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

March 10, 2021

Minnehaha Community Water Corporation
47381 248th Street
Dell Rapids, South Dakota 57022

Attn: Scott Buss

Subj: Geotechnical Exploration
Proposed Water Tower
Minnehaha Community Water Corporation
259th Street
Near Humboldt, South Dakota
GeoTek #21-066

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. Additional copies of our report are 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.

Jared Haskins

Jared Haskins, PE
Geotechnical Manager

Cc: Banner Associates, Attn: Joe Munson, PE & Bryan Lipp, PE

TABLE OF CONTENTS

GEOTECHNICAL EXPLORATION
PROPOSED WATER TOWER
MINNEHAHA COMMUNITY WATER CORPORATION
259TH STREET
NEAR HUMBOLDT, SOUTH DAKOTA
GEOTEK #21-066

INTRODUCTION

Project Information

This report presents the results of the recent geotechnical exploration program for the proposed water tower for Minnehaha Community Water Corporation near Humboldt, South Dakota.

Scope of Services

Our work was performed in accordance with the authorization of Scott Buss with Minnehaha Community Water Corporation. The authorized scope of services included the following:

1. To perform 3 standard penetration test (SPT) borings to gather data on the subsurface conditions at the site.

2. To perform laboratory tests that include moisture content, dry density, Atterberg limits (liquid and plastic limits), unconfined compressive strength, pH, sulfate content, chloride content, resistivity, redox potential and sulfide content.

3. To prepare an engineering report that includes the results of the field and laboratory tests as well as our earthwork and foundation recommendations for design and construction.

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 site for the new water tower is located along the south side of 259th Street (about 1,000 feet east of 457th Avenue) in Minnehaha County, South Dakota. The town of Humboldt is located about 1 mile north of the site. A site location map (Figure 1) is attached showing the location of the site. The site is covered with vegetation. An existing water tower is located at the site.

Ground Surface Elevations & Test Boring Locations

The ground surface elevations at the test boring locations were based on a temporary benchmark provided by Banner Associates and were 1,689.4 feet at test boring 1, 1,690.0 feet at test boring 2 and 1,690.2 feet at test boring 3. A test boring location map (Figure 2) is attached at the conclusion of this report showing the relative location of the test borings.

Subsurface Conditions

Three (3) test borings were performed at the site on February 24, 2021. The subsurface conditions encountered at the test boring locations are illustrated by means of the boring logs included in Appendix A.

The subsurface profile at the test boring locations consisted of the following soil types: topsoil materials, fine alluvium soils and glacial till soils. The topsoil materials were encountered at all of the test borings and extended to depths of 1 foot and 2 feet. The fine alluvium soils were encountered beneath the topsoil materials and extended to a depth of 4 ½ feet. The glacial till soils were encountered beneath the fine alluvium soils and extended to the termination depth of the test borings. The test borings indicated that frozen soils extended to a depth of about 2 feet.

The topsoil materials consisted of lean clay (CL). The fine alluvium soils consisted of fat clay (CH). The glacial till soils consisted of lean clay with sand (CL), fat clay with sand (CH) and sandy lean clay (CL).

The consistency or 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 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 locations. The time and level of the groundwater readings are recorded on the boring logs. Groundwater did not enter the boreholes at the test boring locations at the time of our measurements.

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 the low permeable soils encountered at the test boring locations. Long term groundwater monitoring was not included in our work scope.

ENGINEERING REVIEW & RECOMMENDATIONS

Project Design Data

We understand that the project will consist of constructing a new water tower for Minnehaha Community Water Corporation near Humboldt, South Dakota. The water tower will have a capacity of approximately 250,000 gallons. The finished grade around the base of the water tower is expected to be near elevation 1,691.0 feet (1 foot to 2 feet above existing grades). No specific foundation loading information was provided, but we expect heavy foundation loads. We anticipate that the water tower will be supported by a spread/ring footing foundation (shallow foundation system) that will rest 8 feet to 10 feet below the finished grade. We assume that the width of the ring footing will be around 12 feet to 14 feet (outside diameter of about 40 feet). We also assume that the allowable total settlement is 3 inches for the shallow foundation system.

The information/assumptions detailed in this 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, then it is important that you contact us so that we can review our recommendations with regards to the revised plans.

Discussion

It is our opinion that a spread/ring footing foundation can be used for support of the proposed water tower after the recommended site preparation has been performed.

In our opinion, the topsoil materials and fine alluvium soils are not suitable for support of the water tower. Regarding the glacial till soils, it is our opinion that the glacial till soils have suitable strength to support the water tower. However, the majority of the glacial till soils consisted of fat clay with sand soils. In our opinion, the fat clay with sand soils have a moderate potential for expansion. In order to control or minimize the potential effects of the fat clay with sand soils, we recommend providing a buffer (2 feet) of non-expansive soil (granular material) between the fat clay with sand soils and the foundation of the water tower. We would like to point out that the downward force from the foundation will counteract some of the uplift forces caused by the potential swelling of the fat clay with sand soils.

Site Preparation

The site preparation for the foundation of the water tower should consist of removing any topsoil materials and fine alluvium soils in order to expose the glacial till soils. Following the removals, we recommend that an overexcavation be performed to a minimum depth of 2 feet below the bottom-of-foundation elevation. We recommend that observations and hand auger borings be performed at the bottom of the excavation to determine if further excavation is needed. The overexcavated area should be backfilled with granular structural fill. With our site preparation recommendations, a minimum of 2 feet of granular material will be provided beneath the foundation.

Water or Saturated Soils

If water or saturated soils are encountered at the bottom of the excavation, then we recommend placing a layer (6 inches to 12 inches) of drainage rock at the bottom of the excavation prior to the placement of the granular structural fill or the foundation.

Laterally Oversized Excavation

The bottom of the excavation should be laterally oversized 1 foot beyond the edges of the foundation for each vertical foot of granular structural fill or drainage rock required below the foundation (1 horizontal : 1 vertical).

Excavation

All excavations should be performed with a track backhoe with a smooth edge bucket. The subgrade should not be exposed to heavy construction traffic from rubber tire vehicles. The soils are susceptible to disturbance and can experience strength loss caused by construction traffic and/or additional moisture.

Foundation Loads

If our recommendations are followed during site preparations, then it is our opinion that the spread/ring footing foundation of the water tower can be designed for a net allowable soil bearing pressure of up to 5,000 pounds per square foot (psf). It is our opinion that the recommended bearing pressure should provide a minimum safety factor of 3.0 against shear or base failure. The net allowable soil bearing pressure may be increased by 1/3 for transient wind or seismic loads.

Settlement

Based on our assumptions (a spread/ring footing foundation resting 8 feet to 10 feet below the finished grade, 5,000 psf bearing and a ring footing width of around 12 feet to 14 feet), we estimate that the total settlement of the water tower should be on the order of 1 ½ inches and differential settlement should be on the order of ½ inch. We also estimate that the differential tilting of the foundation will be less than 1 inch. Again, the estimated settlement is based on our assumptions. We recommend that we be contacted to perform another settlement analysis when the foundation loads, dimensions of the foundation and bottom-of-foundation elevation are known. As previously stated, we assume that the allowable total settlement for the shallow foundation system is 3 inches.

Coefficient of Friction

It is our opinion that a friction factor of 0.45 can be used between the granular structural fill or drainage rock and the bottom of the concrete. The friction value is considered an ultimate value. We recommend applying a theoretical safety factor of at least 2.0.

Lateral Loads & Foundation Backfill

We assume that the on-site clay soils and some off-site granular materials will be used as foundation backfill. All backfill placed next to and above the foundation should be compacted. If granular materials are used, then we recommend capping the granular materials with approximately 2 feet of clay soils to minimize infiltration of surface water. We recommend neglecting the soils within 5 feet of the ground surface from the lateral load resistance due to frost softening. The soils below a depth of 5 feet can be assigned a submerged passive equivalent fluid unit weight of 160 pounds per cubic foot (pcf). This value will give ultimate resistance to lateral loads. We recommend using a theoretical safety factor of at least 2.0 to resist the lateral loads.

It is our opinion that the compacted backfill over the foundation can be assigned a total unit weight of 125 pcf above the groundwater level and a submerged unit weight of 63 pcf below the groundwater level. These values provide the ultimate resistance to uplift and moment loads. We recommend using a theoretical safety factor of at least 1.5 to resist the uplift and moment loads.

The design parameters discussed in this section are based on a groundwater level of approximately 5 feet. We would like to point out that this does not mean that groundwater was encountered at a depth of 5 feet; it is to account for future fluctuations in the groundwater level. We can revisit the design parameters once the design elevations for the project are determined.

Frost Protection

We recommend that the foundation be placed at a sufficient depth for frost protection. Foundations for unheated areas and canopies, or foundations that are not protected from frost during freezing temperatures, should be placed such that the bottom of the foundation is a minimum of 5 feet below the finished exterior grade.

Gravel Surfaced Areas

We understand that gravel surfaced areas will be constructed as part of the project. Fine alluvium soils and glacial till soils are expected to be encountered as subgrade soils. In our opinion, the fine alluvium soils and glacial till soils will provide average subgrade support.

We recommend that the subgrade preparation in the gravel surfaced areas consist of removing any vegetation and highly organic materials. A removal depth of 12 inches to 18 inches should be expected. Following the removals, the subgrade should be prepared by cutting or placing subgrade fill to the design elevations. Once the design elevations have been achieved, we recommend that the exposed subgrade be scarified (with a disc harrow) to a minimum depth of 8 inches and adjusted to a moisture level that is 1 percent to 4 percent below the optimum moisture content as determined by standard Proctor (ASTM:D698). The moisture-conditioned soils should then be compacted.

Additional corrections will be needed if unstable areas are encountered. The additional corrections may include the following: moisture conditioning the soils (e.g. drying the soils by scarification), an overexcavation to remove and replace the unstable subgrade soils or the placement of granular subbase at the subgrade surface. The type of correction performed should be determined after observing the condition of the subgrade.

For the thickness of the gravel section, we recommend at least 4 inches of gravel surfacing over 6 inches of aggregate base course. It would be beneficial to provide a geotextile fabric beneath the gravel section. Regarding the geotextile fabric, we recommend using Mirafi HP 370, Propex Geotex 3x3 HF, Huesker Comtrac P 45/45 or approved alternative. Without the geotextile fabric, aggregate loss and additional maintenance could be expected.

Material Types & Compaction Levels

Granular Structural Fill – The granular structural fill should consist of a pit-run or processed sand or gravel having a maximum particle size of 3 inches with less than 15 percent by weight passing the #200 sieve. The granular structural fill should be placed in lifts of up to 1 foot in thickness.

Drainage Rock – The drainage rock should be crushed, washed and meet the gradation specifications shown in Table 1.

Table 1. Drainage Rock Gradation Specifications

Sieve Size	Percent Passing
1 ½-inch	100
1-inch	70 – 90
3/4-inch	25 – 50
3/8-inch	0 – 5

Foundation Backfill – We recommend that non-organic clay soils or granular materials be used as foundation backfill. It is our opinion that the on-site soils could be used as foundation backfill. The topsoil materials should not be used as foundation backfill. The foundation backfill should be placed in lifts of up to 6 inches in thickness. If granular materials are used, then we recommend capping the granular materials with approximately 2 foot of clay soils to minimize infiltration of surface water. Drying should be expected with the on-site clay soils.

Recommended Compaction Levels – The recommended compaction levels listed in Table 2 are based on a material's maximum dry density value, as determined by a standard Proctor (ASTM: D698) test.

Table 2. Recommended Compaction Levels

Placement Location	Minimum Compaction Specifications
Below the Foundation	100%
Foundation Backfill	95%
Non-Structural Areas	90%

Notes: Compaction specifications are not applicable with the drainage rock.

Recommended Moisture Levels – The moisture content of the clay backfill materials, when used as backfill around a foundation should be maintained within a range of plus or minus 2 percent of the materials' optimum moisture content. When the clay backfill materials are used below a vehicle area, or as site grading, the materials' moisture content should be maintained within a range of minus 1 percent to minus 4 percent of the materials' optimum moisture content. The optimum moisture content should be determined using a standard Proctor (ASTM: D698) test.

The moisture content of the granular backfill materials should be maintained at a level that will be conducive for vibratory compaction.

Seismic Site Classification

Based on the 2018 International Building Code (IBC), it is our opinion that the site, as a whole, corresponds to a Site Class D (stiff soil). Also, the ground acceleration values are as follows: S_S = 0.100 g, S_1 = 0.033 g, S_{MS} = 0.160 g, S_{M1} = 0.079 g, S_{DS} = 0.107 g, S_{D1} = 0.053 g. Therefore, the seismic design category is “A”. The ground acceleration values are based on the ASCE 7-16 (referenced standard for 2018 IBC) with Risk Category II/III. If needed, we can provide ground acceleration values for a different design code.

Site Drainage

Proper drainage should be maintained during and after construction. The general site grading should direct surface run-off waters away from the excavation. Water which accumulates in the excavation should be removed in a timely manner.

Corrosive Potential of the Soils

Soil samples were collected from test borings 1 and 3 and were submitted for pH, sulfate content, chloride content, resistivity, redox potential and sulfide content testing. The results of the pH, resistivity, redox potential and sulfide content testing are shown in Table 3 and the results of the chloride content and sulfate content testing are shown in Table 5.

Table 3. pH, Resistivity, Redox Potential and Sulfide Content Results

Test Boring	Depth (ft)	Soil Classification	pH	Resistivity (ohm-cm)	Redox Potential (mV)	Sulfide (mg/kg)
1	7 to 8 ½	CL (Glacial Till)	7.7	871	127	<0.01
3	4 ½ to 7	CH (Glacial Till)	8.0	938	83	<0.01

Note: The resistivity values are minimum values (saturated condition).

Using the Ductile Iron Pipe Research Association’s (DIPRA) 10-point system and the lab results shown in Table 3, we evaluated the corrosive potential of the tested soils. The 10-point system is based on resistivity, pH, redox potential, sulfides and moisture. An explanation of the point system is shown on Figure 3. The results of the evaluation are shown in Table 4. According to DIPRA, a value of 10 or more indicates that the soil is corrosive to underground piping and metals, while a value below 10 indicates that the soil is not corrosive to underground piping and metals. Based on Table 4, the soils tested are considered corrosive. With that said, protective measures should be taken.

Table 4. Results of DIPRA 10-Point System Evaluation

Test Boring	Depth (ft)	Soil Classification	Total Value	Result
1	7 to 8 ½	CL (Glacial Till)	11	Corrosive
3	4 ½ to 7	CH (Glacial Till)	14.5	Corrosive

Notes: A "fair drainage, generally moist" was used for the moisture condition (1 point).

Table 5. Sulfate & Chloride Content Test Results

Test Boring	Depth (ft)	Soil Classification	Sulfate (mg/kg)	Chloride (mg/kg)
1	7 to 8 ½	CL (Glacial Till)	4,154	4
3	4 ½ to 7	CH (Glacial Till)	918	12

As shown in Table 5, the sulfate contents were 918 mg/kg and 4,154 mg/kg. Generally, the sulfate attack on concrete is considered mild if the sulfate content is below 150 mg/kg, moderate if the sulfate content is between 150 mg/kg and 1,500 mg/kg and severe if the sulfate content is above 1,500 mg/kg. Based on the test results, the potential sulfate attack on the concrete will be moderate to severe. Therefore, we recommend using Type II cement for moderate sulfate attack and Type V cement for severe sulfate attack. It should be known that high sulfate levels can also accelerate corrosion of metals in direct contact with soil (coatings for metals should be considered). Regarding the chloride content levels, levels below 250 mg/kg are considered mildly corrosive.

CONSTRUCTION CONSIDERATIONS

Groundwater & Surface Water

Water may enter the excavation due to subsurface water, precipitation or surface run off. 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.

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.

Cold Weather Precautions

If site preparation and construction is anticipated during cold weather, then we recommend all foundations, 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, then 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 should not be placed on frozen subgrades. Frost should not be allowed to penetrate below the foundations. The subgrade soils will likely require reworking and recompacting due to the loss of density caused by the freeze/thaw process.

Excavation Sideslopes

The 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 foundations, 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. These observations should be performed prior to placement of fill or foundations.

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 structural fill and backfill placed below foundations, slabs and pavements, beside foundation walls and behind retaining walls. The tests should be performed to determine if the required compaction has been achieved. As a general guideline, we recommend at least 1 test be taken for every 2,000 square feet of structural fill placed in building and pavement areas, at least 1 test for every 75 feet to 100 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 performed 3 SPT borings on February 24, 2021 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 logs.

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

The soil samples collected from the test boring locations will be retained in our office for a period of 1 month after the date of this report and will then be discarded unless we are notified otherwise.

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. Logs 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 logs 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 boring locations. 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 and strength properties of the soils. The index tests consisted of moisture content, dry density, Atterberg limits (liquid and plastic limits), pH, sulfate content, chloride content, resistivity, redox potential and sulfide content. The strength tests consisted of unconfined compressive strength. The laboratory tests were performed in accordance with the appropriate ASTM procedures. The results of the laboratory tests are shown on the boring logs 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 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.

Jared Haskins, PE
Geotechnical Manager

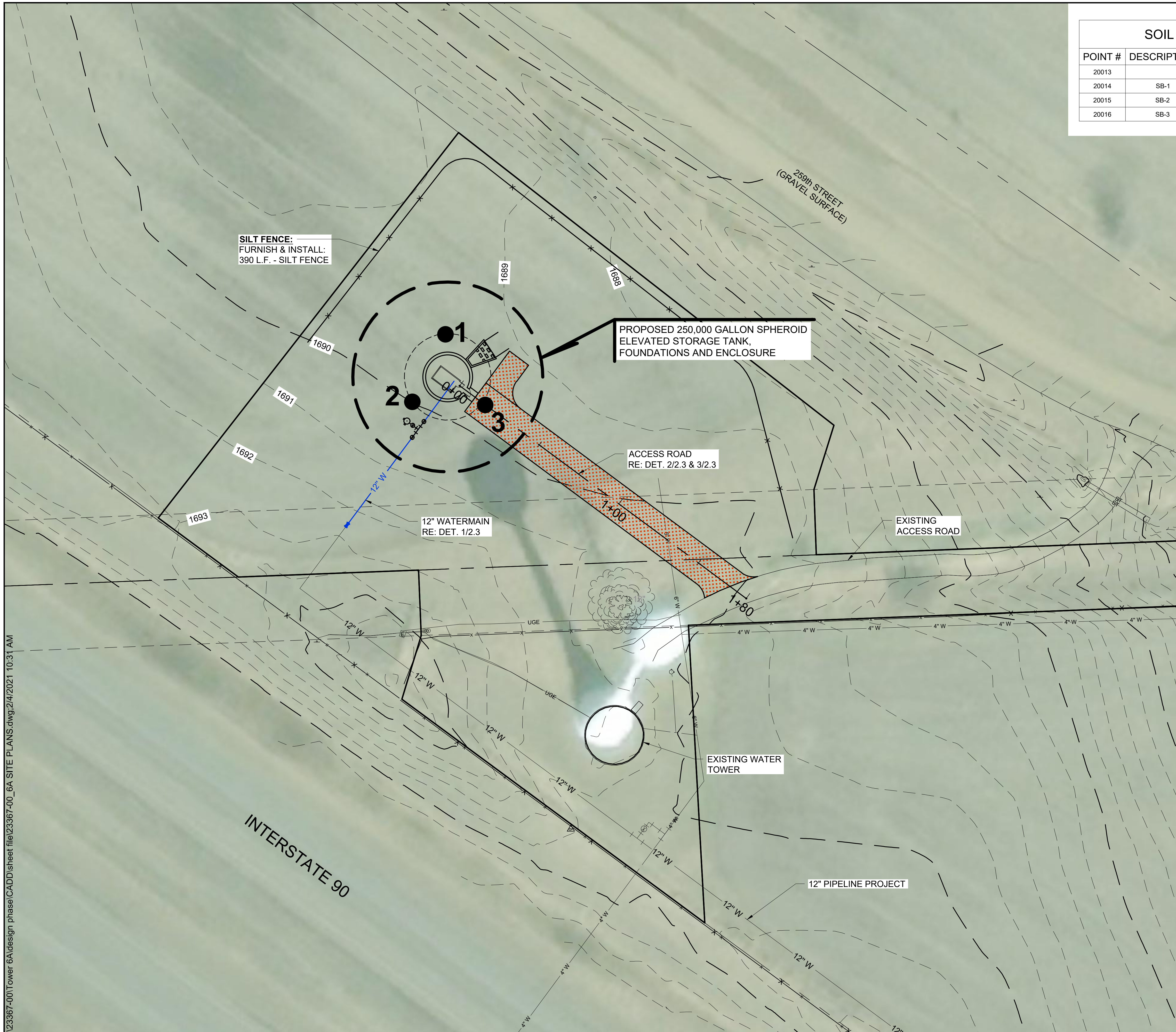
FIGURE 1
SITE LOCATION MAP
PROPOSED WATER TOWER
MINNEHAHA COMMUNITY WATER CORPORATION
259TH
NEAR HUMBOLDT, SD

ACAD/GEOTEK/JARED/21-066

PROJECT#: 21-066

DRAWN BY: MAB

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



SOIL BORING LOCATIONS

POINT #	DESCRIPTION	NORTHING	EASTING	ELEVATION
20013				----
20014	SB-1			1689.4
20015	SB-2			1690.0
20016	SB-3			1690.2

N
0 25 50 FT

NOTES:
1. CONTRACTOR WILL BE RESPONSIBLE TO HAVE ALL UTILITIES LOCATED PRIOR TO EXCAVATION.
2. WATERLINE SHALL BE LAID WITH A MINIMUM OF SIX FEET (6'-0") COVER.
3. ALL SITE PIPE AND PIPING THROUGH TANK FOUNDATIONS WITHIN 5 FT FROM TOWER FOUNDATION SHALL BE EITHER DUCTILE IRON OR STEEL.

LEGEND:

7" CRUSHED CONCRETE SURFACE

SILT FENCE

PROJECT / SHEET TITLE:
MCWC 250,000 GALLON WATER TOWER NO. 6A
SITE IMPROVEMENTS & GRADING PLAN
HUMBOLDT, SOUTH DAKOTA

REV.	DATE	DESCRIPTION

FOR REVIEW ONLY
NOT FOR CONSTRUCTION

JOB No.:	23367.00.01
DATE:	MARCH, 2021
DESIGNED BY:	KAD
CHECKED BY:	BAL
DRAWN BY:	AME

0 1/2" 1"
SCALE REDUCTION BAR

SHEET No. :
2.2

FIGURE 3

Table A.1 Soil-test evaluation

Soil Characteristics Based on Samples Taken Down to Pipe Depth		
Resistivity—ohm-cm (based on water-saturated soil box):		Points*
	<1,500	10
	≥1,500–1,800	8
	>1,800–2,100	5
	>2,100–2,500	2
	>2,500–3,000	1
	>3,000	0
pH:		
	0–2	5
	2–4	3
	4–6.5	0
	6.5–7.5	0†
	7.5–8.5	0
	>8.5	3
Redox potential:		
	> +100 mV	0
	+50 to +100 mV	3.5
	0 to +50 mV	4
	Negative	5
Sulfides:		
	Positive	3.5
	Trace	2
	Negative	0
Moisture:		
	Poor drainage, continuously wet	2
	Fair drainage, generally moist	1
	Good drainage, generally dry	0

*Ten points or greater indicates that soil is corrosive to ductile-iron pipe; protection is needed. Refer to paragraph A.3 for a description of Uniquely Severe Environments and additional considerations.

†If sulfides are present and low (<100 mv) or negative redox-potential results are obtained, add three points for this range.

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

GEOTEK # **21-066** BORING NO. **1 (1 of 1)**

PROJECT **Proposed Water Tower, Minnehaha Community Water Corporation, 259th Street, Near Humboldt, SD**

SURFACE ELEVATION 1689.4 ft

DEPTH in FEET	DESCRIPTION OF MATERIAL	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	WC	D	LL	PL	QU
1	**LEAN CLAY**: black, frozen, (CL)	TOPSOIL									
4½	**FAT CLAY**: brown, frozen to 2' then dry, (CH)	FINE ALLUVIUM			1	FA					
					2	FA					
7	**FAT CLAY WITH SAND**: a little gravel, brown and gray, moist, very stiff, (CH)	GLACIAL TILL	21		3	SPT					
19	**LEAN CLAY WITH SAND**: a little gravel, brown and gray, moist, stiff, (CL)	GLACIAL TILL	12		4	SPT	22	102			
			12		5	SPT	20	104	42	15	3500
			13		6	SPT					
24	**FAT CLAY WITH SAND**: a little gravel, dark brown and dark gray, moist, very stiff, (CH)	GLACIAL TILL	16		7	SPT					
29	**SANDY LEAN CLAY**: a little gravel, brown, moist, stiff, (CL)	GLACIAL TILL	14		8	SPT					
51	**FAT CLAY WITH SAND**: a little gravel, dark brown and dark gray, moist, stiff to very stiff, (CH)	GLACIAL TILL	18		9	SPT					
			15		10	SPT					
			19		11	SPT					
			19		12	SPT					
			20		13	SPT					
	Bottom of borehole at 51 feet.										

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL
--	--	--	--	--	--
--	--	--	--	--	--
--	--	--	--	--	--
--	--	--	--	--	--

START 2-24-21 COMPLETE 2-24-21 11:05 am

METHOD
Rotary Mud Drilling

CREW CHIEF Roy Hanson

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

GEOTEK # **21-066** BORING NO. **2 (1 of 1)**

PROJECT **Proposed Water Tower, Minnehaha Community Water Corporation, 259th Street, Near Humboldt, SD**

DEPTH in FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION 1690.0 ft)	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	WC	D	LL	PL	QU
2	**LEAN CLAY**: black, frozen, (CL)	TOPSOIL			1	HSA					
4½	**FAT CLAY**: brown, dry, stiff, (CH)	FINE ALLUVIUM	15		2	SPT					
7	**FAT CLAY WITH SAND**: a little gravel, brown and gray, moist, very stiff, (CH)	GLACIAL TILL	18		3	SPT	17				
14½	**FAT CLAY WITH SAND**: a little gravel, brown, moist, stiff, (CH)	GLACIAL TILL	10		4	SPT					
					5	SH					
			14		6	SPT	23	104	53	19	5800
					7	SH					
19	**FAT CLAY WITH SAND**: a little gravel, dark brown and dark gray, moist, very stiff, (CH)	GLACIAL TILL	17		8	SPT					
26	**FAT CLAY WITH SAND**: a little gravel, dark grayish brown, moist, very stiff, (CH)	GLACIAL TILL	17		9	SPT					
			18		10	SPT					
	Bottom of borehole at 26 feet.										

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL
2-24-21	12:25 pm	26	--	24	none
--	--	--	--	--	--
--	--	--	--	--	--
--	--	--	--	--	--

START 2-24-21 COMPLETE 2-24-21 12:25 pm

METHOD
3.25" ID Hollow Stem Auger

CREW CHIEF Roy Hanson

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

GEOTEK # **21-066**

BORING NO. **3 (1 of 1)**

PROJECT **Proposed Water Tower, Minnehaha Community Water Corporation, 259th Street, Near Humboldt, SD**

SURFACE ELEVATION 1690.2 ft

DEPTH in FEET	DESCRIPTION OF MATERIAL	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	WC	D	LL	PL	QU
2	**LEAN CLAY**: black, frozen, (CL)	TOPSOIL			1	HSA					
4½	**FAT CLAY**: brown, dry, stiff, (CH)	FINE ALLUVIUM	13		2	SPT					
14½	**FAT CLAY WITH SAND**: a little gravel, brown and gray, moist, stiff to very stiff, (CH)	GLACIAL TILL	19		3	SPT					
			12		4	SPT	21	105	54	19	7800
					5	SH					
			13		6	SPT					
26	**LEAN CLAY WITH SAND**: a little gravel, brown, moist, stiff to very stiff, with lenses of sand (CL)	GLACIAL TILL	12		7	SPT					
			13		8	SPT	20	111	38	16	3600
			16		9	SPT					
	Bottom of borehole at 26 feet.										

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL
2-24-21	1:25 pm	26	--	24	none
--	--	--	--	--	--
--	--	--	--	--	--
--	--	--	--	--	--

START 2-24-21 COMPLETE 2-24-21 1:25 pm

METHOD
3.25" ID Hollow Stem Auger

CREW CHIEF Roy Hanson

SOIL CLASSIFICATION CHART

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

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

BORING LOG SYMBOLS AND DESCRIPTIVE TERMINOLOGY

SYMBOLS FOR DRILLING AND SAMPLING

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

SYMBOLS FOR LABORATORY TESTS

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

DENSITY/CONSISTENCY TERMINOLOGY

Density Term	**N-Value**	**Consistency 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%