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.



GEOTEK ENGINEERING & TESTING SERVICES, INC.

909 East 50th Street North Sioux Falls, South Dakota 57104 605-335-5512 • FAX 605-335-0773 1-800-354-5512 www.geotekeng.com

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 | рH | 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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| 4½ | <u>L</u> | EAN CLAY: (| dark brown, | moist, firm, | (CL) | | FINE ALLUVIUM | 5 | Ť | 3 | X | SPT | | | | | |
| 7 - | <u>Ll</u> br | EAN CLAY V own and gra | VITH SAND : ay mottled, r | a little grav noist, firm, | rel, (CL) | | GLACIAL TILL | - - 7 - | | 4 | X | SPT | 21 | 107 | | | |
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| 14 _ | Li bi | EAN CLAY V | V ITH SAND : stiff, (CL) | a little grav | rel, | | GLACIAL TILL | 7 | | 7 | X | SPT | | | | | |
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| DAT | E | TIME | SAMPLED DEPTH | CASING DEPTH | CAVE-IN DEPTH | | WATER LEVEL | MET | HOD | | | tem A | | | | | - F |
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| GEOTE | | | | | | 187-4- | - 0 No | D | | CD | BOR | ING | NO. | | 12-3 | (1 of 1 | i) |
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| DAT 8-4-8-25 | re l | WA TIME | SAMPLED | L MEASUR CASING | CAVE-IN | · | WATER | | THOE | | | = | OMPL | | <u>8-4</u> | -10 3:5 | os pm |
| 8-4- | | 3:55 pm | DEPTH 21 | DEPTH | DEPTH 19 | | none | 3.25 | <u> </u> | Hollo | w Ste | em A | uger | | | | |
| 8-25 | | 10:25 am | 21 | | 5.5 | <u>Ā</u> | 5 | | | | | | | | | | |
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| DEPTH | $\overline{}$ | | RIPTION OF | | | | GEOLOGIC | | | | MP. | LE | L | ABOR | ATOF | Y TES | STS |
| in FEET | F | | | | | | ORIGIN | N | WL | NO. | TY | /PE | wc | D | LL | PL | QU |
| | FIL mc | | CLAY: brov | wn and blac | k, | | FILL | - - _ 3 | | 1 | | HSA SPT | | | | | |
| 4½ | | AN CLAY: d | lark brown, | moist, firm, | (CL) | | FINE ALLUVIUM | - 6 - | | 3 | X | SPT | | | | | |
| 7 | CL ve | AYEY SANI ry loose, (So | D : fine grain C) | ed, brown, 1 | noist, | | MIXED ALLUVIUM | _ 3 | | 4 | M | SPT | | | | | : |
| 12 | - | | | | | | | - 3 - | | 5 | X | SPT | | | | | |
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| NG.GDT 9/24/10 | (C | EAN CLAY: (:L) | grayish brow | v⊓, moist, fir | m, | | FINE ALLUVIUM | 5 | | 8 | X | SPT | | | | | |
| GEOTECHNICAL TEST BORING 10-870.GPJ GEOTEKENG.GDT 9/24/1 | - - - - | AT CLAY : gr | ayish browr | ı, moist, stifi | f, (CH) | | FINE ALLUVIUM | - - 11 | | 9 | M | SPT | | | | | |
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| · | ROJECT | Prop | osed TW | S Segment 12 | 2, Lewis & Cla | ark Regiona | ai W | ater System, Ne | ar Bere | sford | , SD | | | | | | | |
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| GEOTECHNICAL TEST BORING 10-870.GPJ GEOTEKENG.GDT 9/24/10 | 14 | LEAN soft, (| CLAY: c | ark brownis | h gray, mois | st, | | FINE ALLUVIUM | 2 3 3 3 | ¥. | 1 2 3 4 5 6 7 | | SPT SPT SPT SPT | 41 | 79 | | | |
| RING | | | 18/4 | TED I TO I | L BATTA OLID! | | <u> </u> | | STAF | | 0.5 | 10 | | OMPL | CTT | 0.5 | 10.44- | 10.00 |
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| 崇 | 8-5-10 | | 1:10 am | DEPTH 21 | DEPTH | DEPTH 18 | Ţ | LEVEL 3 | | | | w S | tem A | \uger | | | | |
| 봙 | 8-25-10 | | 1:10 am 0:10 am | 21 | | 15 | Ţ | | 1 | | | | | | | | | |
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| 6 | GEOTE | EK# | 10-870 | | - | | | | | | | BORIN | G NO. | | 12-6 | (1 of 1 |) |
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| | - | LE/ sof | an CLAY : b t, (CL) | orownish gra | y, moist to v | wet, | | FINE ALLUVIUM | - | | 4 | SH | 31 | 94 | | | |
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| GEOTECHNICAL TEST BORING 10-870.GPJ GEOTEKENG.GDT 9/24/10 | • • • | - | | | | | | | - | | | | | | | | |
| 5 4 | | 1 | | | | | | | | | | | | | | | |
| 影 | | | WA | TER LEVE | L MEASUR | EMENTS | | <u></u> | STAF | .' ?T | 8-30 | -10 | COMPL | ETE | 8-30 | -10 1: | 20 pm |
| AL TEST B | DAT |] | TIME | SAMPLED DEPTH | CASING DEPTH | CAVE-IN DEPTH | | WATER LEVEL | MET | HOD |) | w Stem | | | | | |
| | 8-30- | | 1:20 pm | 21 | | 16 | Ţ | <u>7</u> | - | | | | | | | | |
| E | | | | | - | | 士 | | | | | | | | | | |
| 핑 | | | | | - | | | | CRE | W C | HIEF | Roy | Hanso | n | | | |

GEOTEK ENGINEERING & TESTING SERVICES, INC.

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

| GEC | OTEK# | 10-870 | | - | | | | | | | BORING | 3 NO. | | 12-7 | (1 of 1 |) |
|---|-----------------|--------------------------|-------------------------|--------------------------|------------------------|------|---------------------|--------------|----------|------|--------------|--------|-----------|------------|---------|-------|
| PRO | JECT F | Proposed TW | S Segment 1 | 2, Lewis & C | lark Regiona | al W | ater System, Ne | ar Bere | sford | | | | | | | |
| DEP in FEE | 1 | DESCR | RIPTION OF | MATERIA | L | | GEOLOGIC ORIGIN | N | WL | NO. | MPLE TYPE | wc | ABOR D | ATOR LL | Y TES | QU |
| | _ FIL mo | L. MOSTLY ist | CLAY: brov | wn and blac | k, | | FILL | _ | | 1 | HSA | | | | | |
| | - | | | | | | | 5 | | 2 | SPT | | | | | |
| 6 | - | | | | | | | 5 | ▼ | 3 | SPT | i. | | | : | |
| | <u>OF</u> (O | RGANIC LEA L) | AN CLAY: bi | ack, moist, | soft, | | TOPSOÏL | 4 | | 4 | SPT | | | | | |
| 9 | <u> L</u> E | AN CLAY: offt, (CL) | dark brownis | sh gray, moi | st, | | FINE ALLUVIUM | _ | | 5 | зн | 28 | 92 | | | |
| - | - | | | | | | | _ 3 | | 6 | SPT | | | | | |
| 14 | SA | ND: fine to aterbearing, | medium gra medium de | ined, browr nse, (SP) | 1, | | COARSE ALLUVIUM | 10 | | 7 | SPT | | | | | |
| i I | | | | | | | | - | | | | | | | | - |
| 9/24/10 | - | Rotto | m of boreho | le at 21 feet | | | <u> </u> | 11 | | 8 | SPT | | | | | |
| GEOTECHNICAL TEST BORING 10-870.GPJ GEOTEKENG.GDT 9724/10 | - | Dono | 5. 5516110 | .5 6. 21 100 | | | | - | | | | | | | | |
| 10-870.GPJ GE | | | | | | | | - - | | | | | | | | |
| SING | | | | | | | | | | | | | | | | |
| <u></u> | | WA | TER LEVE | | | | | STAF | | 8-5- | <u>10</u> C | OMPLI | ETE | 8-5- | 10 12:2 | 20 pm |
| CAL TEST | DATE 3-5-10 | TIME 12:20 pm | SAMPLED DEPTH 21 | CASING DEPTH | CAVE-IN DEPTH 12 | ¥ | WATER LEVEL 4 | MET 3.25' | | | w Stem / | Auger | | | | |
| NE B | -25-10 | 10:00 am | 21 | | 7 | ¥ | 4 | | | | | | | ••• | | |
| ₫ | | | | | - - | + | | CRE | /// CI | HIFF | Roy I | lansor | · | | | |

Geojek

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| 1 | | 10-870 | . | _ | | | | | | | вс | RING | NO. | | 12-8 | (1 of 1 | 1) |
|---|------------|--------------------|------------------|-----------------|------------------|----------|--------------------|----------|------------|--------|----------|-------------|--|----------|--------------|----------|----------|
| PROJEC | CT F | roposed TW | S Segment 1 | 2, Lewis & C | lark Regional | Wat | ter System, Ne | ar Bere | sford | | | | | | | | |
| DEPTH in | _ | DESCF | RIPTION OF | MATERIA | - | | SEOLOGIC ORIGIN | N | WL | NO. | MP | 'LE 'PE | wc | D D | LL | Y TES | QU |
| FEET | V | AN CLAV. L | lack, moist, | (CL) | | _ | TOPSOIL | | | - | | | | | | | |
| | <u> </u> | AN CLAT: D | iack, moist, | (CL) | <u></u> | 3 | TOPSOIL | - | | 1 | | HSA | | | | | |
| 2 _ | | | | | <u> </u> | | | | | ` | | | | | | | |
| | LE | AN CLAY : d | ark brown, i | moist, soft, | (CL) | | FINE | _ | | | ∇ | 007 | | | | | |
| 3½ | | | | | | | ALLUVIUM | _ 3 | | 2 | M | SPT | | | | | |
| - | LE | AN CLAY: b | rown, moist | , soft, (CL) | | | FINE | _ | | | | | | | | | |
| | | | | | | | ALLUVIUM | | | | М | | ļ | | | | |
| | | | | | | | · | 2 | | 3 | X | SPT | | | | | |
| - | 1 | | | | | | | - | | | П | | | | | : | |
| - | ł | | | | | | | - | | | | | | | | | |
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| - | 1 | | | | | | | - 2 | | 5 | IXI | SPT | | 1 | | | |
| _ | 4 | | | | | | | - | | | Н | | | | | | |
| 12 _ | | | | | /// | <u> </u> | | _ | ÷ | | Ц | | İl 💮 | | | | |
| | 분 | AN CLAY: 0 | rayish brow | n, moist, sc | oft, | | FINE ALLUVIUM | 2 | Ţ | 6 | M | SPT | | | ļ | | |
| - | 1 (| L) | | | | | ALLOVION | _ | * | | Д | | | | 1 | | |
| 1 - | - | | | | | | | - | | | | | | ! | | | |
| - | 4 | | | | | | | - 2 | | 7 | М | SPT | | 1 | | | |
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| - | - | | | | | | | - | - | | | | | | | | |
| 19 . | | TANLOL AV. | | +ft (OL) | | / | | Ļ | | | | | | | | | |
| | 1 | AN CLAY: | orown, mois | t, soit, (CL) | | | FINE ALLUVIUM | | | | М | | | | | | |
| 21 . | | | | | | | | 3 | | 8 | Х | SPT | | | | | |
| 5 41. | 1 | Bottor | n of boreho | le at 21 feet | <u>.</u> | 1 | | | | | Ħ | | | | | <u> </u> | |
| . 19 | - | | | | | | | - | | | | | | | | | |
| · E | - | | | | | | | - | | | | | | | | | |
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| 3 | | | | | | | | | | | | | | | | | 1 |
| 200 | 1 | | | | | | | | | | | | | | | | |
| [프 | + | | | | 1 | | | | | | | | | | | | |
| DAT 5-5-8-25-9-9-9-9-9-9-9-9-9-9-9-9-9-9-9-9-9-9- | _l | | | | | | | | | | | <u> </u> | <u> </u> | <u> </u> | <u></u> | | <u> </u> |
| <u> </u> | | | TER LEVE | | | | 1414777 | STAF | | 8-5 | 10 | c | OMPL | ETE | <u>8-5</u> - | 10 2:0 | 0 pm |
| E DAT | E | TIME | SAMPLED DEPTH | CASING DEPTH | CAVE-IN DEPTH | | WATER LEVEL | | HOD HOL | | A7 C1 | tem / | Auger | | | | |
| 할 8-5-1 | 10 | 2:00 pm | 21 | | 18 | | 15 | 0.20 | 101 | .0.10 | | <u> </u> | .ugur | | | | |
| 동 8-25- | | 9:55 am | 21 | | | Ţ | 13 | | | | | | | | | | |
| | | | | | | | - | CBE | WC | HIEF | | 2011 | lansoi | | | | |
| <u></u> | | | - | - | | | | UKE | .vv C | ושוניו | ŀ | NUY F | าสกรับ | 1 | | | , |

GEOTEK ENGINEERING & TESTING SERVICES, INC.909 E. 50th Street North
Sioux Falls, SD 57104
605-335-5512 Fax 605-335-0773 www.geotekeng.com

| | | 10-870 | | - | | | | | | | во | RING | NO. | | 12-9 | (1 of 1 |) |
|---------------------|------------------|-----------------------------|------------------------|-----------------|------------------------|------|--------------------------------|-------------------|----------------|------|---------|-------------|-------------|----------|------|---------|------------|
| | r — | | | | | al V | Vater System, Net | ar Bere | sford | | MP | ı F | | ABOR | ATOR | YTES | TS |
| DEPTH in FEET | - | DESCF | RIPTION OF | MATERIA | L | | GEOLOGIC ORIGIN | N | WL | NO. | | /PE | wc | D | LL | PL | QU |
| - | <u>OR</u> (OI | | Ñ CLAY: bl | ack, moist, | soft, | | SLOPE WASH | - - _ 3 | ¥ | 1 2 | | HSA SPT | | | | | |
| 4½ - - 7 - | | | prown, moist | | | | FINE ALLUVIUM | 6 | | 3 | X | SPT | | | | | |
| - | LE | AN CLAY: t ist, soft, (C | orown and g L) | ray mottled | • | | FINE ALLUVIUM | - - | | 4 | | SH | 28 | 96 | | | |
| 12 . | LE | AN CLAY: (| grayish brow | n, moist, fir | m, | | FINE | - 2 - | | 5 | | SPT | | | | | |
| 13½ | (C SA | L) I ND : a trace | of gravel, n | nedium grai | ined, | | ALLUVIUM COARSE ALLUVIUM | - 5 - 23 | | 7 | | SPT | | : | | | |
| 19 - | LE br | own, moist, | | _ | | | GLACIAL TILL | - - - 11 | | 8 | X | SPT | | | | | |
| DAT 8-30- | | Botto | m of boreho | e at 21 fee | t. | | | - - | | | | | | | | | |
| | | WA | ATER LEVE | L MEASUR | EMENTS | | <u> </u> | STAF | <u>।</u> २७ | 8-30 | -10 | C | II OMPLI | L ETE | 8-30 | -10 2:4 | 1 10 pm |
| DAT 8-30- | | TIME 2:40 pm | SAMPLED DEPTH 21 | CASING DEPTH | CAVE-IN DEPTH 14 | Ţ | WATER LEVEL 4 | MET | HOD | | | | uger | | | | |
| | -10 | 2:40 pm | | | | | | | W CI | | | | lansoi | | | | |

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| G | EOTE | K# | 10-870 | • | _ | | | | | | | BORING | S NO. | | 12-10 | (1 of | 1) |
|---|-------------------|------------------|-------------------------------|------------------|-----------------|------------------|----------|--------------------|------------------|----------|--------|--------------|--------|-----------|------------|--------|--------|
| P | ROJEC | T <u>P</u> | roposed TV | /S Segment 1 | 2, Lewis & C | lark Region | al W | /ater System, Ne | ar Bere | sford | | | -1 | | | | |
| | EPTH in EET | _ | DESC | RIPTION OF | MATERIA | L | | GEOLOGIC ORIGIN | N | WL | NO. | MPLE TYPE | WC | ABOR D | ATOR LL | Y TES | QU QU |
| | - | FIL mo | L, MOSTLY ist | CLAY: bro | wn and blac | k, | | FILL | 5 | | 1 2 | HSA SPT | | | | | |
| | 7 _ | OR | GANIC LE | AN CLAY: bl | ack, moist, | soft, | | SLOPE | 6 | | 3 | SPT | | | | | |
| | - | (OI | _) | | | | | WASH | - - - 3 | <u>T</u> | 5 | SH | 32 | 89 | | | |
| | 11 _ | <u>LE</u> sof | AN CLAY : (t, (CL) | grayish brow | vn, moist, fir | m to | | FINE ALLUVIUM | 5 | | 6 | SPT | | | | | |
| | - | | | | | | | | _ 3 _ _ | | 7 | SPT | | | | | |
| 24/10 | 19 _ | LE | AN CLAY: | brown, mois | t, soft, (CL) | | | FINE ALLUVIUM | 3 | | 8 | SPT | | <u>.</u> | | | |
| GEOTECHNICAL TEST BORING 10-870.GPJ GEOTEKENG.GDT 9/24/10 | 21 _ | | Botto | m of boreho | le at 21 fee | t. | | | - | | | | | | | | |
| ORING 10-8 | - | | \// | ATER LEVE | I MEASUR | FMFNTS | | | STAR | <u> </u> | 8-5- | 10 0 | OMPLE | TE | 8-5- | 10 3:1 |) nm |
| TESTB | DATI | E | TIME | SAMPLED DEPTH | CASING DEPTH | CAVE-IN DEPTH | T | WATER LEVEL | METI | HOD | | Stem A | | | <u> </u> | 0.1 | o piii |
| HINICAL | 8-5-1 8-25-1 | - | 3:10 pm 9:45 am | 21 | | 18 12.5 | Ā | 8 | 9,49_ | יט ר | VOIIOV | / Otelli F | | | | | |
| SEOTEC | | | | | | - | <u> </u> | - | CRE | N CI | HEF | Rov H | lansor | 1 | | | |

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| G | SEOTE | EK# | 10-870 | | _ | | _ | | | | | BORING | 3 NO. | | 12-11 | (1 of | 1) |
|--|--------------------|---------------|-------------|------------------------------|-----------------|------------------|------------------|--------------------|-------------|----------|------|-----------------|------------|-----------|-------|----------|----------|
| P | ROJEC | OT <u>F</u> | Proposed TW | S Segment 1 | 2, Lewis & C | lark Region | al W | ater System, Ne | ar Bere | sford | | | | | | | |
| D | EPTH in FEET | . | DESCF | RIPTION OF | MATERIA | L | | GEOLOGIC ORIGIN | N | WL | NO. | MPLE TYPE | wc | ABOR D | LL | Y TES | QU |
| \vdash | | | AN CLAY: b | lack, moist, | (CL) | | | TOPSOIL | | † | | Ы | | | ļ | | |
| | 1 - | LE | AN CLAY: g | rayish brow | n, moist to | wet, | | LOESS | _ | | 1 | HSA | II | | | | |
| | - | sof | ft, (CL) | | | | | | - | | | | | | | | |
| | \dashv | | | | | | | | - 3 | | 2 | SPT | | | | | |
| | - | | | | | | | | - | | | | | | | | |
| | _ | | | | | | | | - 3 | | 3 | SPT | | | | | |
| | _ | | | | | | | | - | | | М | | | | | |
| | - | | | | | | | ļ | - | | | | | | | | |
| | _ | | | | | | | | | 1_ | 4 | SH | 30 | 96 | | | |
| | _ | | | | | | | | _ | Ţ | ĺ | | | | | <u>'</u> | |
| | | | | | | | | | | | _ | M | | | | | |
| | _ | | | | | | | | 3 | | 5 | SPT | II . | | | ! | |
| | 12 _ | | | | | | | | | İ | | | | | | | |
| - | - | LE | AN CLAY V | VITH SAND: firm to stiff, | a little grav | el, | 1 | GLACIAL TILL | 5 | | 6 | \bigvee_{SPT} | | | | | |
| | |] ~"` | J. 171010t, | | (02) | | | | Γ | | | | | | | | |
| 1 | - | 1 | | | | | | | _ | | | \sqcup | | | | | |
| | - | 1 | | | | | | | 8 | | 7 | SPT | <u>l</u> i | | | | |
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| 1 | - | $\frac{1}{2}$ | | | | | | | - | | | | | | | | |
| 5 | _ | - | | | | | | | - 11 | | 8 | ∭spτ | | | | | |
| 9728 | 21 _ | 1 | Botto | m of boreho | le at 21 fee | | 92 | | ļ | 4 | | <u> </u> | ╢— | ļ | ļ | | |
| G.GD. | - | $\frac{1}{2}$ | 20 | | | •• | | | - | | | | | | | | |
| | - | _ | | | | | | | - | | | | | | | | |
| GEOTECHNICAL TEST-BORING 10-870.GPJ GEOTEKENG.GDT 9/28 | | - | | | | | | | - | | | | | | | | |
| GB | - | _ | | | | | | | <u>_</u> | | | | | | | | |
| 0-870 | | | | | | | | | - | | | | | | | | |
| SI_ | | | | | | | | | <u> </u> | | | | | <u> </u> | | | <u> </u> |
| | | | WA | TER LEVE | 1 | 1 | 1 | MATER | STAF | _ | 8-5- | 10 C | OMPL | ETE | 8-5- | 10 4:2 | 0 pm |
| L TES | DAT | Έ | TIME. | SAMPLED DEPTH | CASING DEPTH | CAVE-IN DEPTH | | WATER LEVEL | MET 3.25 | | | v Stem | Auger | | | | |
| 황 | 8-5-1 | | 4:20 pm | 21 | | 12 | ¥ | 12 | | | | | | | | | |
| 핡 | 8-25- ⁻ | 10 | 9:40 am | 21 | | 8.5 | _ ₹ | 8.5 | | | | | | | | | |
| 띪 | | | | | - | | | | CRE | W C | HIEF | Roy I | Hansor | 1 | | | |

GEOTEK ENGINEERING

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Sioux Falls, SD 57104
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| GEOTE | FK# | 10-870 | <u></u> | | | | | | | | BOF | RING | NO. | , | 12-12 | (1_of | 1) |
|--|------------|---------------------------|-------------------------------|-------------------|---|--------|--------------------|--------------|--------|-----------|--|------|-------|-----------|------------|---------|----------|
| | | | /S Segment 1 | - 2, Lewis & C | lark Regional | W | ater System, Ne | ar Bere | sford | , SD | | | | | | (, | ·/ |
| DEPTH in FEET | - | DESCF | RIPTION OF | MATERIA | Ĺ | | GEOLOGIC ORIGIN | N | WL | SA NO. | MPL TYI | | wc | ABOR D | ATOR LL | Y TES | TS QU |
| - | 1 7 | | CLAY: brov | wn and blac | k, | × | FILL | - | | 1 | 1 | ISA | | | | | |
| - | | | | | | | | - _ 5 | | 2 | \\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\ | SPT | | | | | |
| 6 _ | OR (OL | GANIC LEA | an Clay : bi | ack, moist, | firm, | ×× -] | SLOPE WASH | - 3 - | | 3 | X | SPT | | | | | |
| - | - (O. |) | | | 11111 | | WAGII | - | | 4 | | SH | 40 | 77 | | : | |
| - | | | | | [| 111111 | | 5 | Ť | 5 | X. | SPT | | | | | |
| 12 - | FAT (CF | Г CLAY : da l) | ark grayish b | rown, moist | , soft, | | FINE ALLUVIUM | 3 | ! | 6 | X. | SPT | | : | | | |
| 14 - | LE/ (CL | AN CLAY: () | grayish brow | n, moist, so | oft, | | FINE ALLUVIUM | 2 | | 7 | X. | SPT | | | | | |
| 19 | SA gra | ND: a trace ined, brow | e of gravel, f n, waterbea | ine to medio | ım (SP) | | COARSE ALLUVIUM | - - 6 | | 8 | M; | SPT | | | | | : |
| 21 DAT DATE DA | - | Botto | m of boreho | le at 21 feet | . · · · · · · · · · · · · · · · · · · · | | | - | | | <i>Y</i> \ | | | | | | |
| ORING 10-8/0,car | | \\/\/ | ATER LEVE | I MEASUR | EMENTS | | | - STAR | T PT | 8-6- | 10 | C | OMPLE | ETF | 8-6 | 10 10:2 | 25 am |
| DAT | re l | TIME | SAMPLED | CASING | CAVE-IN | | WATER | MET | HOD | | | | | | 3.03 | | |
| 8-6- 8-25- | 10 | 10:25 am 9:30 am | DEPTH 21 21 | DEPTH | DEPTH 15 11.5 | Ţ | 10 11 | 3.25" | ' ID F | lollov | v Ste | em A | uger | | | | |
| GEOTE | | | | | | | - | CRE | W CI | HEF | R | оу Н | ansor | 1 | | | |

GEOTEK ENGINEERING

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

| GEO | | 10-870 | | | | | | | | | BORII | NG NO. | | 12-14 | (1 of | 1) |
|---|-------------|--|---------------------|-----------------|------------------|------|--------------------------------------|-------------|-------|--------------|----------|---------------|-------|-------|--------|----------|
| PRO. | JECT | Proposed TW | S Segment 12 | 2, Lewis & Cl | ark Region | al W | ater System, Ne | ar Bere | sford | | . ID. E | | 1.400 | 24705 | V TEC | |
| DEPT in FEE | | DESCR | IPTION OF | MATERIAL | - | | GEOLOGIC ORIGIN | N | WL | NO. | TYPE | $\neg \vdash$ | | LL | PL | QU |
| | OI _ fir | RGANIC LEA m, (OL) | N CLAY : bla | ack, moist, s | soft to | | SLOPE WASH | 3 | | 1 | HS SP | Т | | | | |
| 7 | | EAN CLAY : d oft, (CL) | ark grayish | brown, moi | st, | | FINE ALLUVIUM | - 4 | * | 4 5 | SP | -1 26 | 95 | | | |
| 14 | | EAN CLAY: 9 CL) EAN CLAY: 8 CL) | | | _ | | FINE ALLUVIUM FINE ALLUVIUM | 3 | | 7 | SF | | | | | |
| GEOTECHNICAL TEST BORING 10-870.GPJ GEOTEKENG.GDT 9/24/10 | 1 - | Bottor | n of boreho | le at 21 feet | . | | | - 4 | | 8 | SF | PT | | | | |
| SING. | | | | | | | | <u> </u> | | | | | | | | <u> </u> |
| 8 | | WA | TER LEVE | | | | | STAF | | 8-6 | -10 | COMP | LETE | 8-6- | 10 11: | 35 am |
| TES. | DATE | TIME | SAMPLED DEPTH | CASING DEPTH | CAVE-IN DEPTH | | WATER LEVEL | MET 3.25 | | | w Sten | n Auge | r | | | |
| 8 | -6-10 | 11:35 am | 21 | | 18 | | 10 | 1 | | | , | | | | | |
| = 8- | 25-10 | 9:25 am | 21 | | 14.5 | Ţ | | | | | | | | | | |
| | | | | | | + | | CRE | WC | <u>HIE</u> F | Ro | y Hans | on | | | |

Georek

GEOTEK ENGINEERING & TESTING SERVICES, INC.

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

| GEOTE | ΞK# | 10-870 | | • | | | | | | | BORI | NG | NO. | | 12-15 | (1_of | 1) |
|--|--------------------|--|------------------------------|----------------------------|---------------------------|----------|-----------------------|----------------------|-------|------|--------------|--------|-------|-----|--------|---------|--------------|
| PROJE | CT <u>F</u> | roposed TW | S Segment 1 | 2, Lewis & Cl | ark Regiona | JW | ater System, Nea | ar Bere | sford | | | | | | | | |
| DEPTH in FEET | - | DESCR | RIPTION OF | MATERIAL | - | | GEOLOGIC ORIGIN | N | WL. | NO. | MPLE TYPI | | wc | D | LL | Y TES | QU |
| - | ı₩ | L, MOSTLY ist | CLAY: brov | vn and blac | k, | | FILL | - - | | 1 | HS | SA | | | | | |
| 41/2 | | CANIC LEA | AN CLAV. NI | al maint | | | TOPSOIL | _ 7 - | Ť | 2 | SF | PT | | | : : | : | |
| 7 . | 0 | | | | - - - - - | | FINE | - 4 - | | 3 | X SF | PT | | | | | |
| 9 . | <u></u> (C | ŕ | _ | | | | ALLUVIUM | 4 | | 4 | SF | PT | | | | | |
| - | SA bro | MD: a trace own, waterb | of gravel, n earing, dens | nedium grai se, (SP) | ned, : | | COARSE ALLUVIUM | - - 17 - | | 5 | SI | >⊤ | | | | | |
| 12 | <u>S</u> A - Wa | ND : mediur aterbearing, | n grained, b medium dei | rown, nse, (SP) | | | COARSE ALLUVIUM | 12 | | 6 | SI | PT | | | | | |
| 14 | _ br | AND: a little own, waterb ense, (SP) | gravel, med earing, dens | ium grained se to mediu | i, m | | COARSE ALLUVIUM | 16 | | 7 | SI | PΤ | | i | | | |
| | | | | | | | | <u> </u> - - | | | | | | | | | |
| 21 | | | | | | | | 13 | | 8 | s | PT | | | | | |
| TEST BORING 10-870.GPJ GEOTEKENG.GDT V | | Bottor | n of boreho | e at 21 feel | i. | i | | - | | | | | | | | | |
| NG 10-870.GPJ (| | | | | | <u> </u> | | - | | | | | | | | | |
| BOR | | WA | TER LEVE | | EMENTS | _ | | STAF | ₹Т | 8-6- | 10 | С | OMPLI | ETE | 8-6- | -10 1:0 |)5 pm |
| DAT | | TIME 1:05 pm | SAMPLED DEPTH 21 | CASING DEPTH | CAVE-IN DEPTH 9 | Ţ | WATER LEVEL 3.5 | MET 3.25 | | | v Ster | m A | uger | | | | , |
| 8-6-8-8-25 | -10 | 9:20 am | 21 | | 4.5 | Ÿ | | | | | | | | | | | |
| 8 | | | | | | | | CRE | W C | HIEF | Ro | уΗ | ansor | 1 | | | |

GEOTEK ENGINEERING

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

| . G | EOTE | EK# | 10-870 | | _ | | | | | | | BORING | NO. | | 12-16 | (1 of | 1) |
|---|--------------------|------|---|-----------------------------|----------------------------|--|--------------------|--------------------|--------------|-------|--------------|----------|-----------|------|-------|--------|-------------|
| Р | ROJEC | CT . | Proposed TV | VS Segment 1 | 2, Lewis & C | lark Regior | al V | Vater System, Ne | ear Bere | sforc | | | | | | | |
| | EPTH in FEET | Ţ | DESCI | RIPTION OF | MATERIA | | GEOLOGIC ORIGIN | N | WL | | MPLE TYPE | wc | ABOR D | ATOR | Y TES | QU | |
| | _ | LE | EAN CLAY: I | olack, moist, | (CL) | | | TOPSOIL | - | Ā | 1 | HSA | | | | | |
| | 2 | LE | EAN CLAY: I | orown, moist | t, firm, (CL) | | | FINE ALLUVIUM | 5 | - | 2 | SPT | | | | | |
| | 3½ | br | AND: a trace rown, waterb ense, (SP) | of gravel, nearing, very | nedium grai loose to m | ined, edium | | COARSE ALLUVIUM | - - 3 | | 3 | SPT | | | | | |
| | | | | | | | | | 11 | | 4 | SPT | | | | | |
| | 9 _ | bг | AND : a little rown, waterb ense, (SP) | gravel, med earing, dens | ium grained se to mediu | i, im | | COARSE ALLUVIUM | 20 | | 5 | SPT | | | | | |
| - | 14 _ | 8 | AND: a little | gravel, med | ium to coor | | | COARSE | 13 | | 6 | SPT | | | | | |
| | - | gr | rained, brow loose, (SP) | n, waterbeai | ring, mediu | se m dense | | ALLUVIUM | _ 12 _ | | 7 | SPT | | | | | |
| | - | | | | | | | | - | | | | | | | | |
| 7T 9/28/10 | 21 _ | | Botto | m of boreho | le at 21 fee | <u>. </u> | | | 8 | - | 8 | SPT | | | | | |
| GEOTECHNICAL TEST BORING 10-870.GPJ GEOTEKENG GDT 9/2 | - - - | - | | | | | | | - - - | | | | | | | | |
| ING 10- | - | | | | | | | | - | | | | | | | | |
| | | | W | ATER LEVE | L MEASUR | EMENTS | | | STAR | ₹Τ | 8-6- | 10 C | OMPLE | TE . | 8-6- | 10 2:0 | 5 pm |
| AL TEST | DATE 8-6-1 | | TIME | SAMPLED DEPTH | CASING DEPTH | CAVE-IN DEPTH | | WATER LEVEL | MET 3.25" | | | ∕ Stem A | uger | | | | |
| 計 | 8-25-1 | | 2:05 pm 9:15 am | 21 21 | | 2.5 | Ţ | 1 . 1.5 | - | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| ₩ <u></u> | | | | - | | | | | CRE | W C | HIEF | Roy H | anson | | | | |

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Sioux Falls, SD 57104
605-335-5512 Fax 605-335-0773 www.geotekeng.com

| 0 | GEOTE | EK# | 10-870 | | - | | | | | | | во | RING | NO. | | 12-17 | (1 of | <u>ı)</u> |
|---|--------------------|------------------|-----------------------------|---------------------------------|------------------------------|------------------------|---------|----------------------|--------------|-------|------|------|-------|-------|-----------|-------|--------|-----------|
| F | PROJEC | OT F | Proposed TW | S Segment 1: | 2, Lewis & C | ark Regiona | al W | later System, Ne | ar Bere | sford | | | | | | | | |
| 1 | EPTH in FEET | . | DESCF | RIPTION OF | MATERIA | L. | | GEOLOGIC ORIGIN | N | WL | NO. | TY | PE | wc | ABOR D | LL | Y TES | QU QU |
| ŀ | _ | LE | AN CLAY : b | lack, moist, | (CL) | | | TOPSOIL | - | | 1 |) | HSA | | | | | |
| | 2 _ | LE | AN CLAY: d | lark brown, r | noist, firm, | (CL) | | FINE ALLUVIUM | 5 | | 2 | X. | SPT | | | | | |
| | 7 _ | SA gra (SI | ained, brown | of gravel, fin n, moist, ver | ne to mediu y loose to lo | m oose, | | COARSE ALLUVIUM | - - 4 | | 3 | X. | SPT | | | | | |
| | 9 _ | 84 | ND: a trace | of gravel, m | andium arai | ned | | COARSE | 5 | Ī | 4 | X | SPT | | | | | |
| | _ | bro | own, waterb | earing, dens | se, (SP) | | | ALLUVIUM | 16 | * | 5 | | SPT | | | | - | |
| ļ | - 14 _ | | | | | | | | 16 | | 6 | X | SPT | | | | | |
| - | - | gra | MD: a little ained, brow | gravel, medi n, waterbear | ium to coars ing, dense, | se (SP) | | COARSE ALLUVIUM | 22 | | 7 | X | SPŢ | | | | | |
| 3/28/10 | - - 21 . | | | | | | | | 26 | | 8 | X | SPT | | | | | |
| GEOTECHNICAL TEST BORING 10-870.GPJ GEOTEKENG.GDT 9/28/10 | | - | Botto | n of borehol | ie at 21 feel | | | | - - - | | | | | | | : | | |
| ING 10-870.GF | | | | | | ļ | | | - | | | | | | | | | |
| BOR | | | WA | TER LEVE | | | | | STAR | _ | 8-6- | 10 | _ 0 | OMPLE | ETE | 8-6- | 10 3:0 | 0 pm |
| CAL TEST | DAT 8-6-1 | | TIME 3:00 pm | SAMPLED DEPTH 21 | CASING DEPTH | CAVE-IN DEPTH 10 | | WATER LEVEL 10 | MET 3.25" | | | v St | em A | uger | | | | |
| 홝 | 8-25- | | 9:10 am | 21 | | 9.5 | Ā | | 1 | | | | | | | | | |
| | | | | | | | \perp | | CBE | M/ C | | | Par L | ance | | | | |
| öL | | | | | | | | - | CRE | ۷۷ С | コルビト | | oy H | ansor | ı | | | |

SOIL CLASSIFICATION CHART

| M | AJOR DIVISION | ONS | SYME GRAPH | BOLS LETTER | TYPICAL 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% OF MATERIAL IS | 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 FRACTION | 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 |
| 00.20 | | | | OL | ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY |
| MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE | | | | MH | 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 |
| Н | IGHLY ORGANIC | SOILS | 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 | 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

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

DESCRIPTIVE TERMINOLOGY

| FEBRUARY PROPERTY. | |
|--------------------|--------------------------------|
| <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 | ½" to 6" discontinuous stratum |
| | • |

PARTICLE SIZES

| Hall-service data to the service of | | | | | | |
|---|-------------------|--|--|--|--|--|
| <u>Term</u> | 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 | | | | | |

GRAVEL PERCENTAGES

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