

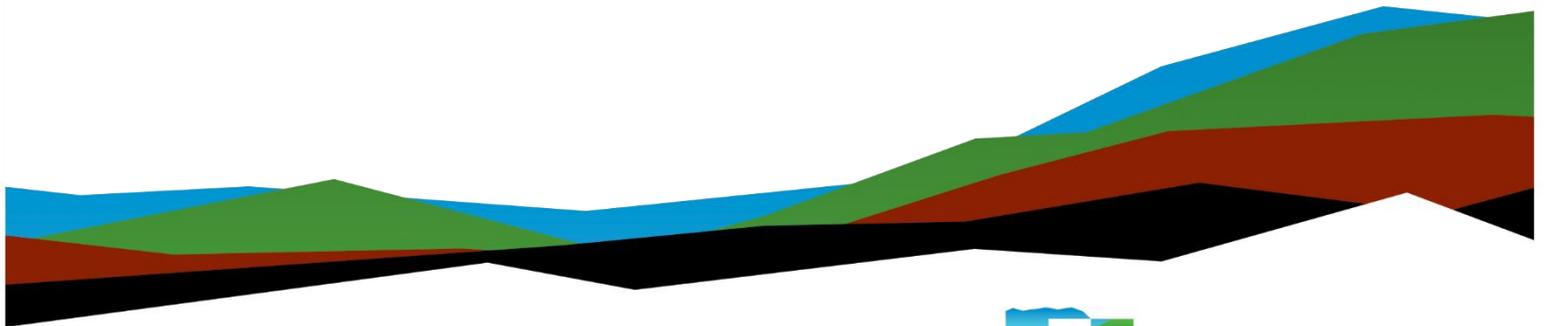
# 1st Street NW Improvements

## Geotechnical Exploration Report

May 9, 2024 | Terracon Project No. M2245018

### Prepared for:

KLJ Engineering LLC  
400 E Broadway Ave, Ste 600  
Bismarck, ND 58501



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May 9, 2024

KLJ Engineering LLC  
400 E Broadway Ave, Ste 600  
Bismarck, ND 58501

Attn: Brad Krogstad  
P: (701) 355 8400  
E: Brad.krogstad@kljeng.com

Re: Geotechnical Exploration Report **\*Revised\***  
1st Street NW Improvements  
Mandan, ND  
Terracon Project No. M2245018

Dear Mr. Krogstad:

We have completed the scope of Geotechnical Exploration services for the above referenced project in general accordance with Terracon Proposal No. PM2245018 dated February 5, 2024. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork for the proposed project.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or if we may be of further service, please contact us.

Sincerely,

**Terracon**

Josh A. Brilz  
Engineer Assistant

Chad A. Cowley, P.E.  
Department Manager

# Table of Contents

<b>Introduction</b> .....	<b>1</b>
<b>Project Description</b> .....	<b>1</b>
<b>Site Conditions</b> .....	<b>1</b>
<b>Geotechnical Characterization</b> .....	<b>2</b>
<b>Corrosivity</b> .....	<b>3</b>
<b>Geotechnical Overview</b> .....	<b>4</b>
<b>General Comments</b> .....	<b>6</b>

## Figures

GeoModel

## Attachments

- Exploration and Testing Procedures**
- Photography Log**
- Site Location and Exploration Plans**
- Exploration and Laboratory Results**
- Supporting Information**

**Note:** This report was originally delivered in a web-based format. **Blue Bold** text in the report indicates a referenced section heading. The PDF version also includes hyperlinks which direct the reader to that section and clicking on the  Terracon logo will bring you back to this page. For more interactive features, please view your project online at [client.terracon.com](http://client.terracon.com).

Refer to each individual Attachment for a listing of contents.

## Introduction

This report presents the results of our subsurface exploration and Geotechnical Exploration services performed for the proposed reconstruction of 1<sup>st</sup> street NW in Mandan, ND. The purpose of these services was to provide information and geotechnical engineering recommendations relative to:

- Subsurface soil conditions
- Groundwater conditions
- Site preparation and earthwork
- Demolition considerations

The geotechnical engineering Scope of Services for this project included the advancement of test borings, laboratory testing, and preparation of this report.

Drawings showing the site and boring locations are shown on the [Site Location](#) and [Exploration Plan](#), respectively. The results of the laboratory testing performed on soil samples obtained from the site during our field exploration are included on the boring logs or as separate graphs in the [Exploration Results](#) section.

## Project Description

Our final understanding of the project conditions is as follows:

Item	Description
<b>Information Provided</b>	Information used to develop our project understanding was provided to us through email correspondence with KLJ.
<b>Project Description</b>	The project will include the reconstruction of approximately one mile of city streets and placement of new utilities. We understand KLJ will be providing the pavement design.

Terracon should be notified if any of the above information is inconsistent with the planned construction, as modifications to our recommendations may be necessary.

## Site Conditions

The following description of site conditions is derived from our site visit in association with the field exploration and our review of publicly available topographic maps.

Item	Description
<b>Parcel Information</b>	The project is bound on the west by 6th Avenue NW, Collins Avenue on the east, Main Street on the south, and 2nd Street NW on the north in Mandan, ND. Latitude: 46.8268° N, Longitude: 100.8951° W See <a href="#">Site Location</a>
<b>Existing Improvements</b>	Two-lane paved roadways with surrounding commercial and residential buildings.
<b>Current Ground Cover</b>	Primarily bituminous pavement with some underlying concrete sections and concrete intersections.
<b>Existing Topography</b>	Using available aerial imagery, the site appears to be relatively level. Total change in elevation across the site is on the order of 4 feet.

We also collected photographs of some of the concrete thickness cores after our field exploration. Representative photos are provided in our [Photography Log](#).

## Geotechnical Characterization

We have developed a general characterization of the subsurface conditions based upon our review of the subsurface exploration, laboratory data, geologic setting and our understanding of the project. This characterization, termed GeoModel, forms the basis of our geotechnical calculations and evaluation of the site. Conditions observed at each exploration point are indicated on the individual logs. The individual logs can be found in the [Exploration Results](#) and the GeoModel can be found in the [Figures](#) attachment of this report.

As part of our analyses, we identified the following model layers within the subsurface profile. For a more detailed view of the model layer depths at each boring location, refer to the GeoModel.

Model Layer	Layer Name	General Description
1	Surface	6 to 9 inches Concrete / 2 to 7½ inches of Asphalt / 3 to 9 inches Aggregate Base Course
2	Fill	Lean Clay or Fat Clay - varying amounts of sand, brown to dark brown
3	Clay 1	Lean Clay - varying amounts of sand, brown to black, medium stiff to stiff

<b>4</b>	<b>Clay 2</b>	Fat Clay - grayish brown to brown, medium stiff to very stiff
<b>5</b>	<b>Sand</b>	Silty Sand / Clayey Sand - fine to medium grained, brown, loose to medium dense
<b>6</b>	<b>Void</b>	Void

The boreholes were observed while drilling and after completion for the presence and level of groundwater. Groundwater was not present in the borings while drilling, or for the short duration the borings could remain open. However, this does not necessarily mean the borings terminated above groundwater. Due to the low permeability of the clays encountered in the borings, a relatively long period may be necessary for a groundwater level to develop and stabilize in a borehole. Long term observations in piezometers or observation wells sealed from the influence of surface water are often required to define groundwater levels in materials of this type. Based on the moisture condition of the samples encountered in the borings, we anticipate the groundwater level was below the depth of our borings at the time of our fieldwork.

Groundwater conditions may be different at the time of construction. Groundwater conditions may change because of seasonal variations in rainfall, runoff, and other conditions not apparent at the time of drilling. Long-term groundwater monitoring was outside the scope of services for this project.

## Corrosivity

The table below lists the results of laboratory soluble sulfate, soluble chloride, electrical resistivity, organic matter, and pH testing. The values may be used to estimate potential corrosive characteristics of the on-site soils with respect to contact with the various underground materials which will be used for project construction.

Boring	Sample Depth (feet)	Soil Description	Soluble Sulfate (ug / g)	Soluble Chloride (ug / g)	Resistivity (Ω-cm)	Organic Matter (%)	pH
B-1	2-3½	Lean Clay & Fat Clay Mix	21.5	13.5	--	2.7	8.13
B-6	4½-6	Fat Clay	83.2	32.4	--	2.2	8.15
B-1 & B-7 Comp.	1-5	Fat Clay with Sand	--	--	4600	--	--

Results of soluble sulfate testing can be classified in accordance with ACI 318 – Building Code Requirements for Structural Concrete. Numerous sources are available to characterize corrosion potential to buried metals using the parameters above. ANSI/AWWA is commonly used for ductile iron, while threshold values for evaluating the effect on steel can be specific to the buried feature (e.g., piling, culverts, welded wire reinforcement, etc.) or agency for which the work is performed. Imported fill materials may have significantly different properties than the site materials noted above and should be evaluated if expected to be in contact with metals used for construction. Consultation with a NACE certified corrosion professional is recommended for buried metals on the site.

## Geotechnical Overview

Based on our understanding of the project as described in [Project Description](#), we anticipate the on-site soils will be utilized in subgrade reconstruction. Use of the existing subgrade soils for pavement support is feasible. Two California Bearing ratios (CBR's) have been determined on composite blends of materials encountered in the borings. The moisture-density relationship test results and CBR test results are presented in the [Exploration Results](#) section.

As an alternative, installation of a geogrid, woven geosynthetic that provides separation and reinforcement, or cement stabilization can be used on the subgrade. Once the planned subgrade elevation has been reached and the subgrade has been prepared, the subgrade soils should be proof-rolled with a fully loaded tandem axle truck. Areas of soft or otherwise unsuitable material should be undercut and replaced with either suitable on-site materials or new structural fill.

For long-term pavement performance, the pavement subgrade and pavement should be sloped to provide for positive drainage. A maintenance program will need to be developed and followed to ensure premature deterioration of pavement does not occur.

The near surface, lean to fat clays encountered in borings could become unstable with typical earthwork and construction traffic, especially after precipitation events. The effective drainage should be completed early in the construction sequence and maintained after construction to avoid potential issues. If possible, the grading should be performed during the warmer and drier time of the year. If grading is performed during the winter months, an increased risk for possible undercutting and replacement of unstable subgrade will persist.

As discussed in the [Geotechnical Characterization](#), undocumented fill was encountered in most of the borings to an approximate depth of two to seven feet. This undocumented fill may be variable in consistency, density and moisture, and therefore may have the potential to increase or decrease in volume with variations in moisture

content. Furthermore, there is an inherent risk for the owner that compressible fill or unsuitable material within or buried by the fill will not be discovered. This risk of unforeseen conditions cannot be eliminated without completely removing the existing fill. Therefore, we recommend completely removing any undocumented fills encountered at this site and replacing them with a structural fill.

If the owner elects to construct pavements on the existing fill, the following protocol should be followed. The existing soils can be removed to a minimum of 24 inches beneath proposed pavement sections. The exposed subgrade should then be scarified and recompacted to a minimum depth of 12 inches. A structural fill meeting the material requirements outlined below should be placed at a minimum in the upper 24 inches beneath the proposed pavement sections. Once the planned subgrade elevation has been reached, the entire pavement area should be proofrolled. Areas of soft or otherwise unsuitable material should be undercut and replaced with either new structural fill or suitable, existing on site materials.

To take advantage of the cost benefit of not removing the entire amount of undocumented fill, the owner must be willing to accept the risk of increased differential performance which can result in increased cracking and abrupt differential settlement. Should this risk be acceptable, floor slabs and pavements can be supported above the fill.

Possible organic clay was encountered in borings B-8, B-9 and B-15 at an approximate depth of 1 foot below the surface. We recommend over-excavations in the vicinity of these borings be extended to remove this organic material.

We anticipate the existing pavements will be razed to accommodate proposed pavements. Materials derived from the demolition of any existing pavements or utilities should be removed from the site, and not be allowed for use on site.

Two California Bearing Ratios (CBR) have been determined on soil samples consisting of a composite blend of material encountered below the topsoil. One composite blend consisted of borings B-1 & B-7 from an approximate depth of 1 to 5 feet below existing grades. The second composite blend consisted of borings B-6 & B-9 at from an approximate depth of 1 to 5 feet below existing grade. This material was compacted at about 90 percent of the modified proctor maximum dry density at about 2 percent above optimum moisture. The moisture-density relationship test and CBR test results are presented in the [Exploration Results](#) section. Due to the loss of strength during spring thaw and the expectation of the quality of subgrade preparation, for pavement design by others, we recommend a reduced subgrade CBR value of 3 be used.

The [General Comments](#) section provides an understanding of the report limitations.

## General Comments

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Variations will occur between exploration point locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. Terracon should be retained as the Geotechnical Engineer, where noted in this report, to provide observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Our Scope of Services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third-party beneficiaries intended. Any third-party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly effect excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety and cost estimating including excavation support and dewatering requirements/design are the responsibility of others. Construction and site development have the potential to affect adjacent properties. Such impacts can include damages due to vibration, modification of groundwater/surface water flow during construction, foundation movement due to undermining or subsidence from excavation, as well as noise or air quality concerns. Evaluation of these items on nearby properties are commonly associated with contractor means and methods and are not addressed in this report. The owner and contractor should consider a preconstruction/precondition survey of surrounding development. If changes in the nature, design, or location of the project are planned, our conclusions and

**Geotechnical Exploration Report**

1st Street NW Improvements | Mandan, ND  
May 9, 2024 | Terracon Project No. M2245018



recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

**Geotechnical Exploration Report**

1st Street NW Improvements | Mandan, ND  
May 9, 2024 | Terracon Project No. M2245018



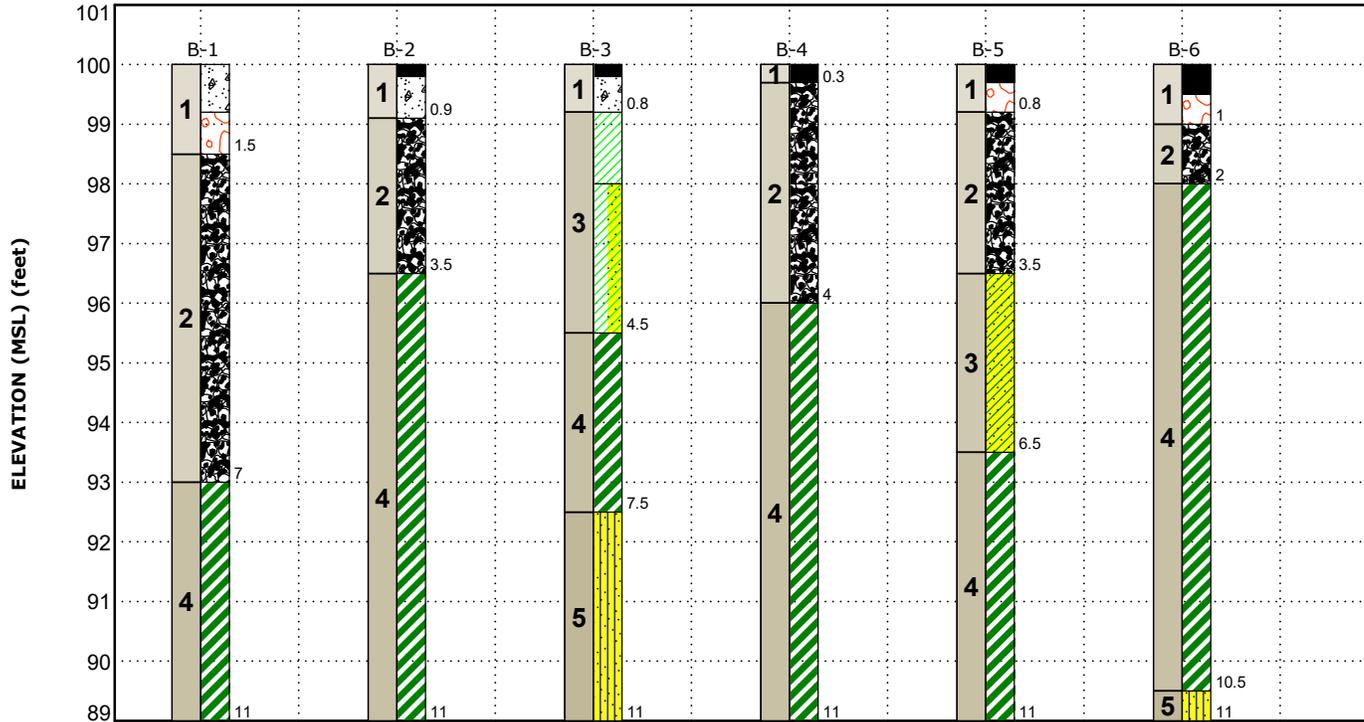
## Figures

**Contents:**

GeoModel (2 pages)

Note: All attachments are one page unless noted above.

## GeoModel

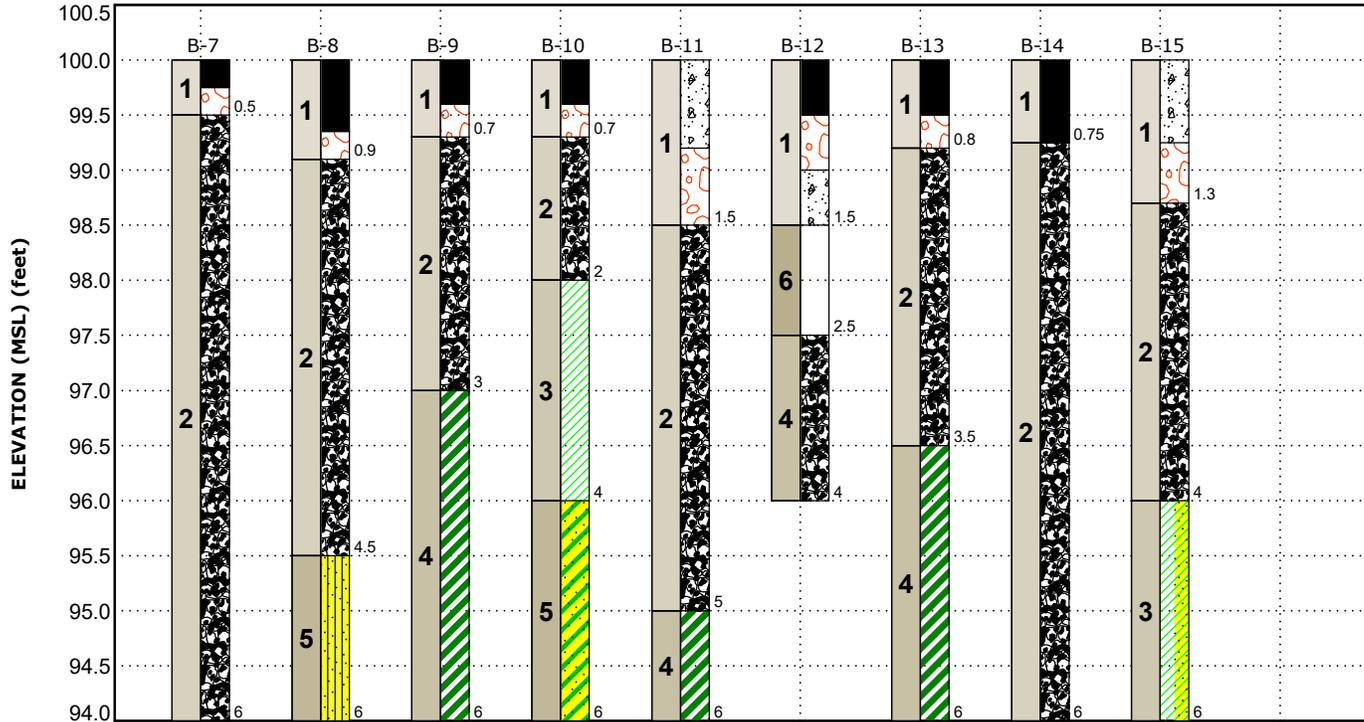


This is not a cross section. This is intended to display the Geotechnical Model only. See individual logs for more detailed conditions.

Model Layer	Layer Name	General Description	Legend	
1	Surface	6 to 9 inches Concrete / 2 to 7½ inches of Asphalt / 3 to 9 inches Aggregate Base Course	Concrete	Aggregate Base Course
2	Fill	Lean Clay or Fat Clay - varying amounts of sand, brown to dark brown	Fill	Fat Clay
3	Clay 1	Lean Clay - varying amounts of sand, brown to black, medium stiff to stiff	Asphalt	Lean Clay
4	Clay 2	Fat Clay - grayish brown to brown, medium stiff to very stiff	Lean Clay with Sand	Silty Sand
5	Sand	Silty Sand / Clayey Sand - fine to medium grained, brown, loose to medium dense	Sandy Lean Clay	
6	Void	Void		

NOTES:  
 Layering shown on this figure has been developed by the geotechnical engineer for purposes of modeling the subsurface conditions as required for the subsequent geotechnical engineering for this project.

## GeoModel



This is not a cross section. This is intended to display the Geotechnical Model only. See individual logs for more detailed conditions.

Model Layer	Layer Name	General Description	Legend			
1	<b>Surface</b>	6 to 9 inches Concrete / 2 to 7½ inches of Asphalt / 3 to 9 inches Aggregate Base Course		Asphalt		Aggregate Base Course
2	<b>Fill</b>	Lean Clay or Fat Clay - varying amounts of sand, brown to dark brown		Fill		Silty Sand
3	<b>Clay 1</b>	Lean Clay - varying amounts of sand, brown to black, medium stiff to stiff		Fat Clay		Lean Clay
4	<b>Clay 2</b>	Fat Clay - grayish brown to brown, medium stiff to very stiff		Clayey Sand		Concrete
5	<b>Sand</b>	Silty Sand / Clayey Sand - fine to medium grained, brown, loose to medium dense				Lean Clay with Sand
6	<b>Void</b>	Void				

**NOTES:**  
 Layering shown on this figure has been developed by the geotechnical engineer for purposes of modeling the subsurface conditions as required for the subsequent geotechnical engineering for this project.

**Geotechnical Exploration Report**

1st Street NW Improvements | Mandan, ND

May 9, 2024 | Terracon Project No. M2245018



## Attachments

# Exploration and Testing Procedures

## Field Exploration

Number of Borings	Approximate Boring Depth (feet)	Location
6	11	1 <sup>st</sup> Street NW
8	6	Intersecting Streets
1 <sup>1</sup>	4	Intersecting Streets

1. Auger refusal was encountered in Boring B-12 at 4 feet.

**Boring Layout and Elevations:** Terracon personnel provided the boring layout using handheld GPS equipment (estimated horizontal accuracy of about ±10 feet) and referencing existing site features. Ground surface elevations were not obtained. If elevations and a more precise boring layout are desired, we recommend borings be surveyed.

**Subsurface Exploration Procedures:** We advanced the borings with a truck-mounted rotary drill rig using continuous flight augers. Samples were obtained at 2½-foot intervals in each boring using split-barrel sampling procedures. In the split-barrel sampling procedure, a standard 2-inch outer diameter split-barrel sampling spoon was driven into the ground by a 140-pound automatic hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration is recorded as the Standard Penetration Test (SPT) resistance value. The SPT resistance values, also referred to as N-values, are indicated on the boring logs at the test depths. We observed and recorded groundwater levels during drilling and sampling. For safety purposes, all borings were backfilled with auger cuttings after their completion. Pavements were patched with cold-mix asphalt.

The sampling depths, penetration distances, and other sampling information was recorded on the field boring logs. The samples were placed in appropriate containers and taken to our soil laboratory for testing and classification by a Geotechnical Engineer. Our exploration team prepared field boring logs as part of the drilling operations. These field logs included visual classifications of the materials observed during drilling and our interpretation of the subsurface conditions between samples. Final boring logs were prepared from the field logs. The final boring logs represent the Geotechnical Engineer's interpretation of the field logs and include modifications based on observations and tests of the samples in our laboratory.

## Laboratory Testing

The project engineer reviewed the field data and assigned laboratory tests. The laboratory testing program included the following types of tests:

- Moisture content
- Dry unit weight
- Atterberg limits
- Grain size analysis
- Moisture-density relationship
- California Bearing Ratio (CBR)

The laboratory testing program often included examination of soil samples by an engineer. Based on the results of our field and laboratory programs, we described and classified the soil samples in accordance with the Unified Soil Classification System.

**Chemical Analysis:** Soil samples from boring B-1 at an approximate depth of 2 to 3½ feet, and boring B-6 at an approximate depth of 4½ to 6 feet were submitted to Minnesota Valley Testing Laboratories, Inc. (MVTL) for chemical analysis, to include the determination of the soils' pH, soluble chloride content, and soluble sulfate content. The results of these chemical analyses are discussed in the [Corrosivity](#) section.

**Soil Electrical Resistivity:** A soil sample from a composite blend from borings B-1 and B-7 at a depth of approximately 1 to 5 feet below existing grades was tested for electrical resistivity. Electrical resistivity data was obtained from these samples in accordance with ASTM G187, Standard Test Method for Measurement of Soil Resistivity Using the Two-Electrode Soil Box Method. The result of this test is discussed in the [Corrosivity](#) section.

## Photography Log



B-1 Pavement Thickness Core



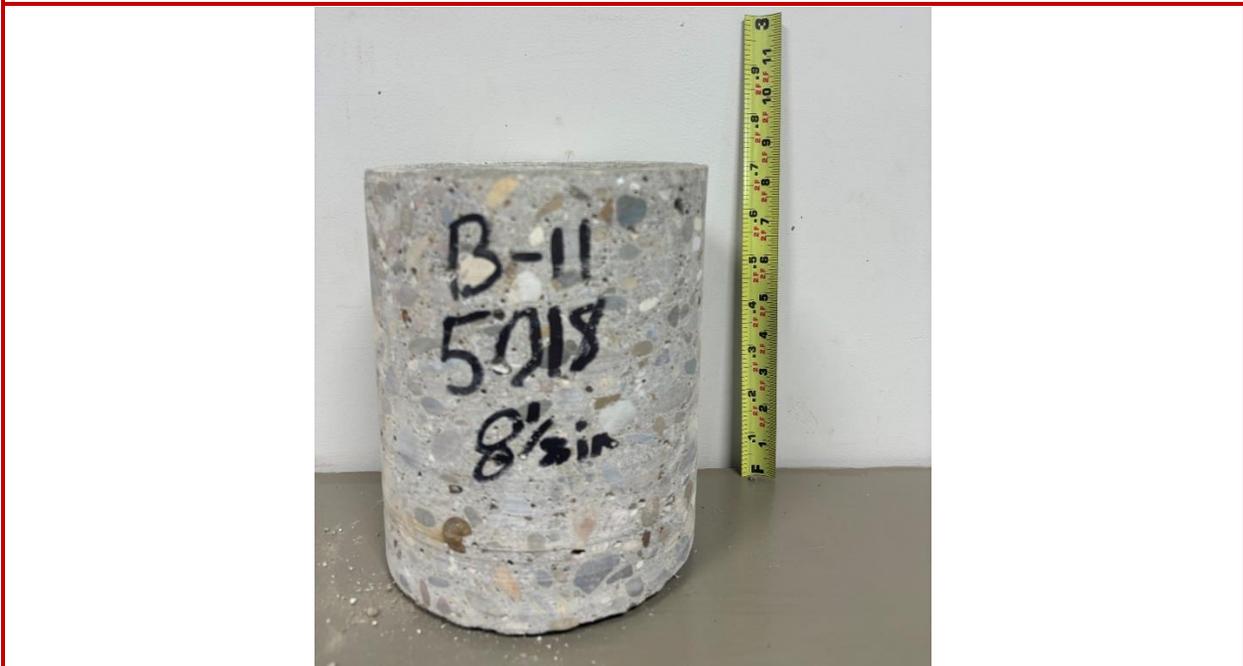
B-3 Pavement Thickness Core

**Geotechnical Exploration Report**

1st Street NW Improvements | Mandan, ND  
May 9, 2024 | Terracon Project No. M2245018



B-6 Pavement Thickness Core



B-11 Pavement Thickness Core

**Geotechnical Exploration Report**

1st Street NW Improvements | Mandan, ND  
May 9, 2024 | Terracon Project No. M2245018



B-15 Pavement Thickness Core

**Geotechnical Exploration Report**

1st Street NW Improvements | Mandan, ND  
May 9, 2024 | Terracon Project No. M2245018



## Site Location and Exploration Plans

**Contents:**

Site Location Plan  
Exploration Plan

Note: All attachments are one page unless noted above.

**Geotechnical Exploration Report**

1st Street NW Improvements | Mandan, ND  
May 9, 2024 | Terracon Project No. M2245018



**Site Location**

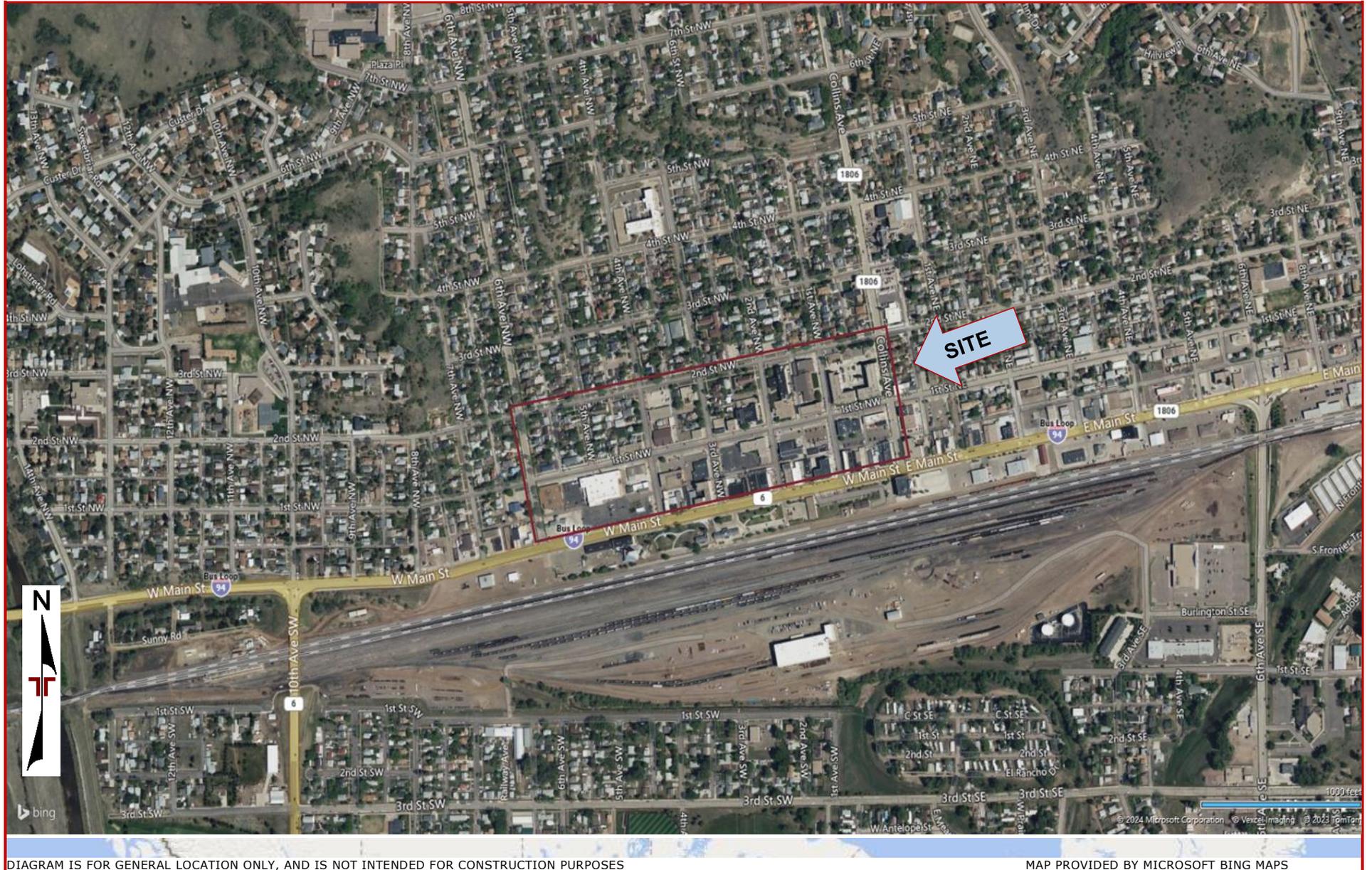


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

## Exploration Plan

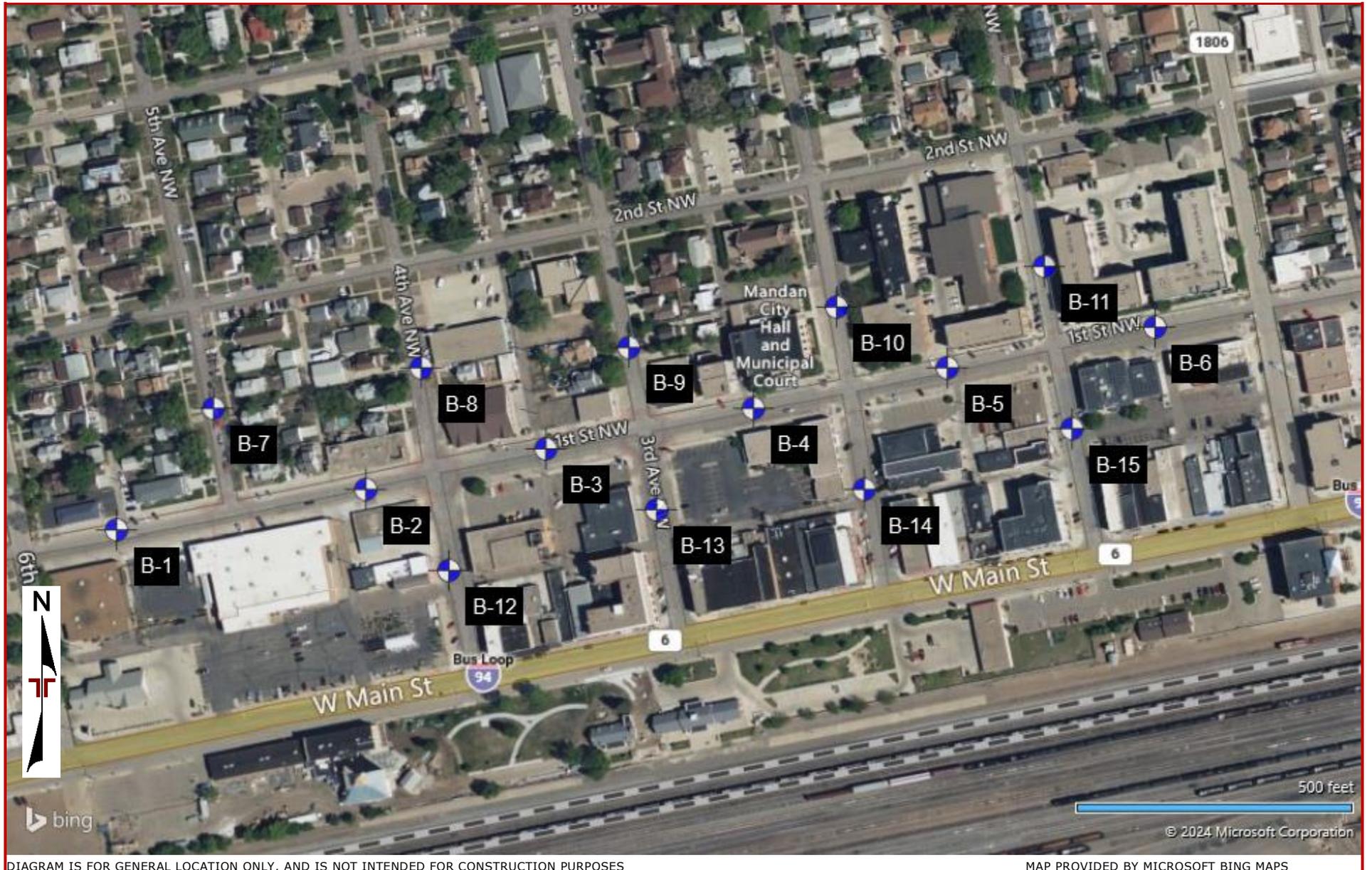


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MAP PROVIDED BY MICROSOFT BING MAPS

**Geotechnical Exploration Report**

1st Street NW Improvements | Mandan, ND  
May 9, 2024 | Terracon Project No. M2245018



## Exploration and Laboratory Results

**Contents:**

Boring Logs (B-1 through B-15)  
Corrosivity (4 pages from MVTL)  
Moisture Density Relationship  
CBR (2 pages)

Note: All attachments are one page unless noted above.

## Boring Log No. B-1

Model Layer	Graphic Log	Location: See <a href="#">Exploration Plan</a> Latitude: 46.8264° Longitude: -100.8983° Depth (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits	
										LL-PL-PI	Percent Fines
1		<b>CONCRETE</b> , 9 inches	0.8			11	6-5-3 N=8	12.4			
		<b>AGGREGATE BASE COURSE</b> , 9 inches	1.5								
2		<b>FILL - LEAN CLAY &amp; FAT CLAY MIXED</b> , trace gravel, brown, varying amounts of sand	7.0			10	2-3-3 N=6				
			5			8	2-3-3 N=6	33.4			
4		<b>FAT CLAY (CH)</b> , grayish brown to brown, stiff, laminations of silt	11.0			20	2-4-6 N=10	31.1	89		
			10			14	2-4-6 N=10	27.4			
		<b>Boring Terminated at 11 Feet</b>									

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (If any).  
 See [Supporting Information](#) for explanation of symbols and abbreviations.  
 Elevation Reference: Elevations not obtained

**Water Level Observations**

**Drill Rig**  
Mobile B-57 Truck

**Hammer Type**  
Automatic

**Driller**  
J. Okeefe

**Notes**

**Advancement Method**  
3¼" HSA, 0-9½'

**Logged by**  
J. Hoeven

**Abandonment Method**  
Boring backfilled with Auger Cuttings  
Surface capped with asphalt

**Boring Started**  
04-05-2024

**Boring Completed**  
04-05-2024



## Boring Log No. B-3

Model Layer	Graphic Log	Location: See <a href="#">Exploration Plan</a> Latitude: 46.8268° Longitude: -100.8952° Depth (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits	
										LL-PL-PI	Percent Fines
1		0.2 <b>ASPHALT</b> , 2¼ inches									
		0.8 <b>CONCRETE</b> , 7¼ inches									
3		0.8 <b>LEAN CLAY (CL)</b> , dark brown to black, medium stiff				9	2-3-4 N=7	31.6			
		2.0 <b>LEAN CLAY WITH SAND (CL)</b> , brown, stiff				14	2-4-5 N=9	28.1			
4		4.5 <b>FAT CLAY (CH)</b> , brown, stiff, laminations of silt and sand	5			13	2-4-7 N=11	28.6	87		
		7.5 <b>SILTY SAND (SM)</b> , fine to medium grained, brown, medium dense				18	5-5-7 N=12	5.9			
5		11.0 <b>Boring Terminated at 11 Feet</b>	10			12	6-7-4 N=11	6.3			

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (If any).  
 See [Supporting Information](#) for explanation of symbols and abbreviations.  
 Elevation Reference: Elevations not obtained

**Water Level Observations**

**Drill Rig**  
Mobile B-57 Truck

**Hammer Type**  
Automatic

**Driller**  
J. Okeefe

**Notes**

**Advancement Method**  
3¾:" HSA, 0-9½'

**Logged by**  
J. Hoeven

**Abandonment Method**  
Boring backfilled with Auger Cuttings  
Surface capped with asphalt

**Boring Started**  
04-05-2024

**Boring Completed**  
04-05-2024

## Boring Log No. B-4

Model Layer	Graphic Log	Location: See <a href="#">Exploration Plan</a> Latitude: 46.8270° Longitude: -100.8937°	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits	
										LL-PL-PI	Percent Fines
1	ASPHALT	Depth (Ft.) 0.3 <b>ASPHALT</b> , 3 inches				9	4-2-4 N=6	25.3	102		
2	FILL - SANDY LEAN CLAY	<b>FILL - SANDY LEAN CLAY</b> , brown									
2	FILL - LEAN CLAY & FAT CLAY MIXED	<b>FILL - LEAN CLAY &amp; FAT CLAY MIXED</b> , brown, varying amounts of sand	2.0			9	3-3-4 N=7	32.8			
4	FAT CLAY (CH)	<b>FAT CLAY (CH)</b> , brown, medium stiff to stiff, laminations of silt	4.0								
4	FAT CLAY (CH)	<b>FAT CLAY (CH)</b> , brown, medium stiff to stiff, laminations of silt	5.0			15	2-4-5 N=9	28.4	89		
4	FAT CLAY (CH)	<b>FAT CLAY (CH)</b> , brown, medium stiff to stiff, laminations of silt	10.5			13	1-2-4 N=6	33.2			
4	FAT CLAY (CH)	<b>FAT CLAY (CH)</b> , brown, medium stiff to stiff, laminations of silt  silty texture at 10.5'	11.0			18	2-2-3 N=5	27.3			
		<b>Boring Terminated at 11 Feet</b>									

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (If any).  
 See [Supporting Information](#) for explanation of symbols and abbreviations.  
 Elevation Reference: Elevations not obtained

**Water Level Observations**

**Drill Rig**  
Mobile B-57 Truck

**Hammer Type**  
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**Driller**  
J. Okeefe

**Notes**

**Advancement Method**  
3¼" HSA, 0-9½'

**Logged by**  
J. Hoeven

**Abandonment Method**  
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**Boring Started**  
04-05-2024

**Boring Completed**  
04-05-2024

## Boring Log No. B-5

Model Layer	Graphic Log	Location: See <a href="#">Exploration Plan</a> Latitude: 46.8272° Longitude: -100.8923°	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits	
										LL-PL-PI	Percent Fines
1		0.3 <b>ASPHALT</b> , 3 inches									
		0.8 <b>AGGREGATE BASE COURSE</b> , 4½ inches									
2		<b>FILL - LEAN CLAY &amp; FAT CLAY MIXED</b> , brown, varying amounts of sand				11	3-3-4 N=7	21.7			
						10	1-1-2 N=3	33.3	80		
3		<b>SANDY LEAN CLAY (CL)</b> , brown, medium stiff	5			10	2-3-4 N=7	30.2			
4		<b>FAT CLAY (CH)</b> , brown, medium stiff, laminations of silt				15	2-3-4 N=7	31.1			
						10	1-2-2 N=4	40.3			
		<b>Boring Terminated at 11 Feet</b>									

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (If any).  
 See [Supporting Information](#) for explanation of symbols and abbreviations.  
 Elevation Reference: Elevations not obtained

**Water Level Observations**

**Drill Rig**  
Mobile B-57 Truck

**Hammer Type**  
Automatic

**Driller**  
J. Okeefe

**Notes**

**Advancement Method**  
3¼:" HSA, 0-9½'

**Logged by**  
J. Hoeven

**Abandonment Method**  
Boring backfilled with Auger Cuttings  
Surface capped with asphalt

**Boring Started**  
04-05-2024

**Boring Completed**  
04-05-2024

## Boring Log No. B-6

Model Layer	Graphic Log	Location: See <a href="#">Exploration Plan</a> Latitude: 46.8274° Longitude: -100.8908°	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits	
										LL-PL-PI	Percent Fines
1		Depth (Ft.)									
		<b>ASPHALT</b> , 5 inches 0.5									
		<b>AGGREGATE BASE COURSE</b> , 9 inches 1.0				18	25-30-14 N=44	9.2			
2		<b>FILL - LEAN CLAY</b> , brown 2.0									
4		<b>FAT CLAY (CH)</b> , brown, medium stiff, laminations of silt									
						10	0-1-2 N=3	35.8			
			5			15	1-2-2 N=4				
						11	1-2-3 N=5	28.6	90		
5		<b>SILTY SAND (SM)</b> , fine to medium grained, brown 10.5 11.0				18	2-3-3 N=6	32.4			
		<b>Boring Terminated at 11 Feet</b>									

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (If any).  
 See [Supporting Information](#) for explanation of symbols and abbreviations.  
 Elevation Reference: Elevations not obtained

**Water Level Observations**

**Drill Rig**  
Mobile B-57 Truck

**Hammer Type**  
Automatic

**Driller**  
J. Okeefe

**Notes**

**Advancement Method**  
3¼:" HSA, 0-9½'

**Logged by**  
J. Hoeven

**Abandonment Method**  
Boring backfilled with Auger Cuttings  
Surface capped with asphalt

**Boring Started**  
04-05-2024

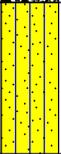
**Boring Completed**  
04-05-2024

## Boring Log No. B-7

Model Layer	Graphic Log	Location: See <a href="#">Exploration Plan</a> Latitude: 46.8270° Longitude: -100.8976°	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits	
										LL-PL-PI	Percent Fines
1		0.3 <b>ASPHALT</b> , 4 inches									
		0.5 <b>AGGREGATE BASE COURSE</b> , 3 inches									
2		<b>FILL - LEAN CLAY &amp; FAT CLAY MIXED</b> , brown, varying amounts of sand	1			1	3-3-6 N=9	12.4			
			6			6	1-2-4 N=6	28.9	87		
			5			6	2-2-4 N=6	21.9			
<b>Boring Terminated at 6 Feet</b>											

<p>See <a href="#">Exploration and Testing Procedures</a> for a description of field and laboratory procedures used and additional data (If any).</p> <p>See <a href="#">Supporting Information</a> for explanation of symbols and abbreviations.</p> <p>Elevation Reference: Elevations not obtained</p>	<p><b>Water Level Observations</b></p>	<p><b>Drill Rig</b> Mobile B-57 Truck</p> <p><b>Hammer Type</b> Automatic</p> <p><b>Driller</b> J. Okeefe</p>
<p><b>Notes</b></p>	<p><b>Advancement Method</b> 3¼:" HSA, 0-4½'</p> <p><b>Abandonment Method</b> Boring backfilled with Auger Cuttings Surface capped with asphalt</p>	<p><b>Logged by</b> J. Hoeven</p> <p><b>Boring Started</b> 04-05-2024</p> <p><b>Boring Completed</b> 04-05-2024</p>

## Boring Log No. B-8

Model Layer	Graphic Log	Location: See <a href="#">Exploration Plan</a> Latitude: 46.8272° Longitude: -100.8961°	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits	
										LL-PL-PI	Percent Fines
1		Depth (Ft.) <b>ASPHALT</b> , 7 inches									
		0.7 0.9 <b>AGGREGATE BASE COURSE</b> , 3 inches				12	3-4-7 N=11	25.4	91		
2		<b>FILL - LEAN CLAY &amp; FAT CLAY MIXED</b> , dark brown to brown, varying amounts of sand, possible organics at 1'									
		4.5				6	1-4-5 N=9	21.7			
5		<b>SILTY SAND (SM)</b> , fine to medium grained, brown, loose									
		6.0				14	3-3-2 N=5	3.8			
<b>Boring Terminated at 6 Feet</b>											

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (If any).  
 See [Supporting Information](#) for explanation of symbols and abbreviations.  
 Elevation Reference: Elevations not obtained

**Water Level Observations**

**Drill Rig**  
Mobile B-57 Truck

**Hammer Type**  
Automatic

**Driller**  
J. Okeefe

**Notes**

**Advancement Method**  
3¼:" HSA, 0-4½'

**Logged by**  
J. Hoeven

**Abandonment Method**  
Boring backfilled with Auger Cuttings  
Surface capped with asphalt

**Boring Started**  
04-06-2024

**Boring Completed**  
04-06-2024

## Boring Log No. B-9

Model Layer	Graphic Log	Location: See <a href="#">Exploration Plan</a> Latitude: 46.8273° Longitude: -100.8946°	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits	
										LL-PL-PI	Percent Fines
1		Depth (Ft.) <b>ASPHALT</b> , 5 inches	0.4			14	3-3-4 N=7	33.7			
			0.7								
2		<b>FILL - LEAN CLAY &amp; FAT CLAY MIXED</b> , dark brown, varying amounts of sand, possible organics at 1'	3.0			7	4-5-7 N=12	22.5			
			6.0								
4		<b>FAT CLAY (CH)</b> , brown, very stiff									
<b>Boring Terminated at 6 Feet</b>											

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (If any).  
 See [Supporting Information](#) for explanation of symbols and abbreviations.  
 Elevation Reference: Elevations not obtained

**Water Level Observations**

**Drill Rig**  
Mobile B-57 Truck

**Hammer Type**  
Automatic

**Driller**  
J. Okeefe

**Notes**

**Advancement Method**  
3¼:" HSA, 0-4½'

**Logged by**  
J. Hoeven

**Abandonment Method**  
Boring backfilled with Auger Cuttings  
Surface capped with asphalt

**Boring Started**  
04-06-2024

**Boring Completed**  
04-06-2024

## Boring Log No. B-10

Model Layer	Graphic Log	Location: See <a href="#">Exploration Plan</a> Latitude: 46.8275° Longitude: -100.8931°	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits	
										LL-PL-PI	Percent Fines
		Depth (Ft.)									
1	ASPHALT	<b>ASPHALT</b> , 4½ inches	0.4								
	AGGREGATE BASE COURSE	<b>AGGREGATE BASE COURSE</b> , 3 inches	0.7								
2	FILL - SANDY LEAN CLAY	<b>FILL - SANDY LEAN CLAY</b> , dark brown				7	3-3-4 N=7	23.8	100		
	LEAN CLAY (CL)	<b>LEAN CLAY (CL)</b> , brown, medium stiff	2.0								
3	CLAYEY SAND (SC)	<b>CLAYEY SAND (SC)</b> , fine to medium grained, brown, loose	4.0			5	1-2-4 N=6	25.3			
5	Boring Terminated at 6 Feet	<b>Boring Terminated at 6 Feet</b>	6.0			14	2-2-2 N=4	16.4			

<p>See <a href="#">Exploration and Testing Procedures</a> for a description of field and laboratory procedures used and additional data (If any).</p> <p>See <a href="#">Supporting Information</a> for explanation of symbols and abbreviations.</p> <p>Elevation Reference: Elevations not obtained</p>	<p><b>Water Level Observations</b></p>	<p><b>Drill Rig</b> Mobile B-57 Truck</p> <p><b>Hammer Type</b> Automatic</p> <p><b>Driller</b> J. Okeefe</p>
<p><b>Notes</b></p>	<p><b>Advancement Method</b> 3¼:" HSA, 0-4½'</p> <p><b>Abandonment Method</b> Boring backfilled with Auger Cuttings Surface capped with asphalt</p>	<p><b>Logged by</b> J. Hoeven</p> <p><b>Boring Started</b> 04-06-2024</p> <p><b>Boring Completed</b> 04-06-2024</p>

## Boring Log No. B-11

Model Layer	Graphic Log	Location: See <a href="#">Exploration Plan</a> Latitude: 46.8277° Longitude: -100.8916°	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits	
										LL-PL-PI	Percent Fines
1		Depth (Ft.) <b>CONCRETE</b> , 8½ inches									
		0.8 <b>AGGREGATE BASE COURSE</b> , 9 inches				17	13-22-10 N=32	10.2			
2		1.5 <b>FILL - FAT CLAY WITH SAND</b> , brown to dark brown									
		5.0				11	2-2-2 N=4	35.0		58-15-43	
4		<b>FAT CLAY (CH)</b> , brown, medium stiff, laminations of silt	5								
		6.0 <b>Boring Terminated at 6 Feet</b>									

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (If any).  
 See [Supporting Information](#) for explanation of symbols and abbreviations.  
 Elevation Reference: Elevations not obtained

**Water Level Observations**

**Drill Rig**  
Mobile B-57 Truck

**Hammer Type**  
Automatic

**Driller**  
J. Okeefe

**Notes**

**Advancement Method**  
3¼:" HSA, 0-4½'

**Logged by**  
J. Hoeven

**Abandonment Method**  
Boring backfilled with Auger Cuttings  
Surface capped with asphalt

**Boring Started**  
04-06-2024

**Boring Completed**  
04-06-2024

## Boring Log No. B-12

Model Layer	Graphic Log	Location: See <a href="#">Exploration Plan</a> Latitude: 46.8262° Longitude: -100.8959°	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits	
										LL-PL-PI	Percent Fines
1	ASPHALT	<b>ASPHALT</b> , 6 inches	0.5			1	50/1"	6.9			
	AGGREGATE BASE COURSE	<b>AGGREGATE BASE COURSE</b> , 6 inches	1.0								
	CONCRETE	<b>CONCRETE</b> , 6 inches	1.5								
6		<b>VOID</b>	2.5								
4	FILL - FAT CLAY WITH SAND	<b>FILL - FAT CLAY WITH SAND</b> , dark brown  auger refusal at 4'	4.0			5	12-3-3 N=6	29.2			
		<b>Auger Refusal at 4 Feet</b>									

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (if any).  
 See [Supporting Information](#) for explanation of symbols and abbreviations.  
 Elevation Reference: Elevations not obtained

<p><b>Water Level Observations</b></p>	<p><b>Drill Rig</b> Mobile B-57 Truck</p> <p><b>Hammer Type</b> Automatic</p> <p><b>Driller</b> J. Okeefe</p>
<p><b>Notes</b></p>	<p><b>Advancement Method</b> 3¼:" HSA, 0-4'</p> <p><b>Abandonment Method</b> Boring backfilled with Auger Cuttings Surface capped with asphalt</p>
	<p><b>Logged by</b> J. Hoeven</p> <p><b>Boring Started</b> 04-06-2024</p> <p><b>Boring Completed</b> 04-06-2024</p>

## Boring Log No. B-13

Model Layer	Graphic Log	Location: See <a href="#">Exploration Plan</a> Latitude: 46.8265° Longitude: -100.8944°	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits	
										LL-PL-PI	Percent Fines
1		Depth (Ft.)									
		0.5 <b>ASPHALT</b> , 6½ inches									
		0.8 <b>AGGREGATE BASE COURSE</b> , 3 inches				7	2-3-3 N=6	32.8			
2		<b>FILL - SANDY LEAN CLAY</b> , dark brown to brown									
		3.5				10	2-4-4 N=8	29.7			
4		<b>FAT CLAY (CH)</b> , brown, stiff, laminations of silt									
		6.0				11	2-4-5 N=9	24.6	96		
<b>Boring Terminated at 6 Feet</b>											

<p>See <a href="#">Exploration and Testing Procedures</a> for a description of field and laboratory procedures used and additional data (If any).                  See <a href="#">Supporting Information</a> for explanation of symbols and abbreviations.                  Elevation Reference: Elevations not obtained</p>	<p><b>Water Level Observations</b></p>	<p><b>Drill Rig</b> Mobile B-57 Truck</p> <p><b>Hammer Type</b> Automatic</p> <p><b>Driller</b> J. Okeefe</p>
<p><b>Notes</b></p>	<p><b>Advancement Method</b> 3¼:" HSA, 0-4½'</p> <p><b>Abandonment Method</b> Boring backfilled with Auger Cuttings Surface capped with asphalt</p>	<p><b>Logged by</b> J. Hoeven</p> <p><b>Boring Started</b> 04-06-2024</p> <p><b>Boring Completed</b> 04-06-2024</p>

## Boring Log No. B-14

Model Layer	Graphic Log	Location: See <a href="#">Exploration Plan</a> Latitude: 46.8266° Longitude: -100.8929°	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits	
										LL-PL-PI	Percent Fines
1	ASPHALT	ASPHALT, 7½ inches	0.8			8	1-2-3 N=5			44-12-32	
2	FILL - SANDY LEAN CLAY	FILL - SANDY LEAN CLAY, trace gravel, brown				5	1-2-2 N=4	27.7	94		
			6.0			11	1-2-3 N=5	35.4			
<b>Boring Terminated at 6 Feet</b>											

<p>See <a href="#">Exploration and Testing Procedures</a> for a description of field and laboratory procedures used and additional data (If any).                  See <a href="#">Supporting Information</a> for explanation of symbols and abbreviations.                  Elevation Reference: Elevations not obtained</p>	<p><b>Water Level Observations</b></p>	<p><b>Drill Rig</b> Mobile B-57 Truck</p> <p><b>Hammer Type</b> Automatic</p> <p><b>Driller</b> J. Okeefe</p>
<p><b>Notes</b></p>	<p><b>Advancement Method</b> 3¼:" HSA, 0-4½'</p> <p><b>Abandonment Method</b> Boring backfilled with Auger Cuttings Surface capped with asphalt</p>	<p><b>Logged by</b> J. Hoeven</p> <p><b>Boring Started</b> 04-06-2024</p> <p><b>Boring Completed</b> 04-06-2024</p>

## Boring Log No. B-15

Model Layer	Graphic Log	Location: See <a href="#">Exploration Plan</a> Latitude: 46.8269° Longitude: -100.8914° Depth (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits	
										LL-PL-PI	Percent Fines
1		<b>CONCRETE</b> , 8½ inches	0.8			14	6-3-3 N=6	18.0	112		
		<b>AGGREGATE BASE COURSE</b> , 8 inches	1.3								
2		<b>FILL - SANDY LEAN CLAY</b> , brown, trace organics	4.0			5	2-3-4 N=7	17.8			
		<b>LEAN CLAY WITH SAND (CL)</b> , brown, medium stiff	6.0								
3						9	2-3-4 N=7	30.2			
<b>Boring Terminated at 6 Feet</b>											

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (If any).  
 See [Supporting Information](#) for explanation of symbols and abbreviations.  
 Elevation Reference: Elevations not obtained

**Water Level Observations**

**Drill Rig**  
Mobile B-57 Truck

**Hammer Type**  
Automatic

**Driller**  
J. Okeefe

**Notes**

**Advancement Method**  
3¼:" HSA, 0-4½'

**Logged by**  
J. Hoeven

**Abandonment Method**  
Boring backfilled with Auger Cuttings  
Surface capped with asphalt

**Boring Started**  
04-06-2024

**Boring Completed**  
04-06-2024





**MINNESOTA VALLEY TESTING LABORATORIES, INC.**

1126 North Front St. ~ New Ulm, MN 56073 ~ 800-782-3557 ~ Fax 507-359-2890  
2616 East Broadway Ave. ~ Bismarck, ND 58501 ~ 800-279-6885 ~ Fax 701-258-9724  
1201 Lincoln Hwy. ~ Nevada, IA 50201 ~ 800-362-0855 ~ Fax 515-382-3885  
www.MVTL.com



**Account #:** 2148

**Client:** Terracon Consultants/Bismarck

**Analytical Results**

**Lab ID:** 45601001      **Date Collected:**      **Matrix:** Soil  
**Sample ID:** B-1 @ 2-3.5'      **Date Received:** 04/16/2024 12:10      **Collector:** Client

**Temp @ Receipt (C):** Ambient

Parameter	Results	Units	RDL	DF	Prepared	Analyzed	Qual
<b>Method: NCR-13 Pub. 221</b>							
Organic Matter	2.7	wt. %	0.100	1		04/18/2024 09:48	
<b>Method: ASTM D516-16</b>							
Sulfate	21.5	ug/g	12.3	1	04/17/2024 09:15	04/17/2024 11:48	
<b>Method: SM4500-CI-E 2011</b>							
Chloride	13.5	ug/g	4.9	1	04/17/2024 09:15	04/23/2024 15:31	
<b>Method: SW9045D</b>							
pH	8.13	units	0.1	1		04/16/2024 14:35	*

**Sample Comments**

Time sampled was not supplied by the client.

**Analysis Results Comments**

**pH**

Sample analyzed beyond holding time.

MVTL guarantees the accuracy of the analysis done on the sample submitted for testing. It is not possible for MVTL to guarantee that a test result obtained on a particular sample will be the same on any other sample unless all conditions affecting the sample are the same, including sampling by MVTL. As a mutual protection to clients, the public and ourselves, all reports are submitted as the confidential property of clients, and authorization for publication of statements, conclusions or extracts from or regarding our reports is reserved pending our written approval.



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**Account #:** 2148

**Client:** Terracon Consultants/Bismarck

**Analytical Results**

**Lab ID:** 45601002      **Date Collected:**      **Matrix:** Soil  
**Sample ID:** B-6 @ 4.5-6'      **Date Received:** 04/16/2024 12:10      **Collector:** Client

**Temp @ Receipt (C):** Ambient

Parameter	Results	Units	RDL	DF	Prepared	Analyzed	Qual
<b>Method: NCR-13 Pub. 221</b>							
Organic Matter	2.2	wt. %	0.100	1		04/18/2024 09:48	
<b>Method: ASTM D516-16</b>							
Sulfate	83.2	ug/g	12.4	1	04/17/2024 09:15	04/17/2024 11:50	
<b>Method: SM4500-CI-E 2011</b>							
Chloride	32.4	ug/g	4.9	1	04/17/2024 09:15	04/23/2024 15:33	
<b>Method: SW9045D</b>							
pH	8.15	units	0.1	1		04/16/2024 14:35	*

**Sample Comments**

Time sampled was not supplied by the client.

**Analysis Results Comments**

**pH**

Sample analyzed beyond holding time.

MVTL guarantees the accuracy of the analysis done on the sample submitted for testing. It is not possible for MVTL to guarantee that a test result obtained on a particular sample will be the same on any other sample unless all conditions affecting the sample are the same, including sampling by MVTL. As a mutual protection to clients, the public and ourselves, all reports are submitted as the confidential property of clients, and authorization for publication of statements, conclusions or extracts from or regarding our reports is reserved pending our written approval.



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Account #: 2148

Client: Terracon Consultants/Bismarck



**LABORATORIES, Inc.**  
2616 East Broadway Avenue  
Bismarck, ND 58501  
Phone: (701) 258-9720

Ch: Terracon Consultants/Bismarck - Chemistry  
WO: 45601

Form #



Page \_\_\_\_ of \_\_\_\_

Toll Free: (800) 279-6885 Fax: (701) 258-9724

Company Name and Address: <b>Terracon PO Box 2084 Bismarck, ND 58502</b>			Account #: <b>701.258.2833</b>			Phone #: <b>701.258.2833</b>													
Billing Address (indicate if different from above):			Contact: Josh Brilz			Fax #: For faxed report check box <input type="checkbox"/>													
			Name of Sampler:			E-mail: <a href="mailto:josh.brilz@terracon.com">josh.brilz@terracon.com</a> For e-mail report check box <input checked="" type="checkbox"/>													
			Quote Number			Date Submitted:													
			Project Name/Number: <b>M2245018</b>			Purchase Order #:													
Sample Information			Bottle Type										Analysis						
Lab Use Only	Lab Number	Sample ID	Sample Type (Soil, Water, Etc.)	Filtered Y or N		Untreated	Sterile	500 ml HNO3	1000 ml H2SO4	250 ml H2SO4	1000 ml NaOH	Amber HCl	Amber Unpres.	VOC Vials HCl	Glass Narrow Neck H2SO4	VOC Vials H2SO4	Other:	Analysis Required	
				Date Sampled	Time Sampled														
	001	B-1 @ 2-3.5'	soil																pH, Sulfates, Chlorides, Organics
	002	B-6 @ 4.5-6'	soil																pH, Sulfates, Chlorides, Organics

Comments:

	Transferred by:	Date:	Time:	Sample Condition:	Received by:	Date:	Time:	Temp:
1.	JZL	4-16-24	12:12		[Signature]	16 Apr 24	12:10	21.5°C
2.								71K 80S

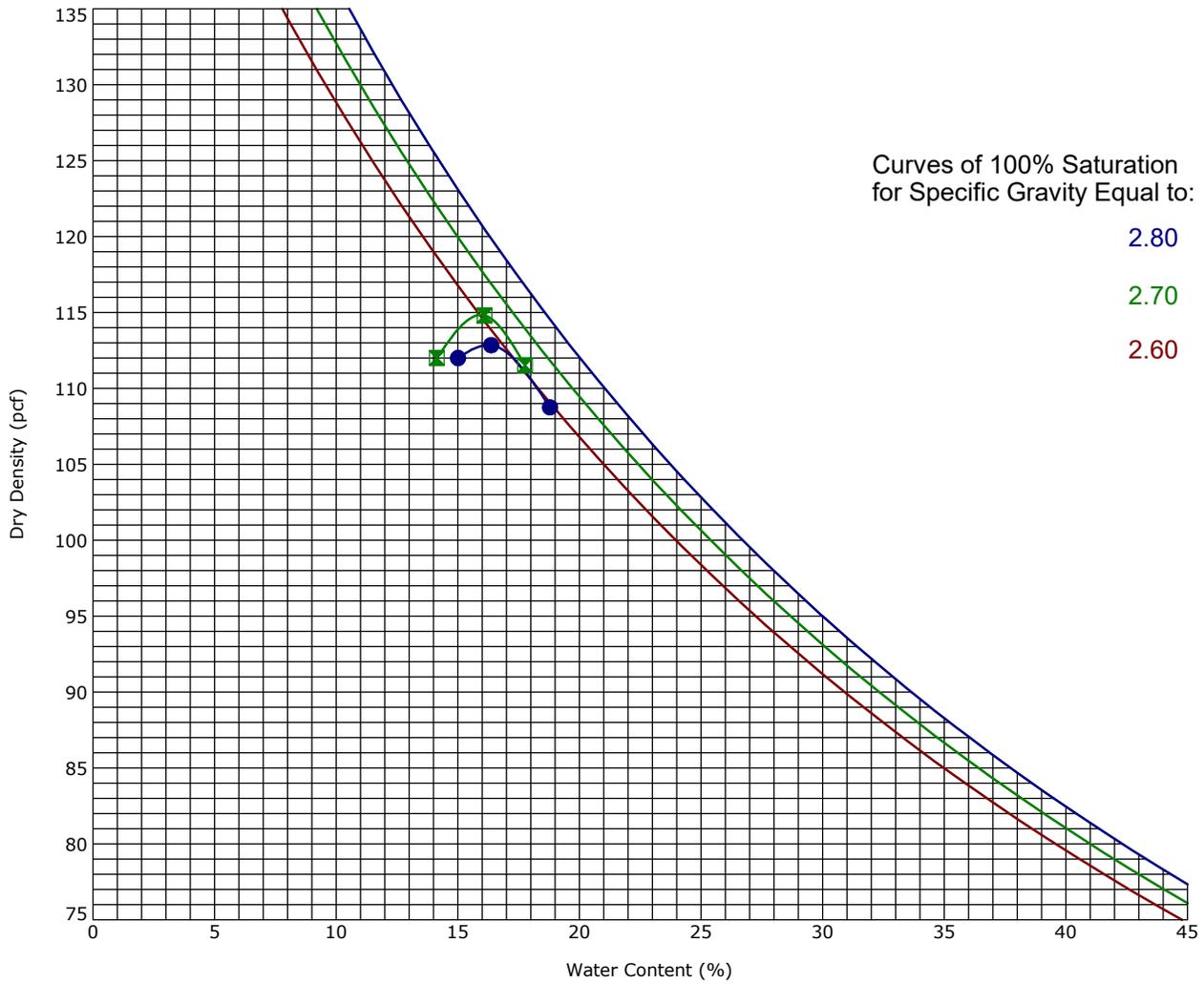
Please submit the top two copies with your samples. We will return the completed original with your results.

MVTL guarantees the accuracy of the analysis done on the sample submitted for testing. It is not possible for MVTL to guarantee that a test result obtained on a particular sample will be the same on any other sample unless all conditions affecting the sample are the same, including sampling by MVTL. As a mutual protection to clients, the public and ourselves, all reports are submitted as the confidential property of clients, and authorization for publication of statements, conclusions or extracts from or regarding our reports is reserved pending our written approval.

Report Date: Wednesday, April 24, 2024 12:35:39 PM

## Moisture-Density Relationship

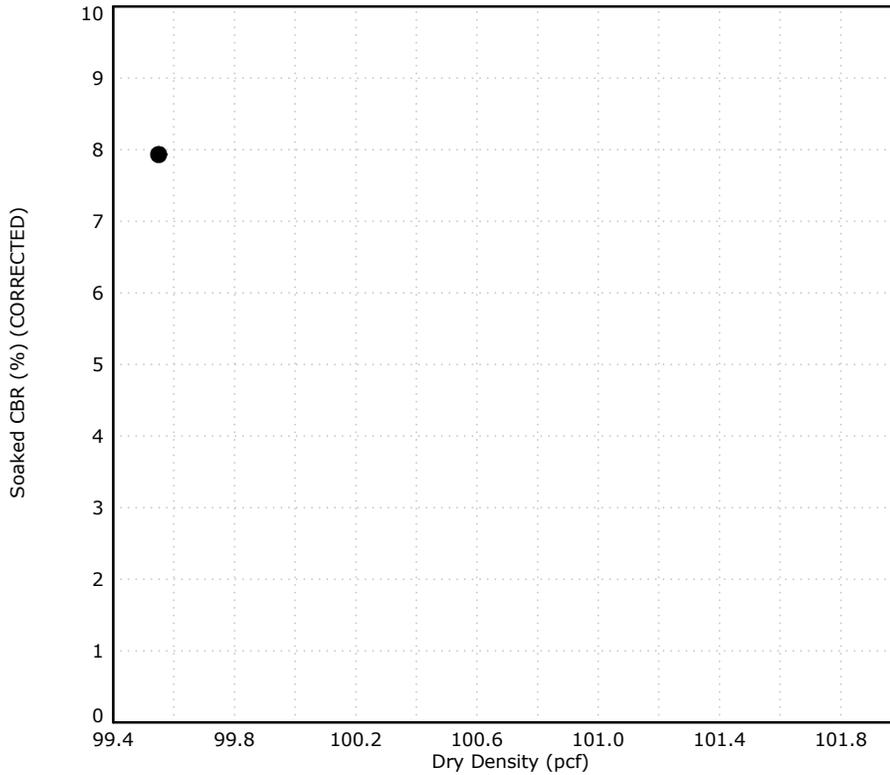
### ASTM D1557-Method A



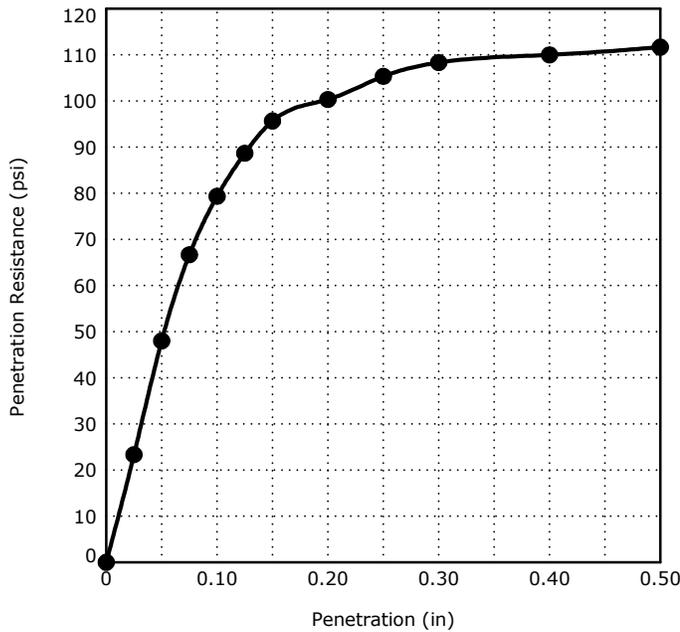
Boring ID	Depth (Ft)	Fines (%)	LL	PL	PI	Description of Materials
● B-1 & B-7 Composite	1 - 5	78	53	14	39	FAT CLAY with SAND (CH)
■ B-6 & B-9 Composite	1 - 5	81	57	16	41	FAT CLAY with SAND (CH)

Boring ID	Depth (Ft)	Test Method	Max DD (pcf)	Optimum WC (%)
● B-1 & B-7 Composite	1 - 5	B-1 A B-7 Composite, 1STM D1557-Method A	112.9	16.2
■ B-6 & B-9 Composite	1 - 5	B-6 A B-9 Composite, 1STM D1557-Method A	114.8	15.9

## California Bearing Ratio ASTM D1883-07<sup>2</sup>

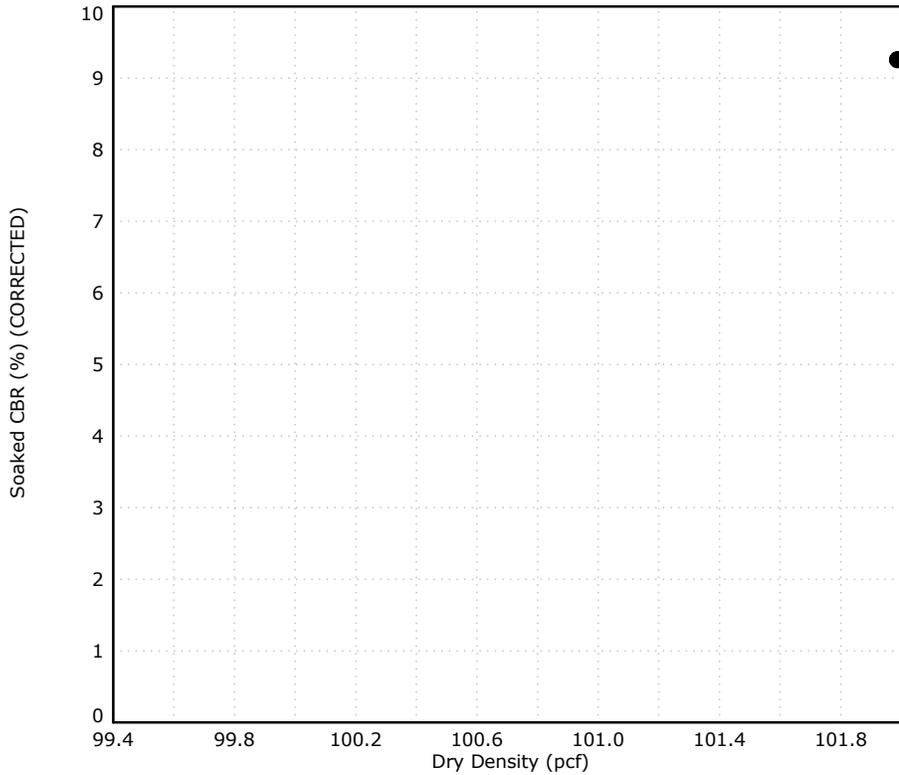


<b>Source of Material</b>	B-1 & B-7 Composite 1.0		
<b>Description of Material</b>	FAT CLAY with SAND(CH)		
<b>Percent Fines</b>	78.4		
<b>Atterberg Limits</b>	LL 53	PL 14	PI 39
<b>Remarks:</b>			

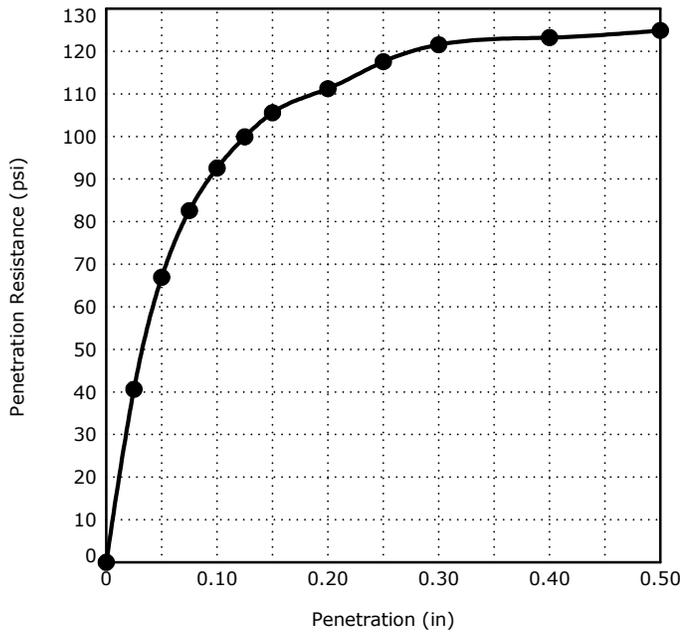


<b>Sample No.</b>	1
<b>Sample Condition</b>	Soaked
<b>Compaction Method</b>	ASTM D1557A
<b>Maximum Dry Density, (pcf)</b>	112.9
<b>Optimum Moisture Content, (%)</b>	16.2
<b>Dry Density before Soaking, (pcf)</b>	99.55
<b>Moisture Content, (%)</b>	
<b>After Compaction</b>	18.2
<b>Top 1" After Soaking</b>	24.2
<b>Surcharge, (lbs)</b>	10.00
<b>Swell, (%)</b>	2.39
<b>Bearing Ratio, (%)</b>	7.9

## California Bearing Ratio ASTM D1883-07<sup>2</sup>



<b>Source of Material</b>	B-6 & B-9 Composite 1.0		
<b>Description of Material</b>	FAT CLAY with SAND(CH)		
<b>Percent Fines</b>	81.5		
<b>Atterberg Limits</b>	LL 57	PL 16	PI 41
<b>Remarks:</b>			



<b>Sample No.</b>	1
<b>Sample Condition</b>	Soaked
<b>Compaction Method</b>	ASTM D1557A
<b>Maximum Dry Density, (pcf)</b>	114.8
<b>Optimum Moisture Content, (%)</b>	15.9
<b>Dry Density before Soaking, (pcf)</b>	101.99
<b>Moisture Content, (%)</b>	
<b>After Compaction</b>	17.5
<b>Top 1" After Soaking</b>	25.2
<b>Surcharge, (lbs)</b>	10.00
<b>Swell, (%)</b>	2.60
<b>Bearing Ratio, (%)</b>	9.3

**Geotechnical Exploration Report**

1st Street NW Improvements | Mandan, ND  
May 9, 2024 | Terracon Project No. M2245018



## Supporting Information

**Contents:**

General Notes  
Unified Soil Classification System

Note: All attachments are one page unless noted above.

## General Notes

Sampling	Water Level	Field Tests
 Split Spoon	 Water Initially Encountered  Water Level After a Specified Period of Time  Water Level After a Specified Period of Time  Cave In Encountered  Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.	N Standard Penetration Test Resistance (Blows/Ft.) (HP) Hand Penetrometer (T) Torvane (DCP) Dynamic Cone Penetrometer UC Unconfined Compressive Strength (PID) Photo-Ionization Detector (OVA) Organic Vapor Analyzer

### Descriptive Soil Classification

Soil classification as noted on the soil boring logs is based Unified Soil Classification System. Where sufficient laboratory data exist to classify the soils consistent with ASTM D2487 "Classification of Soils for Engineering Purposes" this procedure is used. ASTM D2488 "Description and Identification of Soils (Visual-Manual Procedure)" is also used to classify the soils, particularly where insufficient laboratory data exist to classify the soils in accordance with ASTM D2487. In addition to USCS classification, coarse grained soils are classified on the basis of their in-place relative density, and fine-grained soils are classified on the basis of their consistency. See "Strength Terms" table below for details. The ASTM standards noted above are for reference to methodology in general. In some cases, variations to methods are applied as a result of local practice or professional judgment.

### Location And Elevation Notes

Exploration point locations as shown on the Exploration Plan and as noted on the soil boring logs in the form of Latitude and Longitude are approximate. See Exploration and Testing Procedures in the report for the methods used to locate the exploration points for this project. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

### Strength Terms

Relative Density of Coarse-Grained Soils (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance		Consistency of Fine-Grained Soils (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance		
Relative Density	Standard Penetration or N-Value (Blows/Ft.)	Consistency	Unconfined Compressive Strength Qu (psf)	Standard Penetration or N-Value (Blows/Ft.)
Very Loose	0 - 3	Very Soft	less than 500	0 - 1
Loose	4 - 9	Soft	500 to 1,000	2 - 4
Medium Dense	10 - 29	Medium Stiff	1,000 to 2,000	4 - 8
Dense	30 - 50	Stiff	2,000 to 4,000	8 - 15
Very Dense	> 50	Very Stiff	4,000 to 8,000	15 - 30
		Hard	> 8,000	> 30

### Relevance of Exploration and Laboratory Test Results

Exploration/field results and/or laboratory test data contained within this document are intended for application to the project as described in this document. Use of such exploration/field results and/or laboratory test data should not be used independently of this document.

## Unified Soil Classification System

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests <sup>A</sup>				Soil Classification	
				Group Symbol	Group Name <sup>B</sup>
<b>Coarse-Grained Soils:</b> More than 50% retained on No. 200 sieve	<b>Gravels:</b> More than 50% of coarse fraction retained on No. 4 sieve	<b>Clean Gravels:</b> Less than 5% fines <sup>C</sup>	Cu ≥ 4 and 1 ≤ Cc ≤ 3 <sup>E</sup>	GW	Well-graded gravel <sup>F</sup>
		<b>Gravels with Fines:</b> More than 12% fines <sup>C</sup>	Cu < 4 and/or [Cc < 1 or Cc > 3.0] <sup>E</sup>	GP	Poorly graded gravel <sup>F</sup>
			Fines classify as ML or MH	GM	Silty gravel <sup>F, G, H</sup>
		<b>Sands:</b> 50% or more of coarse fraction passes No. 4 sieve	<b>Clean Sands:</b> Less than 5% fines <sup>D</sup>	Fines classify as CL or CH	GC
	Cu ≥ 6 and 1 ≤ Cc ≤ 3 <sup>E</sup>			SW	Well-graded sand <sup>I</sup>
	<b>Sands with Fines:</b> More than 12% fines <sup>D</sup>		Cu < 6 and/or [Cc < 1 or Cc > 3.0] <sup>E</sup>	SP	Poorly graded sand <sup>I</sup>
			Fines classify as ML or MH	SM	Silty sand <sup>G, H, I</sup>
	<b>Fine-Grained Soils:</b> 50% or more passes the No. 200 sieve	<b>Silts and Clays:</b> Liquid limit less than 50	<b>Inorganic:</b>	PI > 7 and plots above "A" line <sup>J</sup>	CL
PI < 4 or plots below "A" line <sup>J</sup>				ML	Silt <sup>K, L, M</sup>
<b>Organic:</b>			$\frac{LL \text{ oven dried}}{LL \text{ not dried}} < 0.75$	OL	Organic clay <sup>K, L, M, N</sup> Organic silt <sup>K, L, M, O</sup>
			<b>Silts and Clays:</b> Liquid limit 50 or more	<b>Inorganic:</b>	PI plots on or above "A" line
PI plots below "A" line		MH			Elastic silt <sup>K, L, M</sup>
<b>Organic:</b>		$\frac{LL \text{ oven dried}}{LL \text{ not dried}} < 0.75$		OH	Organic clay <sup>K, L, M, P</sup> Organic silt <sup>K, L, M, Q</sup>
		<b>Highly organic soils:</b>		Primarily organic matter, dark in color, and organic odor	

- <sup>A</sup> Based on the material passing the 3-inch (75-mm) sieve.
- <sup>B</sup> If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
- <sup>C</sup> Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.
- <sup>D</sup> Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay.
- <sup>E</sup>  $Cu = D_{60}/D_{10}$      $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$
- <sup>F</sup> If soil contains ≥ 15% sand, add "with sand" to group name.
- <sup>G</sup> If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

- <sup>H</sup> If fines are organic, add "with organic fines" to group name.
- <sup>I</sup> If soil contains ≥ 15% gravel, add "with gravel" to group name.
- <sup>J</sup> If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.
- <sup>K</sup> If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.
- <sup>L</sup> If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.
- <sup>M</sup> If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.
- <sup>N</sup> PI ≥ 4 and plots on or above "A" line.
- <sup>O</sup> PI < 4 or plots below "A" line.
- <sup>P</sup> PI plots on or above "A" line.
- <sup>Q</sup> PI plots below "A" line.

