GEOTEK ENGINEERING
& TESTING SERVICES, INC.
909 East 50th Street North
Sioux Falls, South Dakota 57104
Phone 605-335-5512 Fax 605-335-0773

July 28, 2020

City of Lake Norden, SD
508 Main Avenue
Lake Norden, SD 57248

Attn: Mrs. Delores Kangas, City Finance Officer

Subj: Geotechnical Exploration
Proposed Lift Station
Wastewater Treatment Facility
Lake Norden, South Dakota
GeoTek #20-B50

This correspondence presents our written report of the geotechnical exploration program for the referenced project. Our work was performed in accordance with your authorization. We are transmitting an electronic copy of our report for your use. An additional copy is also being sent as noted below.

We thank you for the opportunity of providing our services on this project and look forward to continued participation during the design and construction phases. If you have any questions regarding this report, please contact our office at (605) 335-5512.

Respectfully Submitted,
GeoTek Engineering & Testing Services, Inc.

Daniel R Hanson

Daniel R Hanson, PE
General Manager

Cc: Banner Associates, Inc., Attn: Tanya Miller, PE

TABLE OF CONTENTS

GEOTECHNICAL EXPLORATION
PROPOSED LIFT STATION
WASTEWATER TREATMENT FACILITY
LAKE NORDEN, SOUTH DAKOTA
GEOTEK #20-B50

INTRODUCTION

Project Information

This report presents the results of the recent geotechnical exploration program for the proposed lift station at the Wasterwater Treatment Facility for the City of Lake Norden, South Dakota.

Scope of Services

Our work was performed in accordance with the authorization of Mayor Jason Aho of the City of Lake Norden. The scope of work as presented in this report is limited to the following:

1. To perform 1 standard penetration test (SPT) boring to gather data on the subsurface conditions at the project site.

2. To perform laboratory tests that include moisture content and dry density.

3. To prepare an engineering report that includes the results of the field and laboratory tests as well as our geotechnical engineering opinions and recommendations regarding the following:

    - Lift station excavation & backfill;
    - Temporary shoring;
    - Potential groundwater control;
    - Comments regarding factors that may impact the constructability and final performance of the project;
    - Quality control observations and testing.

The scope of our work was intended for geotechnical purposes only. This scope of work did not include determining the presence or extent of environmental contamination at the site or to characterize the site relative to wetlands status.

SITE & SUBSURFACE CONDITIONS

Site Location & Description

The project site is located on the north side of the existing wastewater treatment lagoons. The existing wastewater treatment facility is located on the south side of Lake Norden.

Test Boring Locations & Ground Surface Elevation

One (1) test boring was performed on July 21, 2020. The attached map shows the test boring location. The test boring was moved 4 feet south of the staked location. The ground surface elevation at the staked test boring location was provided by Banner Associates as 1,673.6. The ground surface elevation at the test boring location (moved 4 feet south) was 1,674.2 feet. The top of the water in the adjacent lagoon and slough to the northwest was at elevation 1,671.1 feet and 1,666.6 feet respectively.

Subsurface Conditions

The subsurface conditions encountered at the test boring locations are illustrated by means of the boring log included in Appendix A.

Existing fill materials and buried topsoil extended to a depth of 3 feet. Fine alluvium soils were encountered beneath the existing fill materials to a depth of 8 feet. At a depth of 8 feet, glacial till soils were encountered and extended to the termination depth of the test boring.

The existing fill materials consisted of lean clay soils. The topsoil consisted of lean clay soils. The fine alluvium soils consisted of lean clay soils. The glacial till soils consisted of lean clay with sand soils.

The consistency or relative density of the soils is indicated by the standard penetration resistance ("N") values as shown on the boring log. A description of the soil consistency or 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 at the site may differ from those found at our test boring locations. If different conditions are encountered during construction, then it is important that you contact us so that our recommendations can be reviewed.

Water Levels

Measurements to record the groundwater levels were made at the test boring location. The time and level of the groundwater measurements are recorded on the boring log. Groundwater did not enter the borehole at the time of our measurement.

The water level indicated on the boring log 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.

ENGINEERING REVIEW & RECOMMENDATIONS

Project Design Data

We understand that the project will consist of constructing a new submersible lift station. The new submersible lift station will be an 8 foot or 10 foot precast box type construction with a depth of about 23 feet. There will also be an adjacent 6' diameter manhole for a valve vault, approximately 8 feet deep. We assume that temporary shoring will be needed for the installation of the lift station.

The information/assumptions detailed in the project design data section of the report are important factors in our review and recommendations. If there are any corrections or additions to the information detailed in this section, it is important that you contact us so that we can review our recommendations with regards to the revised plans.

Excavation, Dewatering & Stable Condition

While groundwater did not enter the bore hole immediately upon completion of drilling, it is our opinion that groundwater will enter the excavation. Our opinion is based on the water levels in

the adjacent lagoon and slough to the northwest. Therefore, dewatering will likely be needed during the installation of the lift station. 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 predominant clayey soils encountered at the test boring. However, if lenses or layers of waterbearing sand soils are encountered, then more extensive dewatering techniques would likely be needed. In an effort to provide a stable condition for the installation of the lift station, we recommend placing a minimum of 12 inches of drainage rock at the bottom of the excavation. The drainage rock should be crushed, washed and have 100 percent by weight passing the 1-inch sieve and no more than 5 percent by weight passing the #4 sieve. The drainage rock will also help facilitate drainage at the bottom of the excavation.

Soil Parameters – Temporary Shoring Design

As previously stated, we assume that temporary shoring will be needed for the installation of the lift station. We have provided soil parameters for the design of the temporary shoring (Figure 2 – attached at the conclusion of the report). We would like to point out that the parameters shown in Figure 2 are based on a groundwater level of approximately 3 feet. This does not mean that groundwater was encountered at a depth of 3 feet; it is to account for future fluctuations in the groundwater level. We can also provide additional soil parameters if needed.

OSHA Soil Types

It is our opinion that the existing fill materials, topsoil and fine alluvium soils would be classified as Type C soils. The glacial till soils would also be classified as a Type B soil.

Backfill

A portion of the on-site soils excavated may not be suitable for use as backfill. These unsuitable materials would consist of highly organic soils as well as soils having high moisture content levels such that the specified compaction level cannot be reasonably achieved. The soils in the upper 12 feet have high moisture contents and may require 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 dryer on-site soils or suitable off-site borrow soils. Below a depth of 12 feet the soils have favorable moisture contents.

Suitable off-site borrow soils should consist of either a granular or clay material. If a granular material is used, it should consist of a pit-run or processed sand or gravel having a maximum particle size of 3 inches. If a clay material is selected, it should consist of a non-organic clay having a liquid limit less than 45. Scrutiny on the clay material's moisture content should be made prior to the acceptance and use.

We recommend that the backfill soils be placed in uniform thin lifts (6-inch maximum lifts). Backfill soils should be compacted to a minimum of 95 percent of standard Proctor density (ASTM:D698). Generally, it will be easier to achieve the compaction specification if the moisture content of the backfill soils is adjusted to within plus or minus 2 percent of the optimum moisture content as determined by standard Proctor (ASTM:D698).

CONSTRUCTION CONSIDERATIONS

Groundwater & Surface Water

Water may enter the excavations due to subsurface water, precipitation or surface run off. Any water that accumulates in the bottom of the excavations should be immediately removed and surface drainage away from the excavations should be provided during construction.

Disturbance of Soils

The soils encountered at the test boring locations are susceptible to disturbance and can experience strength loss caused by construction traffic and/or additional moisture. Precautions will be required during earthwork activities in order to reduce the risk of soil disturbance. Low-ground-pressure construction equipment or excavators with smooth-edged buckets should be used for the earthwork activities.

Cold Weather Precautions

If site preparation and construction is anticipated during cold weather, we recommend all subgrades, slabs and other improvements that may be affected by frost movements be insulated from frost penetration during freezing temperatures. If filling is performed during freezing temperatures, all frozen soils, snow and ice should be removed from the areas to be filled prior to

placing the new fill. The new fill should not be allowed to freeze during transit, placement and compaction. Concrete and asphalt should not be placed on frozen subgrades. If subgrades freeze, we recommend that the frozen soils be removed and replaced, or completely thawed. The subgrade soils will likely require reworking and recompacting due to the loss of density caused by the freeze/thaw process.

Excavation Sideslopes

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.

Observations & Testing

This report was prepared using a limited amount of information for the project and a number of assumptions were necessary to help us develop our conclusions and recommendations. It is recommended that our firm be retained to review the geotechnical aspects of the final design plans and specifications to check that our recommendations have been properly incorporated into the design documents.

The recommendations submitted in this report have been made based on the subsurface conditions encountered at the test boring locations. It is possible that there are subsurface conditions at the site that are different from those represented by the test borings. As a result, on-site observation during construction is considered integral to the successful implementation of the recommendations. We believe that qualified field personnel need to be on-site at the following times to observe the site conditions and effectiveness of the construction.

Excavation

We recommend that a geotechnical engineer or geotechnical engineering technician working under the direct supervision of a geotechnical engineer observe all excavations for utilities, slabs and pavements. These observations are recommended to determine if the exposed soils are

similar to those encountered at the test boring locations, if unsuitable soils have been adequately removed and if the exposed soils are suitable for support of the proposed construction.

Testing

After the subgrade is observed by a geotechnical engineer/technician and approved, we recommend a representative number of compaction tests be taken during the placement of the backfill placed below slabs and pavements. The tests should be performed to determine if the required compaction has been achieved. As a general guideline, we recommend at least one (1) test be taken for every 10,000 square feet of embankment fill placed, at least one (1) test for every 500 feet in trench fill, and for every 2-foot thickness of fill or backfill placed. The actual number of tests should be left to the discretion of the geotechnical engineer. Samples of proposed fill and backfill materials should be submitted to our laboratory for testing to determine their compliance with our recommendations and project specifications.

SUBSURFACE EXPLORATION PROCEDURES

Test Borings

We drilled one SPT boring on July 21, 2020 with a truck rig equipped with hollow-stem auger. Soil sampling was performed in accordance with the procedures described in ASTM:D1586. Using this procedure, a 2-inch O.D. split barrel sampler is driven into the soil by a 140-pound weight falling 30 inches. After an initial set of 6 inches, the number of blows required to drive the sampler an additional 12 inches is known as the penetration resistance, or “N” value. The “N” value is an index of the relative density of cohesionless soils and the consistency of cohesive soils. In addition, thin walled tube samples were obtained according to ASTM:D1587, where indicated by the appropriate symbol on the boring log.

The test boring were backfilled with on-site materials and some settlement of these materials can be expected to occur. Final closure of the hole is the responsibility of the client or property owner.

Soil Classification

As the samples were obtained in the field, they were visually and manually classified by the crew chief according to ASTM:D2488. Representative portions of all samples were then sealed and returned to the laboratory for further examination and for verification of the field classification. In addition, select samples were then submitted to a program of laboratory tests. Where laboratory classification tests (sieve analysis and Atterberg limits) have been performed, classifications according to ASTM:D2487 are possible. Log of the test borings indicating the depth and identification of the various strata, the "N" value, the laboratory test data, water level information and pertinent information regarding the method of maintaining and advancing the drill holes are also attached in Appendix A. Charts illustrating the soil classification procedures, the descriptive terminology and the symbols used on the boring log are also attached in Appendix A.

Water Level Measurements

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

Laboratory Tests

Laboratory tests were performed on select samples to aid in determining the index properties of the soils. The index tests consisted of moisture content. The laboratory tests were performed in accordance with the appropriate ASTM procedures. The results of the laboratory tests are shown on the boring log opposite the samples upon which the tests were performed or on the data sheets included in the Appendix.

LIMITATIONS

The recommendations and professional opinions submitted in this report were based upon the data obtained through the sampling and testing program at the test boring locations. We wish to point out that because no exploration program can totally reveal the exact subsurface conditions for the entire site, conditions between test borings and between samples and at other times may differ from those described in our report. Our exploration program identified subsurface conditions only at those points where samples were retrieved or where water was observed. It is not standard engineering practice to continuously retrieve samples for the full depth of the test borings. Therefore, strata boundaries and thicknesses must be inferred to some extent. Additionally, some soils layers present in the ground may not be observed between sampling intervals. If the subsurface conditions encountered at the time of construction differ from those represented by our test borings, it is necessary to contact us so that our recommendations can be reviewed. The variations may result in altering our conclusions or recommendations regarding site preparation or construction procedures, thus, potentially affecting construction costs.

This report is for the exclusive use of the addressee and its representatives for use in design of the proposed project described herein and preparation of construction documents. Without written approval, we assume no responsibility to other parties regarding this report. Our conclusions, opinions and recommendations may not be appropriate for other parties or projects.

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.

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

Daniel R Hanson, PE
General Manager

REGISTERED PROFESSIONAL ENGINEER
REG. NO. 4629
DANIEL R. HANSON
SOUTH DAKOTA
7-28-20

To City of Lake Norden

BORING IS LOCATED 4' SOUTH OF STAKED LOCATION

450th Avenue

Entrance into Lake Norden Wastewater Treatment Facility. Contact Dan Koistinen at (605) 881-5688 to access facility.

0 25 50 FT

BANNER
engineering a better community
www.bannerassociates.com - Toll Free: 1.855.323.6342

PROJECT / SHEET TITLE:
LAKE NORDEN MAIN LIFT STATION IMPROVEMENTS
ACCESS SITE PLAN
LAKE NORDEN, SOUTH DAKOTA

REV	DATE	DESCRIPTION

FOR REVIEW ONLY NOT FOR CONSTRUCTION

JOB No.:	23227.00.00
DATE:	MAY 2020
DESIGNED BY:	
CHECKED BY:	
DRAWN BY:	

0 1/2" 1"
SCALE REDUCTION BAR

SHEET No. :
1

F:\23227-00\Design Phase\CADD\Sheet File\CIVI SHTS - L AKE NORDEN.dwg;6/29/2020 4:24 PM

FIGURE 2. SOIL PARAMETERS – TEST BORING 1

Soil Type	Geological Origin	Depth Below Existing Grade, ft	At-Rest, pcf		Active, pcf		Passive, pcf	
			Drained	Submerged	Drained	Submerged	Drained	Submerged
Lean Clay	Fill/Topsoil	0-3	65	95	45	85	330	160
Lean Clay	Fine Alluvium	3-8	90	110	75	100	205	100
Lean Clay with Sand	Glacial Till	8-31	85	105	65	95	260	135

Note: The parameters are based on an estimated groundwater level of approximately 3 feet. Therefore, the submerged values should be used below a depth of 3 feet.

Soil Type	Geological Origin	Depth Below Existing Grade, ft	Effective Unit Weight, pcf*	Cohesion, psf	Friction Angle, degrees	Lateral Soil Modulus, K, pci	Strain @ 50%, E50	Relative Density, D_R, %
Lean Clay	Fill/Topsoil	0-3	120	100	15	20	0.020	-
Lean Clay	Fine Alluvium	3-8	60	500	17	50	0.020	-
Lean Clay with Sand	Glacial Till	8-15	66	1500	20	250	0.010	-
Lean Clay with Sand	Glacial Till	15-31	66	2500	20	900	0.005	-

*Based on an estimated groundwater level of approximately 3 feet.

GEOTEK ENGINEERING
& TESTING SERVICES, INC.
909 E 50th St N
SIOUX FALLS, SD 57104
(605) 335-5512 Fax (605) 335-0773
info@geotekeng.com

GEOTECHNICAL TEST BORING LOG

GEOTEK # **20-B50** BORING NO. **1 (1 of 1)**

PROJECT **Proposed Lift Station, Wastewater Treatment Facility, Lake Norden, SD**

DEPTH in FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION 1674.2 ft)	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	LABORATORY TESTS WC	D	LL	PL	QU
	FILL, MOSTLY LEAN CLAY: brown, moist	FILL			1	HSA					
2											
3	**LEAN CLAY**: dark brown, moist, firm, (CL)	TOPSOIL	6		2	SPT					
	LEAN CLAY: mottled brown and gray, moist, firm, (CL)	FINE ALLUVIUM	5		3	SPT	31				
8			5		4	SPT	27				
	LEAN CLAY WITH SAND: a little gravel, brown, moist, stiff, (CL)	GLACIAL TILL	10		5	SPT	25				
			10		6	SPT	18				
			14		7	SPT	18				
19½											
	LEAN CLAY WITH SAND: a little gravel, dark brown, moist, stiff, (CL)	GLACIAL TILL	14		8	SPT	18				
			11		9	SPT	19				
29½											
31	**LEAN CLAY WITH SAND**: a little gravel, gray, moist, stiff, (CL)	GLACIAL TILL	13		10	SPT					
	Bottom of borehole at 31 feet.										

estimated groundwater elevation

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL
7-21-20	3:02 pm	31	--	28	None
--	--	--	--	--	--
--	--	--	--	--	--
--	--	--	--	--	--

START 7-21-20 COMPLETE 7-21-20 3:06 pm

METHOD
3.25" ID Hollow Stem Auger

CREW CHIEF Mike Wagner

GEOTECHNICAL TEST BORING 20-B50.GPJ GEOTEKENG.GDT 7/27/20

BORING LOG SYMBOLS AND DESCRIPTIVE TERMINOLOGY

SYMBOLS FOR DRILLING AND SAMPLING

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

SYMBOLS FOR LABORATORY TESTS

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

DENSITY/CONSISTENCY TERMINOLOGY

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

PARTICLE SIZES

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

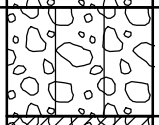
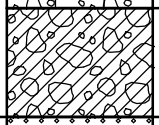
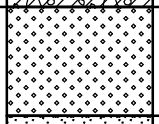
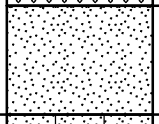
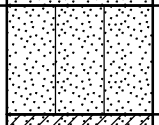
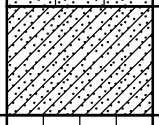
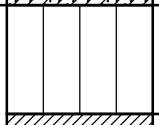
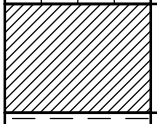
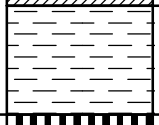
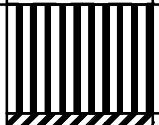
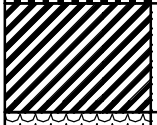
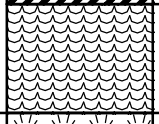
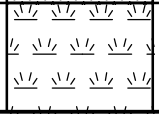
DESCRIPTIVE TERMINOLOGY

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

GRAVEL PERCENTAGES

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

SOIL CLASSIFICATION CHART

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

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS