEOTEK #20-K94





GEOTEK ENGINEERING & TESTING SERVICES, INC.

909 East 50th Street North Sioux Falls, South Dakota 57104 Phone 605-335-5512 Fax 605-335-0773

December 28, 2020

Banner Associates, Inc. 2307 W. 57th Street, Suite 102 Sioux Falls, South Dakota 57108

Attn: Scott Vander Meulen, PE, LS

Subj: Test Borings & Laboratory Tests Proposed Treated Water Pipeline Iowa Segments 4 & 5 Lewis & Clark Regional Water System Hull to Sheldon, Iowa GeoTek #20-K94

Introduction

This correspondence presents our reporting of the recent test borings and laboratory tests for the referenced project. Our work was performed in accordance with your authorization.

Project Information

We understand that the project will consist of installing a treated water pipeline (Iowa Segments 4 and 5). The project begins just south of Hull, Iowa and extends to Sheldon, Iowa.

Test Borings

We performed 19 test borings on December 8, December 9 and December 10, 2020. Table 1 shows the Northings, Eastings and ground surface elevations at the test boring locations (provided by Banner Associates, Inc.). Four (4) test boring location maps (Figures 1 through 4) are also attached showing the relative location of the test borings.

Test Boring	Northing	Easting	Ground Surface Elevation, ft
4-1	3900933.172	4217773.468	1,467.2
4-2	3900524.954	4229200.253	1,377.7
4-3	3905720.995	4233467.888	1,409.5
4-4	3905860.654	4233431.011	1,412.6
4-5	3911142.777	4235023.665	1,412.6

Table 1. Northings, Eastings & Ground Surface Elevations

Test Boring	Northing	Easting	Ground Surface Elevation, ft
4-6	3910722.701	4246678.811	1,422.6
4-7	3910577.455	4249125.873	1,406.7
4-8	3910458.395	4251836.437	1,433.6
4-9	3910619.574	4251985.176	1,440.7
4-10	3910436.728	4254300.797	1,420.5
5-1	3910151.919	4265109.331	1,422.8
5-2	3909792.777	4275461.925	1,438.5
5-3	3909688.374	4277632.510	1,477.6
5-4	3909224.215	4291391.134	1,389.2
5-5	3907055.570	4291953.092	1,375.8
5-6	3907015.779	4292383.221	1,377.3
5-7	3906940.610	4293216.496	1,384.9
5-8	3906860.998	4294172.680	1,382.0
5-9	3906757.971	4294555.031	1,390.9

 Table 1 (Continued). Northings, Eastings & Ground Surface Elevations

Subsurface Conditions

The subsurface profile at the test boring locations consisted of the following soil types: topsoil materials, existing fill materials, loess soils, fine alluvium soils, mixed alluvium soils, coarse alluvium soils, glacial outwash soils and glacial till soils.

The topsoil materials were encountered at the majority of the test borings (15 out of 19) and extended to depths varying from 1 ½ feet to 5 feet. The existing fill materials were only encountered at test borings 4-4, 4-6, 5-2 and 5-7. The existing fill materials extended to depths varying from 1 foot to 4 ½ feet. The loess soils were encountered at about half of the test borings (9 out of 19). The fine alluvium soils were also encountered at test boring 5-4, 5-5, 5-6 and 5-8. The coarse alluvium soils were only encountered at test borings 5-4, 5-8 and 5-9. The glacial outwash soils were only encountered at test boring 5-7. The glacial till soils were encountered at the majority of the test borings (16 out of 19).

The topsoil materials consisted of lean clay (CL). The existing fill materials consisted of lean clay (CL) and lean clay with sand (CL). The loess soils consisted of lean clay (CL) and fat clay (CH). The fine alluvium soils consisted of lean clay (CL), fat clay (CH) and lean clay with sand (CL). The mixed alluvium soils consisted of sandy lean clay (CL) and clayey sand (SC). The coarse alluvium soils consisted of sand with silt (SP-SM) and sand (SP). The glacial outwash soils consisted of sand with silt (SP-SM). The glacial till soils consisted of lean clay (CL), lean clay with sand (CL), fat clay with sand (CH) and sandy lean clay (CL).

The consistency/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/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 along the length of the project may differ from those found at our test boring locations.

Water Levels

Measurements to record the groundwater levels were made at the test boring locations. Delayed groundwater readings were made at all of the test borings except for test boring 4-6 (located within a road). The time and level of the groundwater readings are recorded on the boring logs. Also, a summary of the groundwater levels is shown in Table 2.

Test Boring	Ground Surface Elevation, ft	Groundwater Level, ft	Elevation of Groundwater, ft
4-1	1,467.2	14	1,453.2
4-2	1,377.7	4	1,373.7
4-3	1,409.5	13	1,396.5
4-4	1,412.6	14	1,398.6
4-5	1,412.6	7	1,405.6
4-6	1,422.6	Dry to the Termination Depth	N/A
4-7	1,406.7	7	1,399.7
4-8	1,433.6	Dry to the Termination Depth	N/A
4-9	1,440.7	Dry to the Termination Depth	N/A
4-10	1,420.5	10	1,410.5
5-1	1,422.8	11	1,411.8
5-2	1,438.5	Dry to the Termination Depth	N/A
5-3	1,477.6	Dry to the Termination Depth	N/A
5-4	1,389.2	10 1/2	1,378.7
5-5	1,375.8	5	1,370.8
5-6	1,377.3	6	1,371.3
5-7	1,384.9	12	1,372.9
5-8	1,382.0	9	1,373.0
5-9	1,390.9	8	1,382.9

Table 2. Groundwater Levels

Note: A delayed groundwater reading was not made at test boring 4-6 (located within a road).

The water levels may or may not be an accurate indication of the depth or lack of subsurface groundwater. The limited length of observation restricts the accuracy of the measurements. Long term groundwater monitoring was not included in our scope of work.

Resistivity, pH, Chloride Content & Sulfate Content Results

Twenty (20) soil samples were collected from test borings (2 samples from test boring 5-2) and were submitted for resistivity, pH, chloride content and sulfate content testing. The results of the laboratory tests are shown in Table 3.

Test Boring	Depth (ft)	Soil Type	Resistivity (ohm-cm) (as-received)	Resistivity (ohm-cm) (saturated)	pН	Chloride (mg/kg)	Sulfate (mg/kg)
4-1	$7 - 8\frac{1}{2}$	Lean Clay w/ Sand (GT)	1,675	1,608	8.5	3	7
4-2	$7 - 8\frac{1}{2}$	Lean Clay (FA)	1,474	1,474	8.0	4	29
4-3	$7 - 8\frac{1}{2}$	Lean Clay w/ Sand (GT)	1,139	1,072	8.5	18	31
4-4	12 - 13 1/2	Lean Clay w/ Sand (GT)	1,206	1,206	8.4	8	13
4-5	$7 - 8\frac{1}{2}$	Sandy Lean Clay (GT)	>737,000	3,685	8.5	6	32
4-6	$7 - 8\frac{1}{2}$	Lean Clay (FA)	1,340	1,340	8.4	8	46
4-7	9 ¹ ∕₂ − 11	Lean Clay (FA)	1,608	1,273	8.1	3	24
4-8	9 ¹ ∕₂ − 11	Lean Clay w/ Sand (GT)	1,675	1,608	8.5	8	13
4-9	9 ¹ / ₂ – 11	Lean Clay w/ Sand (GT)	1,809	1,675	8.6	12	29
4-10	9 ¹ ∕₂ − 11	Lean Clay w/ Sand (GT)	2,010	2,010	8.7	10	20
5-1	9 ½ − 11	Lean Clay w/ Sand (GT)	1,809	1,675	8.5	10	21
5-2	$7 - 8\frac{1}{2}$	Lean Clay (L)	1,675	1,675	8.2	7	11
5-2	9 ½ − 11	Lean Clay w/ Sand (GT)	1,608	1,541	8.4	4	15
5-3	$7 - 8\frac{1}{2}$	Lean Clay w/ Sand (GT)	1,541	1,474	8.5	11	12
5-4	9 ¹ / ₂ – 11	Sandy Lean Clay (MA)	5,762	4,690	8.5	4	14
5-5	12 - 13 1/2	Lean Clay w/ Sand (GT)	1,139	1,072	8.5	6	251
5-6	14 ½ – 16	Lean Clay w/ Sand (GT)	1,072	1,005	8.5	5	398
5-7	9 ¹ / ₂ - 11	Lean Clay w/ Sand (GT)	1,474	1,407	8.6	10	27
5-8	$7 - 8\frac{1}{2}$	Lean Clay w/ Sand (FA)	1,675	1,675	8.7	8	22
5-9	9 ¹ ⁄₂ − 11	Lean Clay w/ Sand (GT)	1,541	1,474	8.6	7	21

Table 3. Laboratory Test Results

Note: L – loess soils, FA – fine alluvium soils, MA – mixed alluvium soils and GT – glacial till soils.

Discussion

The subgrade soils anticipated at the invert depths for the pipeline will consist of mostly clay soils and some sand soils (sand soils were only encountered near Sheldon). Where soils having moderate moisture and density values are encountered at the bottom of the trench excavations, it is our opinion that the soils are considered suitable for support of the pipeline, provided they are adequately dewatered, and are not disturbed by construction traffic. Localized areas of wet or soft soils may be encountered at the bottom of the trench excavations. These areas will require subexcavation and trench stabilization methods and materials. Appropriate bedding materials

should be used for the pipeline. Some subexcavation and trench stabilization methods and materials may be needed at and around test borings 4-7 and 5-8 (areas where soft or wet soils are near the invert depths of the pipeline).

Water may enter the trench excavations as a result of subsurface water, precipitation or surface run off. Dewatering procedures may be required in order to control and remove water during the excavation for the pipeline. Where clay soils are encountered, it may be possible to remove and control water entering the trench excavations using normal sump pumping techniques. However, where waterbearing sand soils are encountered, extensive dewatering techniques will likely be required due to the potentially large volumes of water. The contractor should provide appropriate dewatering methods and equipment. It should be noted that groundwater was encountered at the majority of the test borings (see Table 2). Also, wet or waterbearing sand soils were generally encountered near Sheldon. Any water that accumulates at the bottom of the trench excavations should be immediately removed and surface drainage away from the trench excavations should be provided during construction.

A portion of the soils encountered in the trench excavations may not be suitable or ideal for use as trench backfill. The unsuitable soils would consist of organic soils as well as soils having high moisture content levels such that the specified compaction level cannot be reasonably achieved. The organic 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 site or with suitable off-site borrow soils. Based on the moisture content levels, the majority of the loess soils and fine alluvium soils will require significant drying. Some drying may be needed with the existing fill materials, mixed alluvium soils and glacial till soils. Minimal drying should be expected with the coarse alluvium soils.

Pipe jacking will be performed near test borings 4-3, 4-4, 4-8, 4-9, 4-10, 5-2, 5-8 and 5-9. It is our opinion that the loess soils and fine alluvium soils encountered at these test borings have low strength levels. We estimate that the loess soils and fine alluvium soils have unconfined compressive strength values between 0.25 to 0.5 tons per square foot (tsf). Regarding the glacial till soils at these test borings, it is our opinion that the glacial till soils have moderate to moderately high strength levels. We estimate that the glacial till soils have unconfined compressive strength values between 1.5 to 2.5 tsf. Boulders and cobbles may be encountered within the coarse alluvium soils and glacial till soils. The contractor may experience difficulties if boulders or cobbles are encountered during installation.

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.

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.

Remarks

We trust this report provides you with the necessary information for the project. If you have any questions or require additional information, please contact our office.

This report was prepared by: GeoTek Engineering & Testing Services, Inc.

Jared Haskins, PE (SD) Geotechnical Manager

Daniel Hanson, PE (IA) General Manager













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GEOTECHNICAL TEST BORING LOG

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GEOTEK ENGINEERING & TESTING SERVICES, INC. 909 E 50th St N Sioux Falls, South Dakota, 57104 605-335-5512 Fax jhaskins@geotekeng.com

GEOTECHNICAL TEST BORING LOG

GEOTE	EK #	20-K94									В	ORING	S NO.		4-5	(1 of 1)
PROJEC	ст і	Proposed Tr	eated Water	Pipeline, low	a Segments	4 &	5, Lewis & Clark	Region	al Wa	ater S	Syst	em, H	ull to S	heldo	n, IA		
DEPTH		DESC	RIPTION O	F MATERIA	AI					SA	λMF	PLE	L	ABOR	ATOR		STS
in FFFT	s	SURFACE E	LEVATION	1412.6 ft			ORIGIN	N	WL	NO.	Т	YPE	wc	D	LL	PL	QU
	₩ IF		verv dark br	own to blac	k		TOPSOIL										
-	mc	oist, stiff, (C	CL)		ι,			_		1	ľ	HSA					
-								_									
-								_ 10		2	М	SPT	31				
-								_									
5 _	IF		aravish brov	wn and dark	arav		FINE	11		3	\square	SPT	23	103			
-	mc	oist, stiff, (C	SL)		gruy,		ALLUVIUM	_			\square						
7	S۵		I CI AY: a litt	tle gravel h	rown		GLACIAL	-	Ţ								
-	an	d gray, moi	ist, stiff, with	lenses of s	and		TILL	_ 10		4	Х	SPT	14	124			
-	(Cl	L)						-									
-								- 14		5	\square	SPT	16				
-											$ equal onumber { } onumber $. .					
12	IF			· a little arav	رما		GLACIAL	_									
-	bro	own and gra	ay, moist, st	iff, (CL)	, ci,		TILL	_ 15		6	Х	SPT					
-								_									
_								- 14		7	∇	SPT					
16		Botto	m of horeho	le at 16 fee	t	<i>[]]</i>			-		\square						
-		Dollo						_									
-								_									
-								_									
_								_									
-								_									
-								_									
-								_									
								_									
/16/2								_									
								_									
- 6.60								_									
YEN -								_									
								-									
9 7 –								_									
94.6								L									
X-0-Z								L									
SN S																	
		WA	ATER LEVE	L MEASUR	EMENTS			STAR	Г	12-8-	-20	C	OMPLE	ETE _	12-8-2	20 12:	10 pm
DATE		TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN		WATER LEVEI	METH	IOD	مالمن	,	tom ^	uger				
12-8-2	0	12:40 pm	16		15		12	3.25	<u>ח ח</u> ו		13		uger				
12-9-2	0	7:39 am	16		9	Ţ	7										
12-12-2	20	1:52 pm	16 		8	<u> </u>	7	CREV			N	/like \	Vagne	۲			
		-	-	-					- 01		1		agine	<i>.</i>			



GEOTEK ENGINEERING & TESTING SERVICES, INC. 909 E 50th St N Sioux Falls, South Dakota, 57104 605-335-5512 Fax jhaskins@geotekeng.com

GEOTE	EK #	20-K94		_							В	ORING	G NO.		4-6	(1 of 1)
PROJEC	СТ	Proposed Tr	eated Water	Pipeline, low	a Segments	4&	5, Lewis & Clark	Region	al Wa	ater S	Syst	tem, H	ull to S	heldo	n, IA		
DEPTH		DESC								SA	٩MI	PLE	L	ABOR	ATOR	Y TES	STS
in FEFT			I EVATION	1422 6 ft			ORIGIN	Ν	WL	NO.	Т	YPE	wc	D	LL	PL	QU
1	¥ FⅡ				of	$\times\!\!\!\times\!\!\!\times$	FILL										
-	gra	avel, very d	lark brown a	ind black, m	oist	\bigotimes		-		1	1	HSA					
21/2						\bigotimes		-									
	LE	AN CLAY:	black, moist	t, stiff, (CL)			TOPSOIL	_ 9		2	Х	SPT	32	87			
41/2								_									
-	LE	AN CLAY:	brown and g	gray, moist,	stiff,		FINE	- 9		3	\mathbb{N}	SPT	27	94			
-	(0	L)					ALLUVIUM	-			\vdash						
7	IF		aravish brov	vn moist fi	rm		FINE	-			\vdash						
-	(C	L)	grayion brou	wii, moist, n	,		ALLUVIUM	_ 5		4	Х	SPT	27	97			
91/2								_									
-	LE		NITH SAND	a little grav	/el, erel		GLACIAL	10		5	\square	SPT	19				
-	ler	own and gra nses of san	ay, moist, st d (CL)	iii, with sev	eral		IILL			ľ	\vdash						
-			、 ,					_			\vdash						
-								_ 12		6	Х	SPT					
-								_									
-								14		7	\square	SPT					
16 _		Botto	m of boreho	le at 16 fee	t				-		\vdash						
-		Dollo		10 41 10 100				-									
-								-									
-								-									
-								_									
-								_									
-								_									
-								_									
o –								_									
								-									
5 -								-									
19.9								-									
								-									
10 <u>3</u>								-									
្ត្រ –								-									
494.6								F									
- 20-1								F									
N N N N N N N N N N N N N N N N N N N								0715							10.15		50
STBC		VV A						STAR	<u> </u>	12-10	J-20	<u> </u>	JMPLE	:IE _	12-10-	20 12:	50 pm
≝ DATE		TIME	DEPTH	DEPTH			LEVEL	3.25"	ID H	ollov	vS	tem A	uaer				
12-10-2	20	12:50 pm	16		14		none										
H						-											
								CREV	V CH	IIEF	1	Mike V	Vagne	er			
						-											



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GEOTECHNICAL TEST BORING LOG

GEOTE	EK #	20-K94									BORIN	IG NO.		4-7	(1 of 1)
PROJE	СТ	Proposed Tr	reated Water	Pipeline, low	a Segments	4 &	5, Lewis & Clark	Region	al Wa	ater S	system,	Hull to S	heldo	n, IA		
DEPTH		DESC	RIPTION O	F MATERIA	۸L					SA	MPLE		ABOR	ATOR	Y TES	STS
in FEET	{	SURFACE E	LEVATION	1406.7 ft			ORIGIN	N	WL	NO.	TYPE	wc	D	LL	PL	QU
		AN CLAY:	very dark br	rown to blac	k,		TOPSOIL									
2	mo	oist, (CL)						-		1	HS/					
2 _	LE		brown and g	gray, moist t	o wet,		FINE	9		2	SP-	. 25	96			
	Su	II, (CL)					ALLUVIUM				Ĥ					
_								- 10			H_{op}					
_								10 -		3	Д ^{sp}	28	96			
7 _			aravish brov	vn moist to	wet		FINE	_	Ţ		\square					
-	firr	n to stiff, (C	CL)	Mil, molat to	wet,		ALLUVIUM	_ 6		4	SP-	30	93			
_								-								
-								10		5	SP	28	96			
12								-			Ħ.					
	LE	AN CLAY	dark brown,	moist to we	et, firm		FINE	7		6	SP-	42	81			
_		3011, (OL)					ALLOVION	_			Ĥ					
								8		7		-				
-								-		<i>'</i>	Щ					
-								-								
-								_								
-								-								
21								_ 12		8	SP					
_	-	Botto	m of boreho	le at 21 fee	t.			_								
_								_								
-								_								
7/91/7	-							_								
								-								
=								-								
								-								
94.GF								L								
X-07								-								
		\\//			EMENITO			et a da	 r	12.0	20			10.0	20.2.0	1 nm
	_	VV /	SAMPLED		CAVE-IN		WATER	METH	<u></u> חסו	1∠-ŏ-	-20	JOIVIPLE		12-0-	20 2:0	i pm
	=	IIME	DEPTH	DEPTH	DEPTH		LEVEL	3.25"	ID H	ollow	/ Stem	Auger				
12-8-2 12-9-2	20	2:06 pm 7:47 am	21 21		13 12	Ţ	12 7									
12-12-2	20	1:59 pm	21		11	Ţ	7				N 411	\ \ / - ·				
5									V CH	11EF	Mike	vvagne	er			



GEOTEK ENGINEERING & TESTING SERVICES, INC. 909 E 50th St N Sioux Falls, South Dakota, 57104 605-335-5512 Fax jhaskins@geotekeng.com

GEOTE	EK# 20-K94									B	ORING	S NO.		4-8	(1 of 1)
PROJEC	CT Proposed T	reated Water	Pipeline, low	a Segments 4	8	5, Lewis & Clark	Region	al Wa	ater S	yst	em, H	ull to S	heldo	n, IA		
DEPTH	DES			AI					SA	\MF	PLE	L	ABOR	ATOR	Y TES	STS
in FEET		FI EVATION	1433 6 ft			ORIGIN	Ν	WL	NO.	Т	YPE	wc	D	LL	PL	QU
			rown dry ((_	TOPSOIL										
_	LLAN CLAT	very dark b	10wn, ury, (C	/L) [-	_		_		1		HSA					
2			man int finner	(01)	_		_									
_	LEAN CLAT	dark brown	, moist, iinn			LUESS	_ 6		2	Х	SPT	23	98			
A1/ -					\square		_			\square						
4/2	LEAN CLAY	brown and	gray, moist l	o wet,		LOESS	- 10			\bigtriangledown	ODT		0.5			
	stiff, (CL)						- 10		3	riangle	51	28	95			
7							_									
	LEAN CLAY	WITH SAND	: a little grav	/el,		GLACIAL	11		4	M	SPT	15	117			
		, sun, (ol)			\square					Д						
										\vdash						
_							9		5	Х	SPT	17	116			3300
							_									
							- 12		6	\bigtriangledown	SDT					
							_ 12			Д	51.1					
							_									
-							⁻ 12		7	Х	SPT					
16	Botto	om of boreho	ole at 16 fee	t. (1		Ħ						
-							_									
-							_									
-							_									
-							_									
-							_									
-							_									
_							_									
_							_									
							_									
2							_									
99.																
							_									
5							_									
							-									
							-									
<u>v</u> –							-									
	W	ATER LEVE	L MEASUR	EMENTS			STAR	Γ	12-8-	·20	C(OMPLE	TE	12-8-	20 2:5	57 pm
		SAMPLED	CASING	CAVE-IN		WATER	METH	IOD								
		DEPTH	DEPTH	DEPTH		LEVEL	3.25"	ID H	ollow	<u>/ St</u>	tem A	uger				
12-9-2	0 7:51 am 20 2:06 pm	16		14 12		none										
							CREV	V CH	IIEF	Ν	/like \	Vagne	er			



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GEOTE	EK #	20-K94									B	ORING	NO.		4-9	(1 of 1)
PROJEC	ст	Proposed Tr	eated Water	Pipeline, low	a Segments	4 &	5, Lewis & Clark	Region	al Wa	ater S	Syst	em, H	ull to S	heldo	n, IA		
DEPTH		DESC		F MATERIA						SA	٩MF	PLE	L	ABOR	ATOR	Y TES	STS
in FFFT	-5	SURFACE E	LEVATION	1440.7 ft			ORIGIN	N	WL	NO.	Т	YPE	wc	D	LL	PL	QU
			verv dark br	own to blac	k drv	_	TOPSOIL										
-	(C	L)	vory dank bi		it, diy,			_		1	ľ	HSA					
2			brown mois	t stiff (CL)			LOESS	_									
-				si, siii, (O∟)			LOLUU	_ 9		2	Х	SPT	20	99			
116								_			Ē						
-	LE	AN CLAY:	brown and g	gray, moist,	stiff,		LOESS	- a		3	∇	SPT	26				
-	(C	L)						- 5		ľ	\square	011					
7					1			_									
_	bro	<u>AN CLAT N</u> own. moist.	stiff. (CL)	a nue grav	/ei,			_ 10		4	Х	SPT	14	119			
_		, ,	, (-)					_			F						
								- 10		_	\bigtriangledown	ODT	4-	140			
								- 13) ⁵	\square	371	15	119			
_								_									
_								_ 12		6	X	SPT	17	117			
								_			F						
										-	\bigtriangledown	ODT					
16								14			Д	SPT					
		Botto	m of boreho	le at 16 fee	t.			_									
								_									
								_									
								_									
								_									
								_									
								_									
								_									
6/20																	
12/1																	
ENG																	
5								Γ									
4.GP,																	
6X-02																	
								Γ									
POR		WA	ATER LEVE	L MEASUR	EMENTS			STAR	Г	12-8-	-20	C	OMPLE	TE _	12-8-	20 3:3	9 pm
DATE		TIME	SAMPLED	CASING	CAVE-IN		WATER	METH	IOD								
12_8_2(3:39 nm	DEPTH 16			+		3.25"	ID H	ollow	v St	tem A	uger				
12-0-20	0	7:54 am	16		14	+	none										
12-12-2	20	2:09 pm	16		13		none				~						
5								CREV	V CH	IIEF	Ν	/like \	Vagne	r			



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GE	OTE	K #	20-K94									В	ORING	S NO.		4-10	(1 of 1	l)
PRC	DJEC.	TF	Proposed Tr	eated Water	Pipeline, low	a Segments	s 4 &	5, Lewis & Clark	Region	al Wa	ater S	Syst	tem, H	ull to S	heldo	n, IA		
DEP	тн		DESC			71					SA	λMI	PLE	L	ABOR	ATOR	Y TES	STS
in	<u>-</u>				1420 5 ft			ORIGIN	Ν	WL	NO.	т	YPE	wc	D	LL	PL	QU
FEE	=	<u> </u>			1420.5 IL		1-	TODOOU							_		. –	
	_		AN CLAY:	DIACK, MOISI	[, (UL)		<u> </u>	TOPSOIL	_		1		HSA					
	,]								_									
27	^{/2}	FA	T CLAY: da	ark gravish l	orown. mois	st. stiff.		FINE	_ 9		2	N	SPT	19				
		(Cl	H)	5,	,	, ,		ALLUVIUM				Ĥ						
41/	[/] 2 -	IF		aravish brov	vn moist s	tiff		FINE				\vdash						
	7	(Cl	_)	grayion broi	ini, molot, o	,		ALLUVIUM	12		3	М	SPT	25	98			
7	, 1								_									
1		LE	AN CLAY	NITH SAND	: a little grav	/el,		GLACIAL	12			∇	SDT	17	110			
	-	bro	own and gr	ay, moist, st	iff to very st	tiff, (CL)	$\langle / / \rangle$	TILL	_ 12		4	\square			110			
	-								-									
	-								- 12	Ţ	5	M	SPT	16	118			
	-								-			\vdash						
	-						$\langle / / \rangle$		-			\vdash						
	-								_ 15		6	К	SPT	17	115			5400
	_								_									
	_								- 17		7	\bigtriangledown	ODT					
							$\langle \rangle \rangle$		_ 1/		'	\square	501					
	1								_			\vdash						
2	1						$\langle / /$		16		8	X	SPT					
	' †		Botto	m of boreho	le at 21 fee	t.						ſ						
	-								-									
	-								-									
0	-								-									
2/16/2	-								_									
1	-								-									
G.GI	_								_									
KEN	_								_									
EOTE	_								_									
3	_								_									
4.GP																		
20-K0]																	
UGN NG	1								Γ									
BORI			WA	ATER LEVE	L MEASUR	EMENTS			STAR	Г	12-8-	-20	C(OMPLE	TE _	12-8-	20 4:2	28 pm
с EST	ATE			SAMPLED	CASING	CAVE-IN		WATER	METH	IOD								
			4.00	DEPTH	DEPTH	DEPTH	+	LEVEL	3.25"	<u>ID H</u>	ollow	v S	tem A	uger				
U 12 V 12 V 12	-8-20		4:29 pm 7:57 am	21		19 10	-	none										
U 12-	12-20	5	2:14 pm	21		11	Ţ	10	1									
GEC									CREV	V CH	IIEF	[Vike V	Vagne	er			



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GEOTECHNICAL TEST BORING LOG

	GEOTE	EK #	20-K94									B	ORING	S NO.		5-1	(1 of 1)
	PROJE	СТ	Proposed Tr	eated Water	Pipeline, low	a Segments	\$ 4 &	5, Lewis & Clark	Region	al Wa	ater S	Syst	tem, H	ull to S	heldo	n, IA		
Γ	DEPTH		DESC	RIPTION O	F MATERIA	AI					SA	١M	PLE	L	ABOR	ATOR	Y TES	STS
	in FFFT		SURFACE E	LEVATION	1422.8 ft			ORIGIN	N	WL	NO.	Т	YPE	wc	D	LL	PL	QU
ŀ		LE	EAN CLAY:	verv dark br	own to blac	k.	<u> </u>	TOPSOIL										
	-	m	oist, (CL)	· · · , · · · · · · ·		,			-		1	ľ	HSA					
	2	FÆ	T CLAY: bi	rown and da	rk grav, mo	ist.		LOESS	+									
	-	sti	ff, (CH)		5,	,			_ 12		2	Å	SPT	20	102			
	4½								-									
	-	<u>LE</u> fir	EAN CLAY:	brown and g	gray, moist t	o wet,		LOESS	5		3	M	SPT	32	89			
	-		ini, (OL)						-			\vdash						
	-											\bigtriangledown	ODT					
	8½								_ 5		4	\square	SPT	28	96			
	-	br	EAN CLAY N own and gr	<u>NITH SAND</u> : av. moist. st	: a little grav iff. (CL)	/el,		GLACIAL TILI	-									
	-		give and give	,,,	, (•=)				- 11		5	X	SPT	17	118			
	-								-	⊥		\vdash						
	-								15		6	\bigtriangledown	ерт					
	-								_ 15		0	\square	571					
	-								-									
	-								15		7	X	SPT					
	-								-			Ē						
	-								-									
	-								_									
	_											\vdash						
	21								14		8	И	SPT					
			Botto	m of boreho	le at 21 fee	t.												
6/20																		
12/1	_																	
.GDT	_																	
KENG	_																	
OTE																		
с В	_								L									
94.GF	_								L									
20-K	_								Ļ									
SING																		
1 BO			WA	ATER LEVE	L MEASUR	EMENTS			STAR	Г	12-9-	-20	C	OMPLE	TE _	12-9-	20 9:3	9 am_
TES	DATE	:	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN		WATER LEVEL	METH	וOD יי חו	مالمه	,	tom A	uder				
VICAL	12-9-2	0	9:38 am	21		19		none	0.20	חסו				ager				
HCH)	12-12-2	20	2:20 pm	21		14	Ţ	11										
GEOT							+		CREV	V CH	HEF	ľ	Mike V	Vagne	er			



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G	EOTE	EK #	20-K94									В	ORING	G NO.		5-2	(1 of 1)
P	ROJEC	TT E	Proposed Tr	eated Water	Pipeline, low	a Segments	4 &	5, Lewis & Clark	Region	al Wa	ater S	Syst	tem, H	ull to S	heldo	n, IA		
DI	EPTH		DESC								SA	١M	PLE	L	ABOR	ATOR	Y TES	STS
	in	—s		LEVATION	1438.5 ft			ORIGIN	Ν	WL	NO.	Т	YPE	wc	D	LL	PL	QU
ι Γ΄		<u> </u>					\times	EILI										
	_	bro	wn and da	irk brown, m	oist	<u> 110</u> .	\bigotimes		_		1	1	HSA					
	_						\bigotimes		_									
	_						\bigotimes		_ 9		2	IX	SPT	17	110			
	41/						\bigotimes		_			F						
	4 1/2	LE	AN CLAY:	brown and g	gray, moist t	o wet,		LOESS				$\overline{\nabla}$						
		sof	ft to stiff, (C	CL)	, ,,,	,			12		3	Å	SPT	25	97			
									4		4	\mathbb{N}	SPT	29	94			
									_			\vdash			-			
	9½	16			a little area	رما	<i>\///</i>	GLACIAL	F			\vdash						
	-	bro	own and gra	ay, moist, st	iff, (CL)	, ci,		TILL	14		5	K	SPT	17	117			
	-		-	-	. ,				-			Ē						
	-											∇	ODT					
	-								_ 15		0	\square	501					
	-								-									
	_								15		7	M	SPT					
	16		Botto	m of boreho	le at 16 fee	t.	V///			-	<u> </u>	┢						
	-								-									
	-								-									
	-								_									
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	_								_									
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0/20																		
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D L L L L	-																	
LEN	-								-									
۲ و	-								F									
	-								F									
102-	-								F									
<u>و</u> کړ	-								-									
			WA		L MEASUR	EMENTS			STAR	<u>і </u>	I 12-10)-20	L C(I TE	12-10-	20 11 [.]	:43 am
		.		SAMPLED	CASING	CAVE-IN		WATER	METH		0							
	DATE			DEPTH	DEPTH	DEPTH		LEVEL	3.25"	ID H	ollov	v S	tem A	uger				
	12-10-2	20	11:43 am	16		14		none										
	12-2		2.27 pm						<u> </u>									
2							+		CREV		IIEF	1	Mike V	Vagne	er			



GEOTEK ENGINEERING & TESTING SERVICES, INC. 909 E 50th St N Sioux Falls, South Dakota, 57104 605-335-5512 Fax jhaskins@geotekeng.com

GEO	OTEK	# <u>20-K94</u>									В	ORING	G NO.		5-3	(1 of 1)
PRC	JECT	Proposed Tr	eated Water	Pipeline, low	a Segments	4 &	5, Lewis & Clark	Region	al Wa	ater S	Syst	tem, H	ull to S	heldo	n, IA		
DEP	тн	DESC		F MATERIA						SA	٩MI	PLE	L	ABOR	ATOR	TES	STS
in FFF		-SURFACE E	LEVATION	1477.6 ft			ORIGIN	N	WL	NO.	т	YPE	wc	D	LL	PL	QU
	<u> </u>	FAN CLAY	verv dark br	own to blac	k drv	L	TOPSOII										
11/	ζ - t	o moist, (CL)			it, di j		101 0012	-		1	1	HSA					
.,	<u>-</u>	EAN CLAY :	brown and g	gray, dry, fir	m, (CL)		LOESS	-			H						
	-							_ 7		2	И	SPT	13	93			
41/	6							-									
		EAN CLAY	NITH SAND	: a little grav	/el,		GLACIAL	- 10		3	\mathbb{N}	SPT	17	111			
	- '	nown and gr	ay, moist, st	III, (CL)			TILL	-			\vdash						
	-							-			\vdash						
	-							_ 11		4	И	SPT	18	114			
91/	6							-									
	<u>L</u>	EAN CLAY	NITH SAND	: a little grav	vel,	\langle / \rangle	GLACIAL	10		5	\mathbb{N}	SPT					
		frown and gr	ayish brown	, moist, sun	, (CL)		TILL	-			\vdash						
	-							-			\vdash						
	-							_ 12		6	И	SPT					
	-							-									
	-							13		7	\mathbb{N}	SPT					
16	3 <u>├</u>	Botto	m of boreho	le at 16 fee	t.						\vdash						
	-							-									
	-							-									
	-							-									
	-							-									
	-							-									
	-							-									
	-							-									
0	-							-									
2/16/2	-							-									
10	-							-									
4 <u>6</u> .6	-							-									
EXE EXE	-							-									
3EOT	-							-									
) [d5	-							 -									
K94.(-							╞									
20-	-							F									
		\\//			EMENTS			STAP	<u> </u>	12-0	20				12-0 [.]	20 10-	29 am
ST B							WATER	METH	י <u>–</u> חסו	12-9	-20	_ 0		.10	12-9-1	20 10.	∠a qiii
₽ D, 7	ATE	TIME	DEPTH	DEPTH	DEPTH		LEVEL	3.25"	<u>ID H</u>	ollov	v S	tem A	uger				
2 <u>12</u> ∠	-9-20	10:29 am	16		14	_	none						-				
		2.31 pm				+											
GEC								CREV	V C⊦	IIEF	ſ	Mike V	Vagne	er			



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GEOTI	EK #	20-K94									B	ORING	S NO.		5-4	(1 of 1)
PROJE	СТ І	Proposed Tr	eated Water	Pipeline, low	a Segments	4 &	5, Lewis & Clark	Region	al Wa	ater S	Syst	em, H	ull to S	heldo	n, IA		
DEPTH		DESC			.1					SA	ЧМF	PLE	L	ABOR	ATOR	Y TES	STS
in				1380.2 ft			ORIGIN	Ν	WL	NO.	Т	YPE	wc	D	LL	PL	QU
FEEI	V)			1309.2 11			TODOON							_			~~
_		<u>AN CLAY</u> : moist (CL)	very dark br	own to blac	k, dry		TOPSOIL	_		1		HSA					
2		1110131, (OE)								'		110/1					
		AN CLAY	brown and g	gray, moist,	stiff,		LOESS	9		2	\mathbb{N}	SPT	15	95			
-	1 (C	L)						_			\square						
4½	₋_			+ -+:ff (OL)			10500	-									
-	┤┕╘	AN CLAT	brown, mois	si, siii, (CL)			LUESS	_ 12		3	X	SPT	13	114			
	1							-			\vdash						
/ _	SA		I CLAY: a lit	tle gravel, b	rown.	\square	MIXED	+									
-	mc	oist, stiff, (C	CL)	5,	,		ALLUVIUM	_ 14		4	М	SPT	8				
-	-							-									
	-							- 11	•	5	\square	SPT	17				
-	4							- ''	_		\square	JF I					
12 _								L	1								
		AN CLAY:	brown, wet,	stiff, (CL)				_ 9		6	M	SPT	24	108			
13½	SA		SILT: fine to	medium ara	ained.		COARSE				H						
	bro	own, waterk	pearing, loos	se, (SP-SM)	,		ALLUVIUM										
16	1							8		7	Х	SPT					
10 -		Botto	m of boreho	le at 16 fee	t.				1		Ĺ						
-	1							-									
-	1							-									
-	1							-									
-	1							-									
-	-							-									
-	-							-									
-	-							-									
-								_									
6/20																	
12/1																	
- 105	1							F									
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- fag	-							┝									
- 494.0	-							╞									
- 50-	-							╞									
RING								ļ									
		WA	ATER LEVE	L MEASUR	EMENTS	1		STAR	т	12-9-	-20	C	OMPLE	TE _	12-9-2	20 11:	20 am_
	≡	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH		WATER LEVEI	METH	HOD	- II - ·		ha m=					
J 12-9-2	20	11:22 am	16		11	T	10.5	3.25"	<u>א טו</u>		<u>v 5</u>	lem A	uger				
ZH 12-12-	20	2:36 pm	16		11	Ţ	10.5										
Щ 											_						
н В 								CREV	<u> </u>	IIEF	Ν	<u> /like /</u>	Vagne	er			



GEOTEK ENGINEERING & TESTING SERVICES, INC. 909 E 50th St N Sioux Falls, South Dakota, 57104 605-335-5512 Fax jhaskins@geotekeng.com

GEOTECHNICAL TEST BORING LOG

GEOTE	EK# 20-K94									B	ORING	NO.		5-5	(1 of 1)
PROJEC	CT Proposed 1	reated Water	Pipeline, low	a Segments	4&	5, Lewis & Clark	Regior	al Wa	ater S	yst	tem, Hı	ull to S	heldo	n, IA		
DEPTH	DES			41					SA	MF	PLE	L	ABOR	ATOR	Y TES	STS
in FEET		ELEVATION	<u>1375.8 ft</u>			ORIGIN	N	WL	NO.	т	YPE	wc	D	LL	PL	QU
	LEAN CLAY	: verv dark b	rown to blac	k.		TOPSOIL										
-	moist, firm, (CL)		,			-		1		HSA					
-							-									
							_ 8		2	Å	SPI	22	78			
41/2							-									
	brown to bla	<u>ND</u> : fine grai ck_wet_verv	ned, very da loose (SC)	ark			- 3	┸	3	X	SPT	20				
	brown to blu	on, wor, vory	10000, (00)				-			\vdash						
1 1 -	LEAN CLAY	WITH SAND	gray, mois	t, firm,		FINE	+									
-	(CL)					ALLUVIUM	_ 6		4	Å	SPI	20	111			
9½							-									
	dark gravish	brown mois	: a little gra\ st_stiff_(CL)	/el,			11		5	X	SPT	18	114			
-	dant grayion	brown, more	,, oun, (ol)				_			\vdash						
-							-			\bigtriangledown	ODT					
-							_ 10		0	\square	501	19	114			
14½							F									
-	brown and o	rav. moist. v	: a little gra\ erv stiff. (CL	/el, .)			⁻ 16		7	Х	SPT	20	108			
-		· · · , · · · · · · · · · · · · · · · · · · ·	, (01	,			-			\vdash						
-							-									
-							_									
19½							-									
_	brown and d	rav. moist. v	a little grave erv stiff. (CF	1, 1)			26		8	Х	SPT	16	117			3600
	0	, , ,	J	,			-			\square						
							_									
_							-									
_							-									
26							23		9	Х	SPT					
20 _	Bott	om of boreho	ole at 26 fee	t.				1								
_							Ē									
_							Γ									
_							–									
							_									
							Γ									
	W	ATER LEVE	L MEASUR	EMENTS			STAR	г	12-9-	20	_ co	OMPLE	TE _	12-9-	20 1:2	23 pm
DATE	TIME					WATER	METH	IOD		_						
12-9-2	0 1:23 pm	26		12		8	3.25"	<u>ID H</u>	ollow	<u>/ S</u>	tem A	uger				
12-12-2	20 2:43 pm	26		9	Ţ	5										
									비드드	•	Aike M	Voan	r			
										ſ	viike V	vagne	1			

GEOTECHNICAL TEST BORING 20-K94.GPJ GEOTEKENG.GDT 12/16/20



GEOTEK ENGINEERING & TESTING SERVICES, INC. 909 E 50th St N Sioux Falls, South Dakota, 57104 605-335-5512 Fax jhaskins@geotekeng.com

	GEOTE	EK #	20-K94									В	ORING	G NO.		5-6	(1 of 1)
	PROJE	СТ	Proposed Tr	eated Water	Pipeline, low	a Segments	4&	5, Lewis & Clark	Region	al Wa	ater S	Syst	tem, H	ull to S	heldo	n, IA		
f	DEPTH					<u> </u>					SA	١Mڊ	PLE	L	ABOR	ATOR	Y TES	STS
	in FEET		SURFACE E	LEVATION	<u>1377.3 ft</u>	1∟		ORIGIN	N	WL	NO.	т	YPE	wc	D	LL	PL	QU
┢			EAN CLAY:	very dark br	rown to blac	k,		TOPSOIL										
	-	m	oist, firm, (0	CL)					F		1		HSA					
	-								-				ODT	00	100			
	_								- 0		2		571	20	001			
	4½	0			dork brow	n wat	-		-			\vdash						
	_	sc SC	oft, (SC)	I CLAI . Very	y dark brow	n, wei,		ALLUVIUM	2		3	Х	SPT	15				
	7	1								-								
			AYEY SAN	D: a trace o	of gravel, fin	e to		MIXED	9		4	\mathbb{N}	SPT	12				
		de	ense, (SC)	ieu, uaik yla	ay, wei, mei	aium						\vdash						
	91⁄2	LE	EAN CLAY	WITH SAND	: a little grav	/el,		GLACIAL	L									
		da	ark grayish l	prown, mois	t, firm to stil	ff, a few		TILL	13		5	Å	SPT	17	116			
	-		nses of san	d al 13 (CL)				_									
	_								_ 8		6	X	SPT	18	114			
	-								_			\square						
	-								- 12		7	\bigtriangledown	ерт	10	112			
	-						$\langle / / \rangle$		- 12		'	au		19				
	-								-									
	-								-									
	19½								-									
	-	LE br	EAN CLAY	NITH SAND	: a little grav	/el,			24		8	$\overline{\mathbb{N}}$	SPT	16	120			
	-		Swit and gr	ay, moist, ve	51 y 3011, (OL	-)		1166	-			\vdash						
	_								\vdash									
	-						V//		-									
/20	_								F			Ļ						
12/16	_								24		9	X	SPT					
GDT	-								-			ŕ						
ENG.	_								F									
OTEK	=								F									
ŰÜ	-	1							F			\vdash						
4.GP.	31								21		10	X	SPT					
20-K9			Botto	m of boreho	ole at 31 fee	t.												
BNG	_																	
T BOR			WA	TER LEVE	L MEASUR	EMENTS			STAR	Г	12-9-	-20	C	OMPLE	TE _	12-9-	20 3:0)7 pm
. TES	DATE		TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH		WATER LEVEL	METH	וסד יי חו	مالمن	, 0	tom ^	ugor				
	12-9-2	20	3:07 pm	31		15		10	3.23	חטו		/ 3		uyer				
ΞH	12-12-2	20	2:56 pm	31		14	Ţ	6										
EOT									CREV	V CH	IIEF	1	Mike V	Vagne	er			
_ ن														- 3.10				



GEOTEK ENGINEERING & TESTING SERVICES, INC. 909 E 50th St N Sioux Falls, South Dakota, 57104 605-335-5512 Fax jhaskins@geotekeng.com

GEOTECHNICAL TEST BORING LOG

G	GEOTE	EK# <u>20-K94</u>									BC	ORING	S NO.		5-7	(1 of 1)
Р	ROJEC	CT Proposed	reated Water	Pipeline, low	a Segments	4 &	5, Lewis & Clark	Region	al Wa	ater S	yst	em, H	ull to S	heldo	n, IA		
D	EPTH	DES	CRIPTION O	F MATERIA	۸L					SA	\MF	PLE	L	ABOR	ATOR	Y TES	STS
F	in =EET	SURFACE	ELEVATION	1384.9 ft			ORIGIN	N	WL	NO.	Т	YPE	wc	D	LL	PL	QU
		FILL, MOST		SAND: medi	ium	\otimes	FILL					_					
	1 +	-∖grained, dar	k brown, dry		/	\longrightarrow	GLACIAL	_		1		HSA					
	-	brown and c	ray, moist, st	: a little gra\ iff, (CL)	/el,		TILL	-			\square	ерт	14	100			
	-		, ,,,,	, (-)				_ 9			Д	SPI	14	122			
	-							_									
	-							_ 14		3	X	SPT	16	117			
	-							_			H						
	-							12		4	\square	SPT	16	110			
	-							_ 12			Д						
	-							_			\vdash						
	-					\square		_ 14		5	М	SPT	17	118			
	12								•								
		SAND WITH	SILT: a little	gravel, fine	to n donso		GLACIAL	11	-	6	\square	SPT					
		(SP-SM)	neu, biown,	wet, meului	n uense,		OUTWASH	_			Η						
	14½	LEAN CLAY	WITH SAND	: a little grav	/el,		GLACIAL				\square						
	16	brown and d	ark gray, mo	ist, stiff, (CL	_)		TILL	14			М	SPT					
	_	Bott	om of boreho	ole at 16 fee	t.			_									
	_							_									
	_							_									
	_							_									
	_							_									
	-							_									
	-																
0	-							_									
2/16/2	-							_									
DT 12	-							-									
NG.GI	-							_									
ĒKĒ	-							-									
GEOT	-							_									
GPJ	-							_									
-K94.	-							_									
IG 20	-							_									
SORIN		W	ATER LEVE	L MEASUR				STAR	<u>і </u>	ı 12-10	-20		OMPLE	TE	12-10	-20 8:	12 am
ESTE			SAMPLED	CASING	CAVE-IN		WATER	METH	IOD								
			DEPTH	DEPTH	DEPTH		LEVEL	3.25"	ID H	ollow	/ St	em A	uger				
HNIC	12-10-2 12-12-2	20 8:15 am 20 3:02 pm	16		13	T	none 12										
OTEC											_						
Ű								CREV	V CH	IIEF	Ν	/like V	Vagne	er			



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GEOT	ΓEK #	# <u>20-K94</u>									BC	ORING	NO.		5-8	(1 of 1)
PROJE	ECT	Proposed Tr	eated Water	Pipeline, low	a Segments	4 &	5, Lewis & Clark	Region	al Wa	ater S	Syst	em, H	ull to S	heldo	n, IA		
DEPTH	1	DESC	RIPTION O	F MATERIA						SA	١MF	PLE	L	ABOR	ATOR	Y TES	STS
in FEET		SURFACE E	LEVATION	1382.0 ft			ORIGIN	N	WL	NO.	Т	YPE	wc	D	LL	PL	QU
		EAN CLAY:	very dark br	own to blac	k,		TOPSOIL										
	- m	oist, stiff, (C	CL)					-		1		HSA					
	1							- 11				спт	20	01			
	1							- ''		2	Д	571	20	91			
41⁄2					1:66			-									
	- <u>F/</u> (C	ai clai . ve CH)	ery dark bro	wn, moist, s	un,		ALLUVIUM	10		3	Х	SPT	26	98			
7	1							_			M						
	Ļ		<u>WITH SAND</u>	a trace of	gravel,		FINE	3		4	\square	SPT	28	98			
] da	ark grayish i	brown, mois	I IO WET, SOT	ι, (UL)	///	ALLUVIUM		•		Ю						
91⁄2		LAYEY SAN	ID : fine to m	edium arair	ned.		MIXED	_	-		\vdash						
11	da	ark gray, we	t, loose, (SC	<u>C)</u>			ALLUVIUM	8		5	М	SPT	28				
		AND: mediu	m to coarse	grained, br	own,			_									
		aterbearing,	meaninae	ALLOVION	_ 12		6	М	SPT								
	_				_			H									
	_							- 10		-	\square	ODT					
16	-	D - #-		la at 40 fa a	1			18	-	Ľ	Д	501					
	-	Bollo	m or poreno	le at to lee	ι.			-									
	-							_									
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-292-0	1							F									
	1							F									
		WA	ATER LEVE	L MEASUR	EMENTS			START	Г	12-10	-20	_ C	OMPLE	TE _	12-10	-20 9:	52 am
DAT	E	TIME	SAMPLED	CASING	CAVE-IN		WATER	METH	IOD								
12-10	-20	10:04 am	16		13			3.25"	ID H	ollow	<u>/ St</u>	em A	uger				
12-12	-20	3:06 pm	16		10	Ţ	9										
											N	like \	Noan	r			
פ								LKEV	V UF	1165	I\	лке и	vagne				



GEOTEK ENGINEERING & TESTING SERVICES, INC. 909 E 50th St N Sioux Falls, South Dakota, 57104 605-335-5512 Fax jhaskins@geotekeng.com

GEOTECHNICAL TEST BORING LOG

GE	OTE	EK# <u>20</u>)-K94									BC	RING	NO.		5-9 ((1 of 1)
PR	OJEC	CT <u>Prop</u>	oosed Tr	eated Water	Pipeline, low	a Segments	4 &	5, Lewis & Clark	Region	al Wa	ater S	iyste	əm, Hı	ull to S	heldo	n, IA		
DE	PTH		DESC	RIPTION O	F MATERIA	AL.					SA	\MP	LE	L	ABOR	ATOR	Y TES	STS
I FF	in FT	SUR	FACE E	LEVATION	1390.9 ft			ORIGIN	N	WL	NO.	רד	/PE	wc	D	LL	PL	QU
		V SAND	WITH S	SILT: a little	aravel, med	lium to	-11	COARSE										
	-	coarse	e graine	d, brown, di	ry to moist,	medium		ALLUVIUM	_		1		HSA					
	-	dense	, (SP-S	M)					-									
	-								_ 13		2	Й	SPT	8				
	-								_			Ш						
	-								- 14		3	M	SPT	5				
	-								_			Ĥ						
	-								- 10			\square	опт					
	-								_ 12	⊥	4	Д	351	°				
9	1/2				a little grav	vol		CLACIAL	-			\square						
	_	brown	and da	irk gray, moi	ist, stiff to v	ery stiff,		TILL	⁻ 17		5	М	SPT	15	121			
		(CL)							_									
						17		6	\square	SPT								
								_			Α							
	_											\square						
1	16 🗍								15		7	М	SPT					
	_		Botto	m of boreho	le at 16 fee	t.			_									
	-								_									
	_								_									
	_								_									
	-								_									
	-								_									
	-								_									
Q	-								_									
2/16/2	_								_									
DT 1	-								_									
NG.G	-								_									
TEKE	-								-									
GEC	-								F									
.GPJ	-								-									
0-K9	-								-									
DNG NG	-																	
ROK			WA	TER LEVE	L MEASUR	EMENTS			START	ſ	12-10	-20	C	OMPLE	TE_	12-10-	20 10:	45 am
	DATE	г	IME					WATER	METH	IOD		_						
JU 12	2-10-2	20 10:	:48 am	16		11		8.5	3.25"	<u>ID H</u>	ollow	<u>/ St</u>	em A	uger				
NH 12	2-12-2	20 3:	13 pm	16		10	Ţ	8										
EOTE							-		CREV			N	like V	Vagne	r			
Ű	-	1		-	-					, 01		10		, agiit				

SOIL CLASSIFICATION CHART

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

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

SYMBOLS FOR DRILLING AND SAMPLING

<u>Symbol</u>	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
Ν	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
WI	Water level directly measured in boring
V	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	<u>N-Value</u>	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

<u>Term</u>	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 1/2" thick stratum
Layer	¹ / ₂ " to 6" thick stratum
Lens	$^{1\!\!/_2\!\!\!2}$ 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%