BRAUN INTERTEC
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February 22, 2017 Project B1608780

Mr. Andrew Albrecht
Highlands Engineering & Surveying, PLLC
319 24th Street East
Dickinson, ND 58601

Re: Addendum 1 to Geotechnical Evaluation
8th Street Improvements
Dickinson, North Dakota

Dear Mr. Albrecht:

This letter serves as Addendum 1 to our Revised Geotechnical Evaluation Report for this project, dated December 12, 2016. This Addendum addresses pavement reconstruction west of Main Avenue.

Background

Our Geotechnical Evaluation Report provided recommendations for portions of 8th Street South. We provided recommendations for a mill and overlay west of Main Avenue, and pavement reconstruction east of Main Avenue.

Clarification

Section A.1 of our report stated “Borings were not performed west of 5th Avenue SE.” This should read “Borings were not performed east of 5th Avenue SE.” A revised Boring Location Sketch, to include the entire section of proposed roadway reconstruction, is also attached to this addendum.

New Information

According to Mr. Andrew Schrank, PE, Highlands Engineering performed a pavement condition analysis of the roadway section west of Main Avenue. They will recommend that this section of roadway also be reconstructed. Since the curbs and gutters will remain unchanged, they desire to keep the same top of roadway elevation.

Recommendations

We anticipate that the minimum combined thicknesses of existing bituminous pavement and aggregate base west of Main Avenue is 19 inches, and consisted of at least 5 inches of asphalt and 14 inches of aggregate base course. We recommend the following pavement thicknesses for reconstruction of the roadway west of Main Avenue. For bituminous sections, we recommend removing existing asphalt and aggregate base to a depth of 7 inches below existing grade, re-compacting the remaining aggregate base, and placing 7 inches of bituminous surfacing. For concrete sections, we recommend removing existing asphalt and aggregate base to a depth of 9 inches below existing grade, re-compacting the remaining aggregate base, and placing 9 inches of concrete surfacing. These sections will be equivalent to the pavement sections we provided in our December 12 report.

Remarks

This Addendum should be attached to and considered a part of our original Geotechnical Evaluation Report. With the exception of any results or recommendations changed by this Addendum, the information contained in our Geotechnical Evaluation Report remains unchanged.

In performing its services, Braun Intertec used that degree of care and skill ordinarily exercised under similar circumstances by reputable members of its profession currently practicing in the same locality. No warranty, express or implied, is made.

If you have any questions about this Addendum, please contact Wes Dickhut at 701.355.5430 or WDickhut@braunintertec.com.

Sincerely,

BRAUN INTERTEC CORPORATION

REGISTERED PROFESSIONAL ENGINEER
CHARLES W. DICKHUT
PE-9213
DATE 2/22/17
NORTH DAKOTA

Professional Certification:
I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Registered Professional Engineer under the laws of the State of North Dakota.

Charles W. (Wes) Dickhut, PE
Associate Principal/Senior Engineer
Registration Number: PE-9213
February 22, 2017

Brianne J. Nauman, EI
Staff Engineer

Attachments:
Boring Location Sketch

BRAUN INTERTEC

DENOTES APPROXIMATE LOCATION OF STANDARD PENETRATION TEST BORING

125' 0 250'

SCALE: 1" = 250'

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Bismarck, ND 58504
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SOIL BORING LOCATION SKETCH

GEOTECHNICAL EVALUATION
8TH STREET SO.
DICKINSON, NORTH DAKOTA

Project No:	B1608780
Drawing No:	B1608780
Scale:	1" = 250'
Drawn By:	BJB
Date Drawn:	10/5/16
Checked By:	BJN
Last Modified:	2/22/17
Sheet:	Fig:
of	

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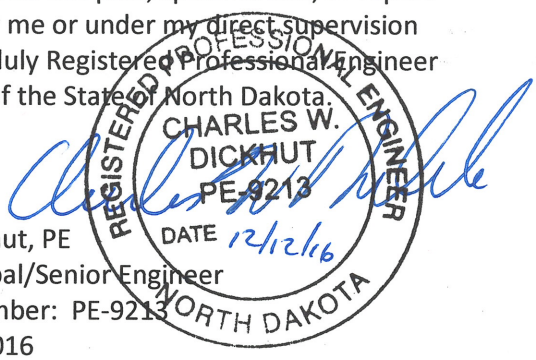
Geotechnical Evaluation Report

8th Street Improvements
8th Street South
Dickinson, North Dakota

Prepared for

Highlands Engineering & Surveying, PLLC

Professional Certification:
I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Registered Professional Engineer under the laws of the State of North Dakota.



Charles W. Dickhut, PE
Associate Principal/Senior Engineer
Registration Number: PE-9213
December 12, 2016

Project B1608780

Braun Intertec Corporation

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December 12, 2016

Project B1608780

Mr. Andrew Albrecht
Highlands Engineering & Surveying, PLLC
319 24th Street East
Dickinson, ND 58601

Re: Revised Geotechnical Evaluation
8th Street Improvements
Dickinson, North Dakota

Dear Mr. Albrecht:

We are pleased to present this Revised Geotechnical Evaluation Report for the proposed street improvements of 8th Street South from 2nd Avenue SW to 6th Avenue SE. We revised the report based on comments received from you on our November 17 report.

Thank you for making Braun Intertec Corporation your geotechnical consultant for this project. If you have questions about this report, or if there are other services that we can provide in support of our work to date please contact Brianne Nauman at 701.388.9683 (BNauman@braunintertec.com).

Sincerely,

BRAUN INTERTEC CORPORATION

Brianne J. Nauman, EI
Staff Engineer

Charles W. (Wes) Dickhut, PE
Associate Principal/Senior Engineer

AA/EOE

Table of Contents

Description **Page**

Table of Contents (continued)

Description **Page**

A. Introduction

A.1. Project Description

This Geotechnical Evaluation Report addresses the proposed design and construction of 8th Street South from 2nd Avenue SW to 6th Avenue SE with the exception of the ND highway 22 (Main Avenue) intersection. Highland Engineering indicated the project would be either a mill and overlay or total reconstruction. Currently, the site exists as an urban asphalt pavement with sidewalks on both sides of the roadway. Table 1 provides project details.

Table 1. Site Aspects and Grading Description

Aspect	Description
Provided Pavement loads	20-Yr Flexible ESALs*: 1,571,714
	30-Yr rigid ESALs*: 4,101,958
Grade changes	No vertical or horizontal alignment changes

*Equivalent 18,000-lb single axle loads based on the design life provided.

We noted a miscommunication regarding the extent of the proposed reconstruction. Google Earth™ incorrectly labeled 6th Avenue SE as 9th Avenue SE and the drive to a housing complex as 6th Avenue SE. Borings were not performed west of 5th Avenue SE. We believe our recommendations are representative throughout the remainder of 8th Street South.

A.2. Purpose

The purpose of our geotechnical evaluation is to characterize subsurface geologic conditions at selected exploration locations and evaluate their impact on the design and construction of the proposed improvements.

A.3. Background Information and Reference Documents

We reviewed the following information:

- Aerial photographs of the site from Google Earth™ dated June 1995 to September 2014;

- Geologic map of the area titled “Geology of the Dickinson North Dakota Area”, Geologic Investigations No. 10, North Dakota Geological Survey, 2005;
- Traffic loadings provided by Andrew Schrank, PE, of Highlands Engineering.

We have described our understanding of the proposed construction and site to the extent others reported it to us. Depending on the extent of available information, we may have made assumptions based on our experience with similar projects. If we have not correctly recorded or interpreted the project details, the project team should notify us. New or changed information could require additional evaluation, analyses and/or recommendations.

A.4. Scope of Services

We originally submitted our scope of services for this project as a Proposal to Mr. Andrew Albercht of Highlands Engineering & Surveying, PLLC. We received authorization to proceed from KC Homiston, PE, of Highlands Engineering on September 13, 2016. The following sections describe the tasks we completed in accordance with our authorized scope of services. The following sections also note the nature of and factors contributing to deviations from our authorized scope of services.

Our scope of services did not include environmental services or testing, and the personnel performing the evaluation are not trained to provide environmental services or testing. We can provide these services or testing at your request.

A.4.a. Staking and Surveying

We staked exploration locations by geo-referencing your selected boring locations into Google Earth™ and selecting latitude and longitude coordinates. We measured surface elevations using a surveyor’s level and referenced the surface elevations to hydrant 725 located northeast of the intersection of 8th Street South and 1st Avenue SE. We assumed the hydrant had an elevation of 150 feet.

A.4.b. Subsurface Exploration

We performed penetration test borings at the locations shown on Boring Location Sketch attached in the Appendix and extended to approximately 6 feet below the existing ground surface. We obtained thin-walled tube samples at various depths while advancing the borings. We obtained bulk samples of the geologic materials encountered at beneath the aggregate surfacing in several borings.

Prior to commencing with our subsurface exploration activities, we cleared the exploration locations of underground utilities through North Dakota One Call.

B. Results

B.1. Geologic Overview

We based the geologic origins used in this report on the soil types, in-situ and laboratory testing, and available common knowledge of the geological history of the site. Because of the complex depositional history, geologic origins can be difficult to ascertain. We did not perform a detailed investigation of the geologic history for the site.

B.2. Boring Results

Tables 2 and 3 provide a summary of the soil boring results, in the general order we encountered the strata. Please refer to the Log of Boring sheets in the Appendix for additional details. The Descriptive Terminology sheets in the Appendix include definitions of abbreviations used in Table 3.

Table 2. Pavement Materials

Boring	Pavement Thicknesses (inches)			Comments
	Bituminous	Aggregate Base*	Total	
ST-01	5 ½	18	23 ½	
ST-02	5	14	19	
ST-03	5	6	11	
ST-04	5 ½	0	5 ½	No aggregate base noted at the location of the boring.
ST-05	6	0	6	No aggregate base noted at the location of the boring.
ST-06	4	3	7	
ST-07	6	3	9	

Boring	Pavement Thicknesses (inches)			Comments
	Bituminous	Aggregate Base*	Total	
ST-08	4	2	6	
AVERAGE	5.1	5.7	10.9	

* The drillers identified "Aggregate Base" in the field; this does not imply conformance of the materials to a particular specification.

Table 3. Subsurface Profile Summary*

Strata	Soil Type - ASTM Classification	Range of Penetration Resistances	Commentary and Details
Pavement section			▪ Bituminous thickness 4 to 6 inches. ▪ Aggregate base ranges from 0 to 18 inches.
Fill	SP, SM	3 to 23 blows per foot (BPF)	▪ Moisture condition generally damp to moist. ▪ Thicknesses at boring locations varied from 1 ½ feet to over 5 feet. ▪ Generally brown and dark brown. ▪ Possible cobbles and boulders.
Sentinel Butte Formation Bedrock	Sandstone, Claystone, Siltstone	16 to 33 BPF	▪ Bedrock encountered in Borings ST-05 and ST-06. ▪ Sandstone texturally classified as Silty Sand (SM), Claystone texturally classified as Fat Clay (CH), and Siltstone texturally classified as Silt (ML).

*Abbreviations defined in the attached Descriptive Terminology sheets.

For simplicity in this report, we define fill to mean existing, uncontrolled or undocumented fill.

B.3. Groundwater

We did not observe groundwater while advancing our borings. Therefore, it appears that groundwater is below the depths explored. Project planning should anticipate seasonal and annual fluctuations of groundwater.

B.4. Laboratory Test Results

We performed 2 standard Proctor tests (per ASTM D698) and 2 California Bearing Ratio (CBR) tests (per ASTM D1883) were performed on selected samples to aid in soil classification and estimation of engineering properties. The Appendix contains the results of these tests. Table 4 presents the results of our laboratory tests. The remolded densities correspond to 95 percent relative compaction in ST-02, corresponding to compacted subgrade, and 90 percent relative compaction in ST-07, corresponding to the in-place density of the soil reflected by the standard penetration resistance values.

Table 4. Laboratory Test Results

Location	Sample Depth (ft)	Classification	Maximum Dry Density (γ, pcf)	Optimum Moisture Content (%)	Percent Passing a #200 Sieve	CBR Value (at optimum moisture, at percent Std Proctor noted)
ST-02	1-5	Silty Sand (SM)	121.0	11.8	25	17.7 (95%)
ST-07	1-5	Silty Sand (SM)	119.5	11.7	36	5.0 (90%)

C. Recommendations

C.1. Design and Construction Discussion

Since there was little to no aggregate base present in the borings in the existing roadway east of Main Avenue to 6th Avenue SE, we recommend that section of the roadway can be stripped of pavement and any aggregate present, and the subgrade be scarified to 1 foot, blended, moisture conditioned, and recompacted. The subgrade should be proofrolled prior to placing aggregate base.

It is our opinion that a mill and overlay of the pavement section from west of Main Avenue to 2nd Avenue SW is acceptable. Since the aggregate thickness varied, it would be prudent to base the overlay section on a conservative existing condition. Our recommendations are based on the existing conditions encountered

C.2. Pavements

C.2.a. Traffic Data

As mentioned previously, we used ESAL loading provided by Highlands Engineering. The estimated 20-year design ESALs for the flexible pavement are 1,571,714 ESALs and the estimated 30-year design ESALs for rigid pavement are 4,101,958 ESALs.

C.2.b. Subgrade Preparations

Within the area of pavement reconstruction, from West of Main Avenue, we recommend gravel surfacing, scoria, topsoil, organic materials, vegetation, trees and their root masses, and any foreign materials be removed from below the proposed pavement areas. After completion of the removals, we recommend the resulting subgrades be scarified (thoroughly mixed/disced) to a depth of at least 1-foot, moisture conditioned to a moisture content at or above optimum, and recompacted to a minimum of 95 percent of the materials' standard Proctor maximum dry density. Deeper excavations or imported materials may be required if compaction cannot be achieved.

Based on the laboratory tests performed to evaluate the California Bearing Ratio (CBR) of the subgrade materials and the subgrade preparation recommendations above, we recommend using a design CBR value of 17 for the reconstructed pavement subgrade east of Main Avenue. We recommend a design CBR of 5 for the pavement west of Main Avenue that will receive a mill and overlay.

C.2.c. Pavement Subgrade Proofroll

After preparing the subgrade as described above and prior to the placement of the aggregate base, we recommend proofrolling the subgrade soils with a fully loaded tandem-axle truck. We also recommend having a geotechnical representative observe the proofroll. Areas that fail the proofroll likely indicate soft or weak areas that will require additional soil correction work to support pavements.

The contractor should correct areas that display excessive yielding or rutting during the proofroll, as determined by the geotechnical representative. Possible options for subgrade correction include moisture conditioning and recompaction, subcutting and replacement with soil or crushed aggregate, chemical stabilization and/or geotextiles. We recommend performing a second proofroll after the aggregate base material is in place, and prior to placing bituminous or concrete pavement.

C.2.d. Bituminous Surfaced Pavements

C.2.d.1. Bituminous Surfaced Pavement Thickness Calculations

For the bituminous-surfaced portions of the pavements, we utilized the simplified design chart for calculating pavement thicknesses presented in "Figure 3.1. - Design Chart for Flexible Pavements Based on Using Mean Values for Input", of the AASHTO Guide for Design of Pavement Structures (1993). The parameters used to perform the calculations were assumed/calculated as follows:

- Reliability = 85%;
- Standard Deviation = 0.45;
- ESALs = 1,571,714; and
- Design Serviceability Loss = 2.2 (Initial Serviceability = 4.2, Terminal Serviceability = 2.0).

The above design method provides a Design Structural Number (SN), which is then used to iteratively calculate the required pavement thickness. The Design Structural Number obtained for bituminous surfaced pavements is provided in Table 5 below. The pavement thicknesses are calculated from the equation:

$$SN = (D_1 \times a_1) + (D_2 \times a_2 \times m_2)$$

- D_1 = Bituminous Thickness (inches);
- a_1 = Structural Layer Coefficient for Bituminous = 0.40;
- D_2 = Aggregate Base Thickness (inches);
- a_2 = Structural Layer Coefficient for Aggregate Base = 0.10; and
- m_2 = Drainage Modifier = 0.9.

Solving the above equation for the Structural Numbers provided, we recommend the bituminous-surfaced pavement sections for the roadway consist of the following sections:

Table 5. Recommended Bituminous Pavement Sections

Pavement Sections	West of Main Avenue	East of Main Avenue
Pavement design condition	Mill and Overlay	Complete Pavement Reconstruction
Minimum total asphalt thickness (inches)	6*	5
Minimum NDDOT Class 5 aggregate base thickness (inches)	14**	10
Required Structural Number	3.6	2.7

*The recommended asphalt thickness in the mill and overlay section, west of Main Avenue, is the total asphalt thickness after milling.

** Aggregate base thickness west of Main Avenue based on minimum observed aggregate base thickness in area.

The above pavement designs are based upon a 20-year performance life. This is the amount of time before major reconstruction is anticipated. This performance life assumes maintenance, such as seal coating and crack sealing, is routinely performed. The actual pavement life will vary depending on variations in weather, traffic conditions, and maintenance.

C.2.d.2. Materials and Compaction

We recommend specifying crushed aggregate base meeting the requirements of North Dakota Department of Transportation (NDDOT) Specification 816.02 for Class 5 Aggregate Base. We recommend that the aggregate base be compacted to a minimum of 100 percent of its maximum standard Proctor dry density.

C.2.e. Concrete Pavements

We have provided recommendations for removing the asphalt and leaving the existing aggregate base course in place to the west of Main Avenue, and for complete reconstruction of the subgrade and pavement section east of Main Avenue. The recommendation for reconstruction will be adequate for the pavement west of Main Avenue if a partial reconstruction is not compatible with the existing grades.

C.2.e.1. Concrete Pavement Thickness Calculations

We utilized Figure 3.7 of the AASHTO Guide for Design of Pavement Structures for calculation of the rigid pavement thicknesses. The input parameters used in our rigid pavement thickness calculations were:

- Concrete elastic modulus (E_c) = 3.6 ksi;
- Mean concrete modulus of rupture = 580 psi;
- Load transfer coefficient = 2.6 (assuming the pavements will be joint-reinforced);

- Drainage coefficient = 0.9;
- Design serviceability loss = 2.2;
- ESALs = 4,101,958;
- Reliability = 85%; and
- Standard deviation = 0.35.

We recommend the concrete-surfaced pavement sections for the roadway consist of the following sections:

Table 6. Recommended Bituminous Pavement Sections

Pavement Sections	West of Main Avenue	East of Main Avenue
Pavement design condition	Asphalt removal	Complete pavement reconstruction
Minimum concrete thickness (inches)	8 1/2	8
Minimum NDDOT Class 5 aggregate base thickness (inches)	14*	6
Design modulus of subgrade reaction (k)	150 pci	260 pci

* Class 5 thickness west of Main Avenue based on minimum observed aggregate base thickness in area.

The effective modulus of subgrade reaction for the section west of Main Avenue provided assuming removal of existing asphalt and recompaction of existing aggregate base. Sections thicknesses provided are assuming that the joints will be reinforced.

C.2.e.2. Materials and Compaction

We recommend specifying concrete for pavements that has a minimum 28-day compressive strength of 4,000 psi, and a modulus of rupture (M_r) of at least 580 psi. We also recommend Type I cement meeting the requirements of ASTM C 150. We recommend specifying 5 to 8 percent entrained air for exposed concrete to provide resistance to freeze-thaw deterioration. We also recommend using a water/cement ratio of 0.45 or less for non-reinforced concrete exposed to de-icers; and a water/cement ratio of 0.40 or less for reinforced concrete exposed to de-icers.

C.2.f. Subgrade Drainage

Providing drainage for the pavements' aggregate base layer will aid in maximizing the life of the pavements by improving subgrade conditions and reducing the potential for development of cracks. We recommend drainage be provided by installing perforated drainpipes throughout pavement areas at low points and about catch basins. The drainpipes should be placed in small trenches extended at least 8 inches below the aggregate base and routing them to a suitable drainage location.

D. Procedures

D.1. Penetration Test Borings

We drilled the penetration test borings with a truck-mounted core and auger drill equipped with hollow-stem auger. We performed the borings in general accordance with ASTM D1586 taking penetration test samples at 2 1/2- or 5-foot intervals. We collected thin-walled tube samples in general accordance with ASTM D1587 at selected depths. The boring logs show the actual sample intervals and corresponding depths. We also collected bulk samples of auger cuttings at selected locations for laboratory testing.

D.2. Exploration Logs

D.2.a. Log of Boring Sheets

The Appendix includes Log of Boring sheets for our penetration test borings. The logs identify and describe the penetrated geologic materials, and present the results of penetration resistance and other in-situ tests performed. The logs also present the results of laboratory tests performed on penetration test samples and groundwater measurements. The Appendix also includes a Fence Diagram intended to provide a summarized cross-sectional view of the soil profile across the site.

We inferred strata boundaries from changes in the penetration test samples and the auger cuttings. Because we did not perform continuous sampling, the strata boundary depths are only approximate. The boundary depths likely vary away from the boring locations, and the boundaries themselves may occur as gradual rather than abrupt transitions.

D.2.b. Geologic Origins

We assigned geologic origins to the materials shown on the logs and referenced within this report, based on: (1) a review of the background information and reference documents cited above, (2) visual classification of the various geologic material samples retrieved during the course of our subsurface exploration, (3) penetration resistance, (4) laboratory test results, and (5) available common knowledge of the geologic processes and environments that have impacted the site and surrounding area in the past.

D.3. Material Classification and Testing

D.3.a. Visual and Manual Classification

We visually and manually classified the geologic materials encountered in accordance with ASTM D2488. The Appendix includes a chart explaining the classification system.

D.3.b. Laboratory Testing

The exploration logs in the Appendix note most of the results of the laboratory tests performed on geologic material samples. The remaining laboratory test results follow the exploration logs. We performed the tests in general accordance with ASTM procedures.

D.4. Groundwater Measurements

The drillers checked for groundwater while advancing the penetration test borings, and again after auger withdrawal. We then filled the boreholes as noted on the boring logs.

E. Qualifications

E.1. Variations in Subsurface Conditions

E.1.a. Material Strata

We developed our evaluation, analyses and recommendations from a limited amount of site and subsurface information. It is not standard engineering practice to retrieve material samples from exploration locations continuously with depth. Therefore, we must infer strata boundaries and thicknesses to some extent. Strata boundaries may also be gradual transitions, and project planning should expect the strata to vary in depth, elevation and thickness, away from the exploration locations.

Variations in subsurface conditions present between exploration locations may not be revealed until performing additional exploration work, or starting construction. If future activity for this project reveals any such variations, you should notify us so that we may reevaluate our recommendations. Such variations could increase construction costs, and we recommend including a contingency to accommodate them.

E.1.b. Groundwater Levels

We made groundwater measurements under the conditions reported herein and shown on the exploration logs, and interpreted in the text of this report. Note that the observation periods were relatively short, and project planning can expect groundwater levels to fluctuate in response to rainfall, flooding, irrigation, seasonal freezing and thawing, surface drainage modifications and other seasonal and annual factors.

E.2. Continuity of Professional Responsibility

E.2.a. Plan Review

We based this report on a limited amount of information, and we made a number of assumptions to help us develop our recommendations. We should be retained to review the geotechnical aspects of the designs and specifications. This review will allow us to evaluate whether we anticipated the design correctly, if any design changes affect the validity of our recommendations, and if the design and specifications correctly interpret and implement our recommendations.

E.2.b. Construction Observations and Testing

We recommend retaining us to perform the required observations and testing during construction as part of the ongoing geotechnical evaluation. This will allow us to correlate the subsurface conditions exposed during construction with those encountered by the borings and provide professional continuity from the design phase to the construction phase. If we do not perform observations and testing during construction, it becomes the responsibility of others to validate the assumption made during the preparation of this report and to accept the construction-related geotechnical engineer-of-record responsibilities.

E.3. Use of Report

This report is for the exclusive use of the addressed parties. Without written approval, we assume no responsibility to other parties regarding this report. Our evaluation, analyses and recommendations may not be appropriate for other parties or projects.

E.4. Standard of Care

In performing its services, Braun Intertec used that degree of care and skill ordinarily exercised under similar circumstances by reputable members of its profession currently practicing in the same locality. No warranty, express or implied, is made.

Appendix

DENOTES APPROXIMATE LOCATION OF STANDARD PENETRATION TEST BORING

100' 0 200'

SCALE: 1" = 200'

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Bismarck, ND 58504
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SOIL BORING LOCATION SKETCH
GEOTECHNICAL EVALUATION
8TH STREET SOUTH
DICKINSON, NORTH DAKOTA

Project No:	B1608780
Drawing No:	B1608780
Scale:	1" = 200'
Drawn By:	BJB
Date Drawn:	10/5/16
Checked By:	BN
Last Modified:	10/5/16
Sheet: of	Fig:

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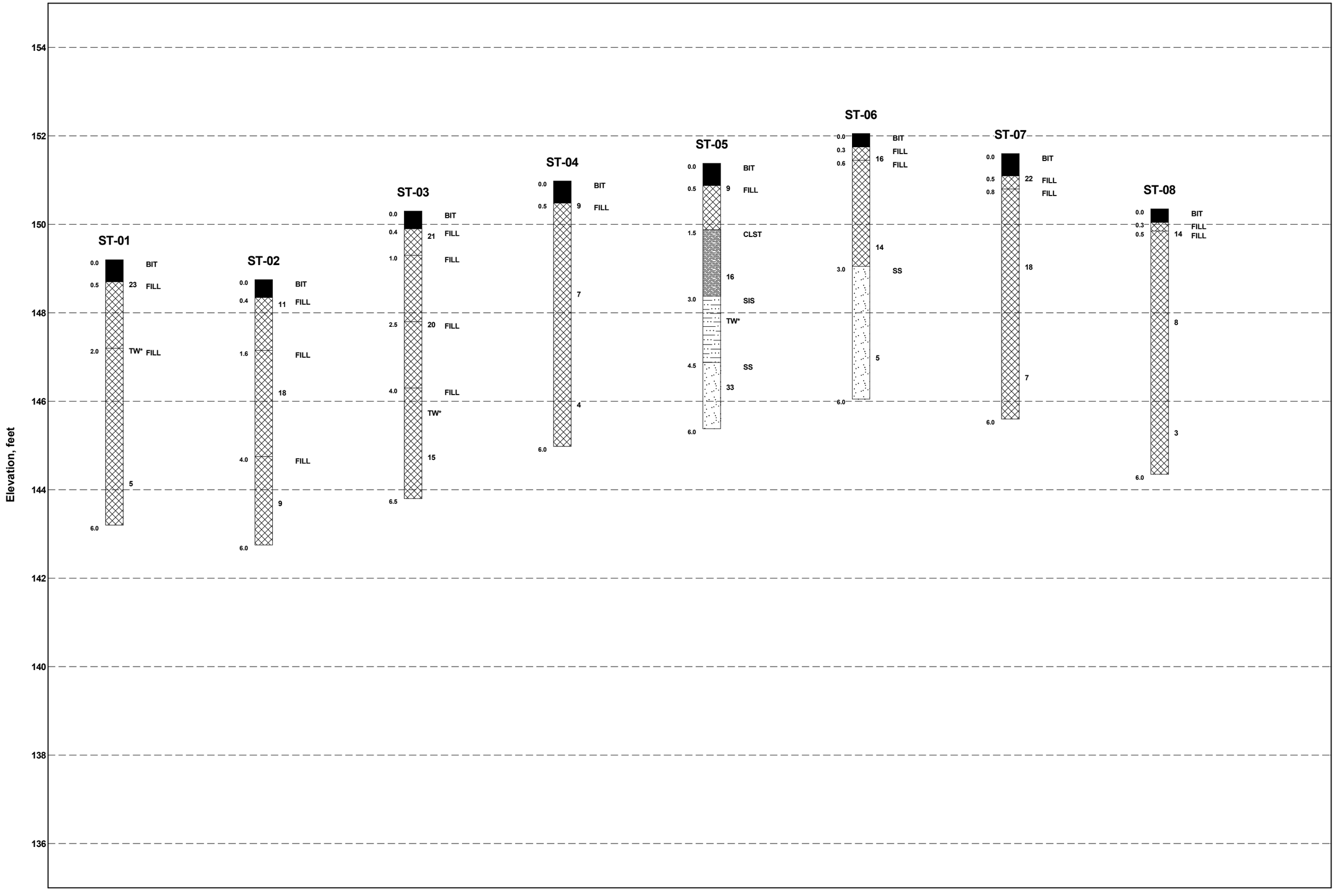

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FENCE DIAGRAM
GEOTECNICAL EVALUATION
8TH STREET SOUTH STREET RECONSTRUCTION
8TH STREET SOUTH
DICKINSON, NORTH DAKOTA

Project No: B1608780
Scale: Vert=2 ft Hor NTS
Date: 11-17-16
Figure:

11X17 ELEVATION-TITLE BLOCK 08780.GPJ BRAUN_V8_CURRENT.GDT 11/17/16 16:34

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LOG OF BORING

Braun Project B1608780
Geotecnical Evaluation
8th Street South Street Reconstruction
8th Street South
Dickinson, North Dakota

BORING: **ST-01**

LOCATION: See sketch

DRILLER: A.Horner | METHOD: 3 1/4" HSA, Autohammer | DATE: **9/21/16** | SCALE: **1" = 3'**

Elev. feet	Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
149.2	0.0						
148.7	0.5	BIT	FILL: 5 1/2 inches of Asphalt surfacing.				
		FILL	FILL: 18 inches of Poorly Graded Gravel.	23			
147.2	2.0	FILL	FILL: Silty Sand, fine-grained, dark brown, moist.	TW*		10	*4 inches of recovery. WD=126 pcf, DD=115 pcf
				5			
143.2	6.0		END OF BORING.				
			Water not observed with 4 1/2 feet of hollow stem auger in the ground.				Elevations referenced to hydrant 725 located northeast of the intersection of 8th Street South and 1st Avenue SE with and assumed elevation of 150 feet.
			Boring then backfilled and Asphalt patched at the surface.				

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\AX PROJECTS\2016\08780.GPJ BRAUN_V8_CURRENT.GDT 11/17/16 16:30

BRAUN INTERTEC

LOG OF BORING

Braun Project B1608780
Geotecnical Evaluation
8th Street South Street Reconstruction
8th Street South
Dickinson, North Dakota

BORING: **ST-02**

LOCATION: See sketch

DRILLER: A.Horner | METHOD: 3 1/4" HSA, Autohammer | DATE: **9/21/16** | SCALE: **1" = 3'**

Elev. feet	Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
148.8	0.0					
148.4	0.4	BIT	FILL: 5 inches of Asphalt surfacing.			
		FILL	FILL: 14 inches of Poorly Graded Gravel.	11		
147.2	1.6	FILL	FILL: Silty Sand, fine-grained, trace Gravel, dark brown, moist.	18		Bag sample collected from 1 to 5 feet.
144.8	4.0	FILL	FILL: Silty Sand, fine-grained, brown, moist.	9		
142.8	6.0		END OF BORING. Water not observed with 4 1/2 feet of hollow stem auger in the ground. Boring then backfilled and Asphalt patched at the surface.			

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\AX PROJECTS\2016\08780.GPJ BRAUN_V8_CURRENT.GDT 11/17/16 16:30

BRAUN INTERTEC

LOG OF BORING

Braun Project B1608780
Geotecnical Evaluation
8th Street South Street Reconstruction
8th Street South
Dickinson, North Dakota

BORING: **ST-03**

LOCATION: See sketch

DRILLER: A.Horner | METHOD: 3 1/4" HSA, Autohammer | DATE: **9/21/16** | SCALE: **1" = 3'**

Elev. feet	Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
150.3	0.0					
149.9	0.4	BIT	FILL: 5 inches of Asphalt surfacing.			
149.3	1.0	FILL	FILL: 6 inches of Poorly Graded Gravel.	21		
		FILL	FILL: Silty Sand, fine-grained, dark brown, moist.			
147.8	2.5					
		FILL	FILL: Silty Sand with Gravel, fine- to coarse-grained, dark brown, damp.	20		
146.3	4.0					
		FILL	FILL: Silty Sand, fine-grained, dark brown, moist.	TW*		*6 inches of recovery.
				15		
143.8	6.5					
			END OF BORING. Water not observed with 4 1/2 feet of hollow stem auger in the ground. Boring then backfilled and Asphalt patched at the surface.			

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\AX PROJECTS\2016\08780.GPJ BRAUN_V8_CURRENT.GDT 11/17/16 16:30

BRAUN INTERTEC

LOG OF BORING

Braun Project B1608780
Geotecnical Evaluation
8th Street South Street Reconstruction
8th Street South
Dickinson, North Dakota

BORING: **ST-04**

LOCATION: See sketch

DRILLER: A.Horner | METHOD: 3 1/4" HSA, Autohammer | DATE: **9/21/16** | SCALE: **1" = 3'**

Elev. feet	Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
151.0	0.0					
150.5	0.5	BIT	FILL: 5 1/2 inches of Asphalt surfacing.			
		FILL	FILL: Silty Sand, fine-grained, brown and dark brown, moist.	9		
				7		Bag sample collected from 1 to 5 feet.
				4		
145.0	6.0		END OF BORING. Water not observed with 4 1/2 feet of hollow stem auger in the ground. Boring then backfilled and Asphalt patched at the surface.			

(See Descriptive Terminology sheet for explanation of abbreviations)

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BRAUN INTERTEC

LOG OF BORING

Braun Project B1608780
Geotecnical Evaluation
8th Street South Street Reconstruction
8th Street South
Dickinson, North Dakota

BORING: **ST-05**

LOCATION: See sketch

DRILLER: A.Horner | METHOD: 3 1/4" HSA, Autohammer | DATE: **9/21/16** | SCALE: **1" = 3'**

Elev. feet	Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	q_p tsf	Tests or Notes
151.4	0.0						
150.9	0.5	BIT	FILL: 6 inches of Asphalt surfacing.				
149.9	1.5	FILL	FILL: Silty Sand, fine- to coarse-grained, trace Gravel, brown, damp.	9			
148.4	3.0	CLST	SENTINEL BUTTE FORMATION, CLAYSTONE, interbedded with Siltstone, gray, moist, decomposed, very soft, hand deformed sample classified as "Fat Clay (CH)".	16		4	
146.9	4.5	SIS	SENTINEL BUTTE FORMATION, SILTSTONE, trace iron staining, gray, moist, decomposed, very soft, sample retrieved as non-cemented "Silt (ML)".	TW*			*6 inches of recovery.
145.4	6.0	SS	SENTINEL BUTTE FORMATION, SANDSTONE, fine-grained, brown, moist, decomposed, very soft, sample retrieved as non-cemented "Silty Sand (SM)".	33			
			END OF BORING. Water not observed with 4 1/2 feet of hollow stem auger in the ground. Boring then backfilled and Asphalt patched at the surface.				

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\AX PROJECTS\2016\08780.GPJ BRAUN_V8_CURRENT.GDT 11/17/16 16:30

BRAUN INTERTEC

LOG OF BORING

Braun Project B1608780
Geotecnical Evaluation
8th Street South Street Reconstruction
8th Street South
Dickinson, North Dakota

BORING: **ST-06**

LOCATION: See sketch

DRILLER: A.Horner | METHOD: 3 1/4" HSA, Autohammer | DATE: **9/21/16** | SCALE: **1" = 3'**

Elev. feet	Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
152.1	0.0					
151.8	0.3	BIT	FILL: 4 inches of Asphalt surfacing.			
151.5	0.6	FILL	FILL: 3 inches of Poorly Graded Gravel.	16		
		FILL	FILL: Silty Sand, fine-grained, brown, moist.			
149.1	3.0			14		
		SS	SENTINEL BUTTE FORMATION, SANDSTONE, fine-grained, brown, moist, decomposed, very soft, sample retrieved as non-cemented "Silty Sand (SM)".			
				5		
146.1	6.0					
			END OF BORING.			
			Water not observed with 4 1/2 feet of hollow stem auger in the ground.			
			Boring then backfilled and Asphalt patched at the surface.			

(See Descriptive Terminology sheet for explanation of abbreviations)

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BRAUN INTERTEC

LOG OF BORING

Braun Project B1608780
Geotecnical Evaluation
8th Street South Street Reconstruction
8th Street South
Dickinson, North Dakota

BORING: **ST-07**

LOCATION: See sketch

DRILLER: A.Horner | METHOD: 3 1/4" HSA, Autohammer | DATE: **9/21/16** | SCALE: **1" = 3'**

Elev. feet	Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
151.6	0.0					
151.1	0.5	BIT	FILL: 6 inches of Asphalt surfacing.			
150.8	0.8	FILL	FILL: 3 inches of Poorly Graded Gravel.	22		
		FILL	FILL: Silty Sand, fine-grained, dark brown, moist.	18		Bag sample collected from 1 to 6 feet.
				7		
145.6	6.0		END OF BORING.			
			Water not observed with 4 1/2 feet of hollow stem auger in the ground.			
			Boring then backfilled and Asphalt patched at the surface.			

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\AX PROJECTS\2016\08780.GPJ BRAUN_V8_CURRENT.GDT 11/17/16 16:30

BRAUN INTERTEC

LOG OF BORING

Braun Project B1608780
Geotecnical Evaluation
8th Street South Street Reconstruction
8th Street South
Dickinson, North Dakota

BORING: **ST-08**

LOCATION: See sketch

DRILLER: A.Horner | METHOD: 3 1/4" HSA, Autohammer | DATE: **9/21/16** | SCALE: **1" = 3'**

Elev. feet	Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
150.4	0.0					
150.1	0.3	BIT	FILL: 4 inches of Asphalt surfacing.			
149.9	0.5	FILL	FILL: 2 inches of Poorly Graded Gravel.	14		
		FILL	FILL: Silty Sand, fine-grained, dark brown, moist.	8		
				3		
144.4	6.0		END OF BORING. Water not observed with 4 1/2 feet of hollow stem auger in the ground. Boring then backfilled and Asphalt patched at the surface.			

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\AX PROJECTS\2016\08780.GPJ BRAUN_V8_CURRENT.GDT 11/17/16 16:30

Braun Intertec Corporation
1341 South 20th Street, Suite 5, P.O. Box 1836
Bismarck, ND 58504
Phone: 701.255.7180

Proctor Report

Report No: PTR:W16-008816-S1
Issue No: 1

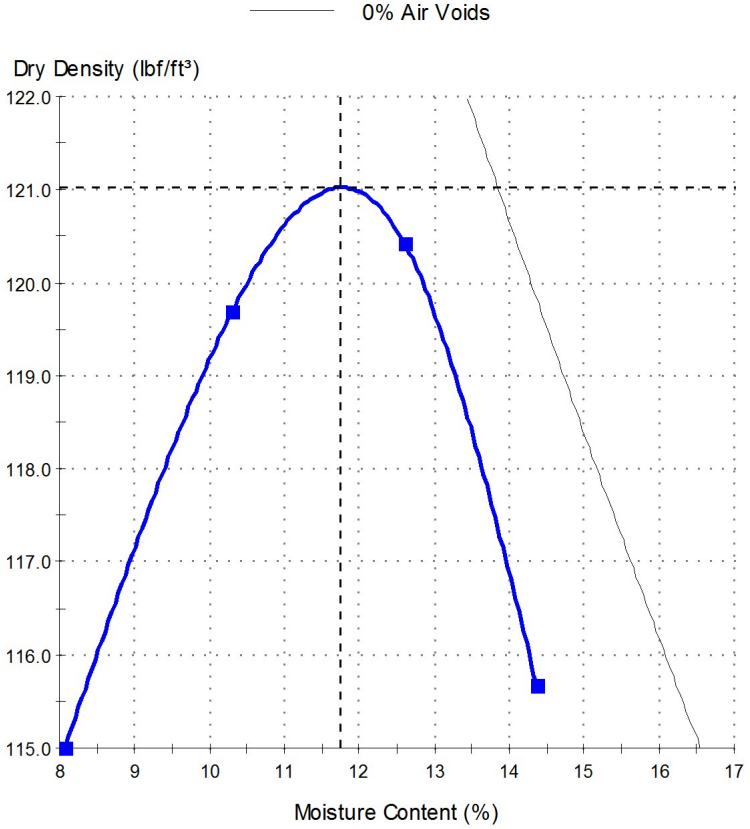
Client: Andrew Albrect
Highlands Engineering & Surveying, PLLC
319 24th St E
Dickinson, ND, 58601
Project: B1608780
8th Street South
8th Street South
Dickinson, ND, 58601
TR: Brianne Nauman, bnauman@braunintertec.com

Kara Seibel
E1
Date of Issue: 10/4/2016

Sample Details

Sample ID:	W16-008816-S1	Alternate Sample ID:	B-02
Date Sampled:	9/21/2016	Date Submitted:	9/30/2016
Sampled By:	Drill Crew	Sampling Method:	Auger Sample
Source:	Native		
Material:	Silty Sand (SM)		
Specification:	General Soil		
Location:	B-02, 1'-5'		
Date Tested:	10/3/2016		

Dry Density - Moisture Content Relationship



Test Results

ASTM D 698 - 07

Maximum Dry Density (lbf/ft³):	121.0
Corrected Maximum Dry Density (lbf/ft³):	121.0
Optimum Moisture Content (%):	11.8
Corrected Optimum Moisture Content (%):	11.8
Method:	A
Preparation Method:	Moist
Specific Gravity (Fines):	2.65
Specific Gravity Method:	Assumed
Retained Sieve No 4 (4.75mm) (%):	1
Passing Sieve No 4 (4.75mm) (%):	99
Visual Description:	Silty Sand (SM)

Comments

P200=25%

Braun Intertec Corporation
1341 South 20th Street, Suite 5, P.O. Box 1836
Bismarck, ND 58504
Phone: 701.255.7180

Proctor Report

Report No: PTR:W16-008816-S2
Issue No: 1

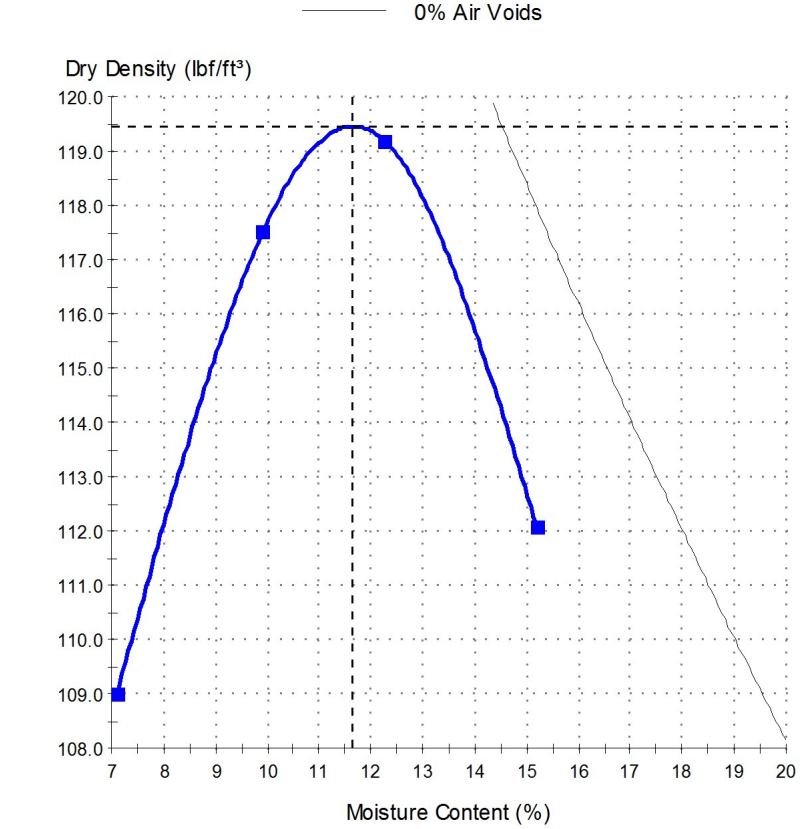
Client: Andrew Albrect
Highlands Engineering & Surveying, PLLC
319 24th St E
Dickinson, ND, 58601
Project: B1608780
8th Street South
8th Street South
Dickinson, ND, 58601
TR: Brianne Nauman, bnauman@braunintertec.com

Kara Seibel
E1
Date of Issue: 10/4/2016

Sample Details

Sample ID:	W16-008816-S2	Alternate Sample ID:	B-07
Date Sampled:	9/21/2016	Date Submitted:	9/30/2016
Sampled By:	Drill Crew	Sampling Method:	Auger Sample
Source:	Native		
Material:	Silty Sand (SM)		
Specification:	General Soil		
Location:	B-07, 1'-5'		
Date Tested:	10/3/2016		

Dry Density - Moisture Content Relationship



Test Results

ASTM D 698 - 07

Maximum Dry Density (lbf/ft³):	119.5
Corrected Maximum Dry Density (lbf/ft³):	119.5
Optimum Moisture Content (%):	11.7
Corrected Optimum Moisture Content (%):	11.7
Method:	A
Preparation Method:	Moist
Specific Gravity (Fines):	2.65
Specific Gravity Method:	Assumed
Retained Sieve No 4 (4.75mm) (%):	0
Passing Sieve No 4 (4.75mm) (%):	100
Visual Description:	Silty Sand (SM)

Comments

P200=36%

Braun Intertec Corporation
1341 South 20th Street, Suite 5, P.O. Box 1836
Bismarck, ND 58504
Phone: 701.255.7180

California Bearing Ratio Test Report

Report No: CBR:W16-009158-S1
Issue No: 1

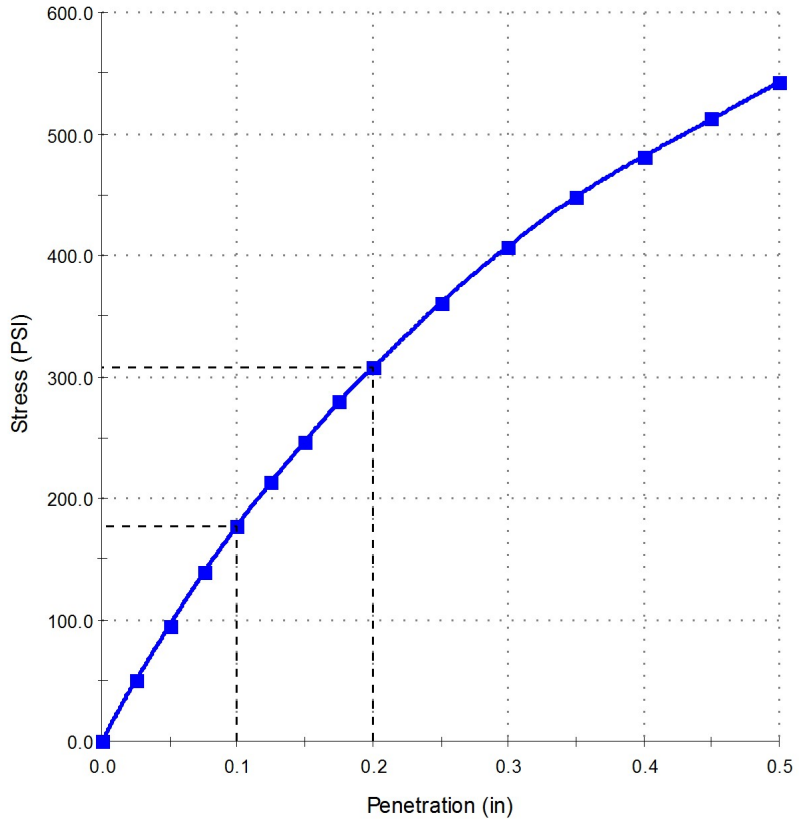
Client: Andrew Albrect
Highlands Engineering & Surveying, PLLC
319 24th St E
Dickinson, ND, 58601
Project: B1608780
8th Street South
8th Street South
Dickinson, ND, 58601
TR: Brianne Nauman, bnauman@braunintertec.com

Kevin Ficek
Field Technician III
Date of Issue: 10/12/2016

Sample Details

Sample ID:	W16-009158-S1	Alternate Sample ID:	B-02 (At Optimum)
Sampled By:	Drill Crew	Date Sampled:	9/21/2016
Sampling Method:	Auger Cuttings	Source:	Native
Material:	Silty Sand (SM)	Specification:	General Soil
Sample Location:	B-02, 1'-5'		

Stress vs Penetration



Test Results

ASTM D 1883 - 07

CBR At 0.1in (%):	17.7
CBR At 0.2in (%):	20.5
Compactive Effort:	ASTM D 698
Number of Blows:	27
% of Maximum Dry Density:	95.8
Dry Density Before Soaking (lb/ft³):	115.9
MC Before Compaction (%):	11.8
MC After Compaction (%):	11.7
Moisture Content of Top 1in (%):	14.2
Average Moisture Content (%):	
Maximum Dry Density (lb/ft³):	121.0
Optimum Moisture Content (%):	11.8
Sample Condition:	soaked
Swell (%):	0.0
Surcharge Mass (lb):	10.00
Oversize Material (%):	0.0
Date Tested:	10/11/2016

Comments

Braun Intertec Corporation
1341 South 20th Street, Suite 5, P.O. Box 1836
Bismarck, ND 58504
Phone: 701.255.7180

California Bearing Ratio Test Report

Report No: CBR:W16-009158-S2
Issue No: 1

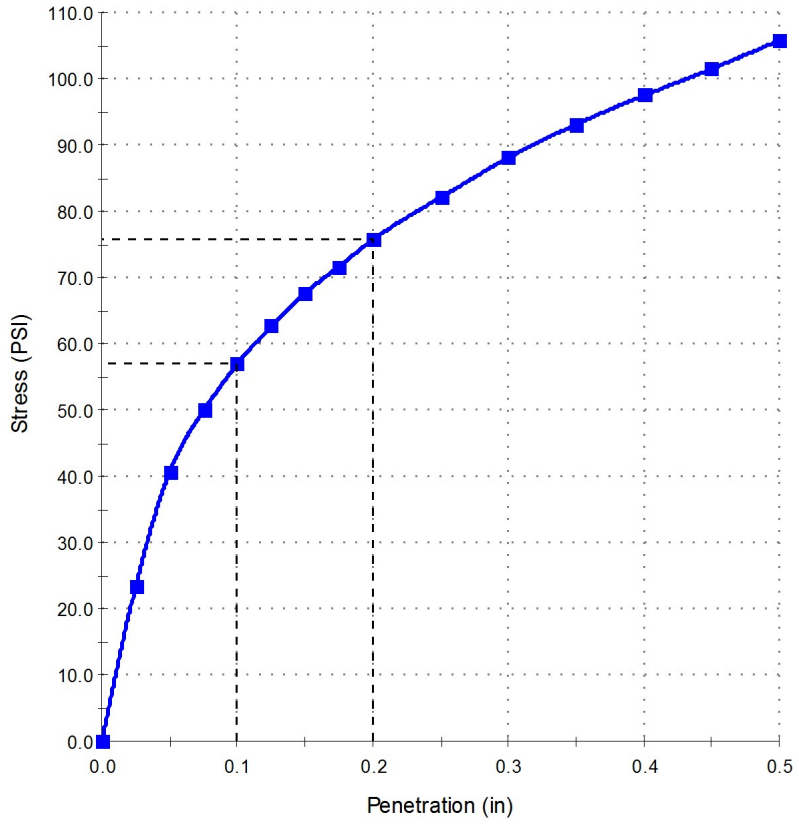
Client: Andrew Albrect
Highlands Engineering & Surveying, PLLC
319 24th St E
Dickinson, ND, 58601
Project: B1608780
8th Street South
8th Street South
Dickinson, ND, 58601
TR: Brianne Nauman, bnauman@braunintertec.com

Kevin Ficek
Field Technician III
Date of Issue: 10/12/2016

Sample Details

Sample ID:	W16-009158-S2	Alternate Sample ID:	B-07 (At Optimum)
Sampled By:	Drill Crew	Date Sampled:	9/21/2016
Sampling Method:	Auger Cuttings	Source:	Native
Material:	Silty Sand (SM)	Specification:	General Soil
Sample Location:	B-07, 1'-5'		

Stress vs Penetration



Test Results

ASTM D 1883 - 07

CBR At 0.1in (%):	5.7
CBR At 0.2in (%):	5.0
Compactive Effort:	ASTM D 698
Number of Blows:	18
% of Maximum Dry Density:	89.4
Dry Density Before Soaking (lb/ft³):	106.8
MC Before Compaction (%):	11.9
MC After Compaction (%):	11.8
Moisture Content of Top 1in (%):	16.5
Average Moisture Content (%):	
Maximum Dry Density (lb/ft³):	119.5
Optimum Moisture Content (%):	11.7
Sample Condition:	soaked
Swell (%):	0.3
Surcharge Mass (lb):	10.00
Oversize Material (%):	0.0
Date Tested:	10/11/2016

Comments

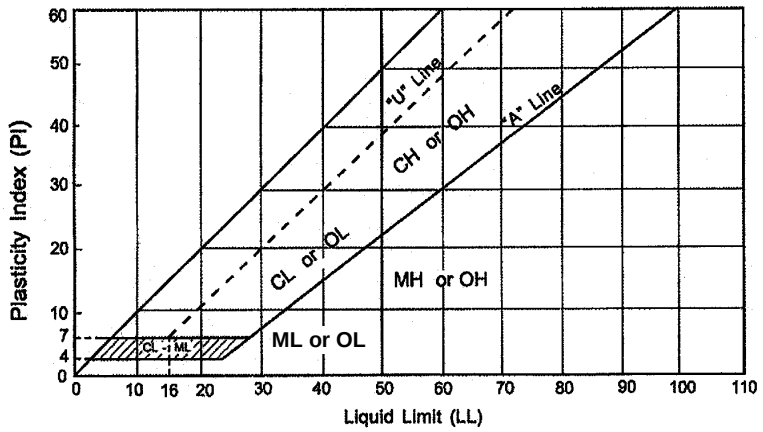
BRAUN INTERTEC

Descriptive Terminology of Soil

Standard D 2487
Classification of Soils for Engineering Purposes
(Unified Soil Classification System)

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [a]				Soils Classification	
				Group Symbol	Group Name [b]
Coarse-grained Soils more than 50% retained on No. 200 sieve	Gravels More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines [e]	$C_u \geq 4$ and $1 \leq C_c \leq 3$ [c]	GW	Well-graded gravel [d]
			$C_u < 4$ and/or $1 > C_c > 3$ [c]	GP	Poorly graded gravel [d]
		Gravels with Fines More than 12% fines [e]	Fines classify as ML or MH	GM	Silty gravel [d f g]
			Fines classify as CL or CH	GC	Clayey gravel [d f g]
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines [i]	$C_u \geq 6$ and $1 \leq C_c \leq 3$ [c]	SW	Well-graded sand [h]
			$C_u < 6$ and/or $1 > C_c > 3$ [c]	SP	Poorly graded sand [h]
		Sands with Fines More than 12% [i]	Fines classify as ML or MH	SM	Silty sand [f g h]
			Fines classify as CL or CH	SC	Clayey sand [f g h]
Fine-grained Soils 50% or more passed the No. 200 sieve	Silts and Clays Liquid limit less than 50	Inorganic	PI > 7 and plots on or above "A" line [j]	CL	Lean clay [k l m]
			PI < 4 or plots below "A" line [j]	ML	Silt [k l m]
		Organic	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OL	Organic clay [k l m n]
				OL	Organic silt [k l m o]
	Silts and clays Liquid limit 50 or more	Inorganic	PI plots on or above "A" line	CH	Fat clay [k l m]
			PI plots below "A" line	MH	Elastic silt [k l m]
		Organic	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OH	Organic clay [k l m p]
				OH	Organic silt [k l m q]
Highly Organic Soils	Primarily organic matter, dark in color and organic odor			PT	Peat

a. Based on the material passing the 3-inch (75mm) sieve.
b. If field sample contained cobbles or boulders, or both, add "with cobbles or boulders or both" to group name.
c. $C_u = D_{60}/D_{10}$ $C_c = \frac{(D30)^2}{D_{10} \times D_{60}}$
d. If soil contains ≥15% sand, add "with sand" to group name.
e. 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
f. If fines classify as CL-ML, use dual symbol GC-GM or SC-SM.
g. If fines are organic, add "with organic fines: to group name.
h. If soil contains ≥15% gravel, add "with gravel" to group name.
i. Sand 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
j. If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay.
k. If soil contains 10 to 29% plus No. 200, add "with sand" or "with gravel" whichever is predominant.
l. If soil contains ≥ 30% plus No. 200, predominantly sand, add "sandy" to group name.
m. If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.
n. PI ≥ 4 and plots on or above "A" line.
o. PI < 4 or plots below "A" line.
p. PI plots on or above "A" lines.
q. PI plots below "A" line.



Laboratory Tests

DD	Dry density, pcf	**OC**	Organic content, %
WD	Wet density, pcg	**S**	Percent of saturation, %
MC	Natural moisture content, %	**SG**	Specific gravity
LL	Liquid limit, %	**C**	Cohesion, psf
PL	Plastic limits, %	**Ø**	Angle of internal friction
PI	Plasticity index, %	**qu**	Unconfined compressive strength, psf
P200	% passing 200 sieve	**qp**	Pocket penetrometer strength, tsf

Particle Size Identification

Boulders..... over 12"
Cobbles ..... 3" to 12"
Gravel
  Coarse ..... 3/4" to 3"
  Fine..... No. 4 to 3/4"
Sand
  Coarse ..... No. 4 to No. 10
  Medium..... No. 10 to No. 40
  Fine..... No. 40 to No. 200
Silt ..... <No. 200, PI< 4 or below "A" line
Clay ..... <No. 200, PI ≥ 4 and on or about "A" line

Relative Density of Cohesionless Soils

Very Loose..... 0 to 4 BPF
Loose..... 5 to 10 BPF
Medium dense ..... 11 to 30 PPF
Dense ..... 31 to 50 BPF
Very dense..... over 50 BPF

Consistency of Cohesive Soils

Very soft..... 0 to 1 BPF
Soft..... 2 to 3 BPF
Rather soft ..... 4 to 5 BPF
Medium..... 6 to 8 BPF
Rather stiff ..... 9 to 12 BPF
Stiff ..... 13 to 16 BPF
Very stiff..... 17 to 30 BPF
Hard..... over 30 BPF

Drilling Notes

Standard penetration test borings were advanced by 3 1/4" or 6 1/4" ID hollow-stem augers, unless noted otherwise. Jetting water was used to clean out auger prior to sampling only where indicated on logs. All samples were taken with the standard 2" OD split-tube samples, except where noted.

Power auger borings were advanced by 4" or 6" diameter continuous flight, solid-stern augers. Soil classifications and strata depths were inferred from disturbed samples augered to the surface, and are therefore, somewhat approximate.

Hand auger borings were advanced manually with a 1 1/2" or 3 1/4" diameter auger and were limited to the depth from which the auger could be manually withdrawn.

BPF: Numbers indicate blows per foot recorded in standard penetration test, also known as "N" value. The sampler was set 6" into undisturbed soil below the hollow-stem auger. Driving resistances were then counted for second and third 6" increments, and added to get BPF. Where they differed significantly, they are reported in the following form: 2/12 for the second and third 6" increments, respectively.

WH: WH indicates the sampler penetrated soil under weight of hammer and rods alone; driving not required.

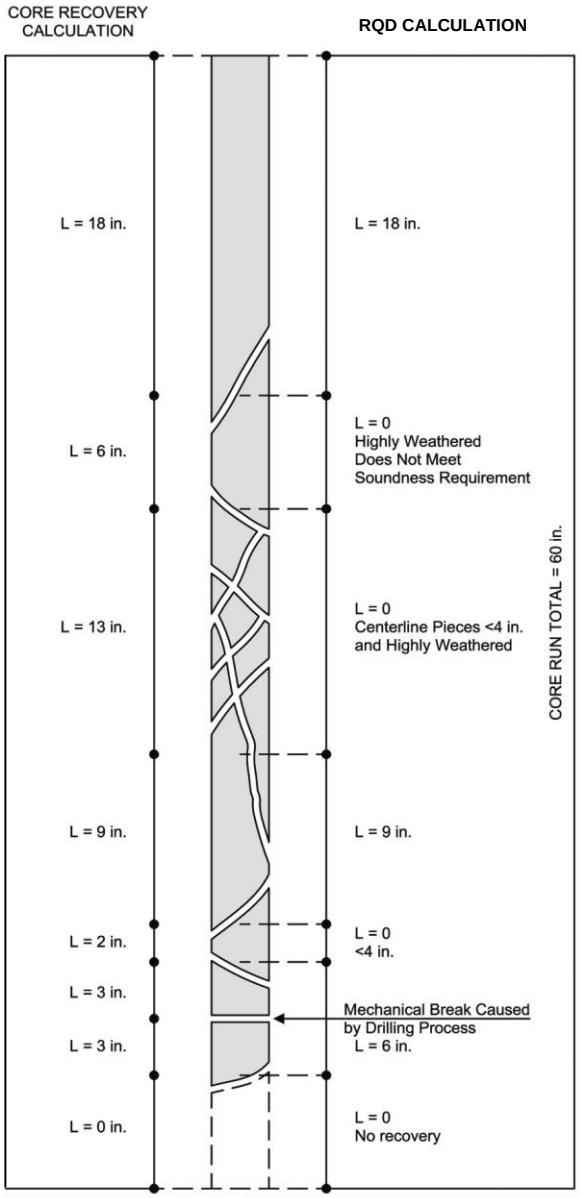
WR: WR indicates the sampler penetrated soil under weight of rods alone; hammer weight, and driving not required.

TW: TW indicates thin-walled (undisturbed) tube sample.

Note: All tests were run in general accordance with applicable ASTM standards.

Descriptive Terminology of Rock

Based on U.S. Army Corps of Engineers EM 1110-1-2908



Example Calculations

Core Recovery, CR = $\frac{\text{Total length of rock recovered}}{\text{Total core run length}}$

Example:CR = $\frac{(18 + 6 + 13 + 9 + 2 + 3 + 3)}{(60)}$

CR = 90%

RQD = $\frac{\text{Sum of sound pieces 4 inches or larger}}{\text{Total core run length}}$

RQD Percent	Rock Quality
< 25	very poor
25 < 50	poor
50 < 75	fair
75 < 90	good
90 < 100	excellent

Example: RQD = $\frac{(18 + 9 + 6)}{(60)}$

RQD = 55%

Weathering

Unweathered: No evidence of chemical or mechanical alteration.

Slightly weathered: Slight discoloration on surface, slight alteration along discontinuities, less than 10% of rock volume altered.

Moderately Weathered: Discoloration evident, surface pitted and altered with alteration penetrating well below rock surfaces, weathering halos evident, 10% to 50% of the rock altered.

Highly Weathered: Entire mass discolored, alteration pervading nearly all of the rock, with some pockets of slightly weathered rock noticeable, some mineral leached away.

Decomposed: Rock reduced to a soil consistency with relict rock texture, generally molded and crumbled by hand.

Hardness

Very soft:	Can be deformed by hand
Soft:	Can be scratched with a fingernail
Moderately hard:	Can be scratched easily with a knife
Hard:	Can be scratched with difficulty with a knife
Very hard:	Cannot be scratched with a knife

Texture

Sedimentary Rocks:	*Grain Size*
Coarse grained	2 – 5 mm
Medium grained	0.4 – 2 mm
Fine grained	0.1 – 0.4 mm
Very fine grained	< 0.1 mm

Igneous and Metamorphic Rocks:	
Coarse grained	5 mm
Medium grained	1 – 5 mm
Fine grained	0.1 – 1 mm
Aphanitic	< 0.1 mm

Thickness of Bedding

Massive:	3 ft. thick or greater
Thick bedded:	1 to 3 ft. thick
Medium bedded:	4 in. to 1 ft. thick
Thin bedded:	4 in. thick or less

Degree of Fracturing (Jointing)

Unfractured:	Fracture spacing 6 ft. of more
Slightly fractured:	Fracture spacing 2 to 6 ft.
Moderately fractured:	Fracture spacing 8 in. to 2 ft.
Highly fractured:	Fracture spacing 2 in. to 8 in.
Intensely fractured:	Fracture spacing 2 in. or less