GEOTECHNICAL ENGINEERING REPORT

RECONSTRUCTION

Project No.	**PCN**
NHU-6-986(116)120	20734

SOUTH COLUMBIA ROAD
40TH AVENUE SOUTH TO 47TH AVENUE SOUTH

GRAND FORKS, NORTH DAKOTA

Prepared by

Terracon Consultants, Inc.

Geotechnical Engineering Report

Proposed Street Reconstruction
South Columbia Road
40th Avenue South to 47th Avenue South
Grand Forks, North Dakota

March 4, 2015
Revised March 10, 2015
Terracon Project No. M5145060

Prepared for:
CPS, Ltd.
Grand Forks, North Dakota

Prepared by:
Terracon Consultants, Inc.
Grand Forks, North Dakota

March 10, 2015

CPS, Ltd.
308 2nd Avenue North
Grand Forks, ND 58201

Attn: Mr. Deon Wawrzyniak, PE
P: [701] 738-4056
E: deon.wawrzyniak@cpsengineering.net

Re: Geotechnical Engineering Report
Proposed Street Reconstruction
South Columbia Road
40th Avenue South to 47th Avenue South
Grand Forks, North Dakota
Terracon Project Number: M5145060

Dear Mr. Wawrzyniak:

Terracon Consultants, Inc. (Terracon) has completed the geotechnical engineering services for the above referenced project. This study was performed in general accordance with our proposal number PM5140044 dated June 9, 2014. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of pavements.

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 Consultants, Inc.

Corey D. Lindeman, EI
Field Engineer

William R. Olson, PE
Geotechnical Department Manager

REGISTERED PROFESSIONAL ENGINEER
WILLIAM R. OLSON
PE-5549
DATE 3/10/2015
NORTH DAKOTA

Enclosures
cc: 1 – Client
1 – Client (pdf)
1 – File

TABLE OF CONTENTS

EXECUTIVE SUMMARY ..... **i**
1.0 INTRODUCTION **1**
2.0 PROJECT INFORMATION **1**
2.1 Project Description 1
2.2 Site Location and Description 2
3.0 SUBSURFACE CONDITIONS **2**
3.1 Typical Profile 2
3.2 Groundwater 3
4.0 RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION **3**
4.1 Geotechnical Considerations 3
4.2 Pavement Construction 4
4.2.1 Subgrade Preparation 4
4.2.2 Utility Trench Backfill 5
4.2.3 Design Recommendations 5
4.2.4 Asphaltic Cement Concrete Thickness Design Recommendations 6
4.2.5 Portland Cement Concrete Thickness Design Recommendations 7
4.2.6 Pavement Drainage 7
4.2.7 Pavement Maintenance 7
4.3 Signal Foundation 7
4.3.1 Drilled Pier Design Recommendations 8
4.3.2 Drilled Pier Foundation Construction Considerations 8
5.0 GENERAL COMMENTS **8**

APPENDIX A – FIELD EXPLORATION
Exhibit A-1 Site Location Map
Exhibit A-2 Exploration Plan
Exhibit A-3 Field Exploration Description
Exhibit A-4 – A-9 Boring Logs

APPENDIX B – SUPPORTING INFORMATION
Exhibit B-1 Laboratory Testing
Exhibit B-2 Atterberg Limits
Exhibit B-3 Grain Size Distribution
Exhibit B-4 – B-5 Unconfined Compression Testing
Exhibit B-6 Moisture-Density Relationship Testing
Exhibit B-7 California Bearing Ratio Testing
Exhibit B-8 ESAL Calculation for Bituminous Pavement
Exhibit B-9 ESAL Calculation for Concrete Pavement

APPENDIX C – SUPPORTING DOCUMENTS
Exhibit C-1 General Notes
Exhibit C-2 Unified Soil Classification System

EXECUTIVE SUMMARY

Geotechnical engineering services have been completed for the proposed street reconstruction of South Columbia Road in Grand Forks, North Dakota. Six (6) soil test borings were advanced to depths ranging from 16 to 31 feet below the existing ground surface.

Based on the information obtained from our subsurface exploration, the following geotechnical considerations were identified:

- The soils encountered beneath the existing asphalt roadway consisted of fill containing silty sands with gravel, lean clays and buried topsoil. The fill was underlain by inorganic lean and fat clays which extended to the termination depth of our borings.

- Use of the existing subgrade soils for support of the proposed pavement is feasible.

- The natural clayey soils encountered in our borings are susceptible to frost heaving. Therefore the completed roadway will be subject to movement and cracking.

- Supporting the proposed traffic signal on a drilled pier foundation is feasible.

- Close monitoring of the construction operations discussed herein will be critical in achieving the design subgrade support. We therefore recommend that Terracon be retained to monitor this portion of the work.

This summary should be used in conjunction with the entire report for design purposes. It should be recognized that details were not included or fully developed in this section, and the report must be read in its entirety for a comprehensive understanding of the items contained herein. The section titled **GENERAL COMMENTS** should be read for an understanding of the report limitations.

GEOTECHNICAL ENGINEERING REPORT
PROPOSED STREET RECONSTRUCTION
SOUTH COLUMBIA ROAD
40TH AVENUE SOUTH TO 47TH AVENUE SOUTH
GRAND FORKS, NORTH DAKOTA

Terracon Project No. M5145060
March 10, 2015

1.0 INTRODUCTION

Geotechnical engineering services have been completed for the proposed street reconstruction of South Columbia Road in Grand Forks, North Dakota. Six (6) soil test borings were advanced to depths ranging from 16 to 31 feet below the existing ground surface. Logs of the borings along with a Site Location Map and Exploration Plan are included in Appendix A of this report.

The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- subsurface soil conditions
- groundwater conditions
- signal base design and construction
- earthwork
- pavement design and construction

2.0 PROJECT INFORMATION

2.1 Project Description

Item	Description
Site layout	See Appendix A, Exhibit A-2: Exploration Plan
Proposed improvements	The project will include reconstruction of the existing roadway and installation of underground utilities and traffic signals. Both asphalt concrete and Portland cement concrete pavement sections are being considered. We understand the street is planned to be expanded to accommodate the increased traffic levels of new development areas. The roadway will be constructed along the existing alignment and the roadway elevation will be lowered approximately 1 ½ feet and have curb and gutter added. Traffic loading information was provided by CPS, Ltd. and is included in Appendix B of this report.
Structure	Traffic signal

Item	Description
Maximum loads	Signal bases - 30 kips vertical (assumed)

2.2 Site Location and Description

Item	Description
Location	Along South Columbia Road from 40th Avenue South proceeding south to approximately 300 feet south of 47th Avenue South. See Appendix A, Exhibit A-1: Site Location Map
Existing improvements	Existing roadway with nearby overhead and underground utilities. The roadway surface consists of asphalt which showed some minor distress due to age. We are not aware of any settlement problems with the existing roadway embankment.
Current ground cover	Bituminous pavement
Existing topography	Relatively flat; road surface elevation increases approximately 1 ½ feet from 40th Avenue South to 47th Avenue South.

3.0 SUBSURFACE CONDITIONS

3.1 Typical Profile

Based on the results of the borings, subsurface conditions on the project site can be generalized as follows:

Stratum	Approximate Depth to Bottom of Stratum (feet)	Material Description	Consistency/Density
1	½	Bituminous pavement	N/A
2	2 to 4 ½	Existing fill consisting of silty sand with gravel	N/A
3	3 ½ to 7	Existing fill consisting of lean clays and/or topsoil	N/A
4	7 to 9 ½ [1]	Inorganic lean clays containing lenses and layers of silt	Ranges from soft to medium stiff or loose
5	Undetermined [2]	Fat clays containing varying amounts of silt	Ranges from soft to medium stiff

1. Inorganic lean clays were not observed in boring B-4.
2. All borings were terminated at their planned depths of 16 to 31 feet below the existing ground surface within this stratum. The soft to medium stiff fat clays would be expected to extend to depths on the order of 130 feet or more where dense/hard glacial till would be encountered.

Conditions encountered at each boring location are indicated on the individual boring logs. Stratification boundaries on the boring logs represent the approximate location of changes in soil types; in situ, the transition between materials may be gradual. Details for each of the borings can be found on the boring logs in Appendix A of this report.

3.2 Groundwater

The boreholes were observed while drilling and after completion for the presence and level of groundwater. Groundwater was not observed in the borings while drilling, or for the short duration that the borings were allowed to remain open. However, this does not necessarily mean these borings terminated above groundwater. Due to the low permeability of the soils encountered in the borings, a relatively long period of time may be necessary for a groundwater level to develop and stabilize in a borehole in these materials. 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.

Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the borings were performed. Therefore, groundwater levels during construction or at other times in the life of the structure may be higher or lower than the levels indicated on the boring logs. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

4.0 RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION

4.1 Geotechnical Considerations

In our opinion, use of the existing subgrade for pavement support is feasible. The native silt and clay soils encountered in our borings are highly susceptible to frost heaving and ice lens formation, especially when the water table is in the freezing zone. Therefore, pavement movement and cracking should be expected due to the extreme temperature changes that will occur. To prevent movement from frost action, the entire pavement area would need to be subcut to frost depth (6 – 8 feet) and the material replaced with a free draining granular fill maintained in a drained condition. This is usually cost prohibitive. Therefore, seasonal movement from frost action should be expected if the silts and lean clays are not removed. Increasing the thickness of a granular subbase should provide improved pavement performance. The thickness of granular soils below the pavement should be uniform to prevent differential frost heave (such as within utility trenches backfilled with sand).

It is our understanding that consideration is being given to utilizing the existing sandy soils as fill for the new roadway. The silty sand with gravel encountered beneath the pavement in our borings appeared to be inorganic in nature. Grain size distribution test results indicate one of

the samples did not meet the requirements for NDDOT 816.01 Class 3 or Class 5. Consideration could be given to blending the subbase soils with other materials to meet the requirements of salvage base (NDDOT Section 817). Further evaluation of the excavated soils could be performed at the time of construction. Care should be taken during excavation to keeping the soils separate from any organic soils.

Our borings encountered existing fill consisting of old topsoil extending to a depth of approximately 3 ½ feet below the existing grade. Organic soils are generally considered undesirable for support of pavements since they have a reduced level of performance as compared to inorganic soils. Engineered fill consisting of inorganic lean clay would be preferred. If the existing organic fills are left in place below the roadway, we would expect similar performance to that of the existing pavement.

The soils at this site are also susceptible to a significant loss of strength during spring thaw. Load-supporting capacity of the pavement is decreased during frost melting since water cannot drain through the soil that is still frozen below. Also, if the aggregate base course becomes saturated, its strength is significantly reduced. Therefore, consideration should be given to providing internal drainage within the aggregate base/subbase section.

For long term pavement performance, the pavement should have good surface drainage to catch basins. A maintenance program consisting of filling and maintaining the cracks that develop are needed for long term pavement performance.

4.2 Pavement Construction

4.2.1 Subgrade Preparation

After excavation to the desired subgrade elevation, we recommend subgrade soils be scarified to a depth of 12 inches, and recompacted to a minimum of 95 percent of maximum density as determined by the Standard Proctor AASHTO T-99. The water content at the time of compaction should be within three percent of optimum. Moisture conditioning may be needed to obtain the recommended water contents.

If additional fill is needed to obtain the subgrade elevation, we recommend inorganic lean clays be used. The fill should be placed in loose lift thicknesses of 6 inches or less and compacted to a minimum of 95 percent of the maximum density as determined by AASHTO T-99. The water content at the time of compaction should be within 3 percent of optimum.

Due to avoid potential construction delays associated with moisture conditioning of the subgrade soils, consideration could be given to placing the subbase over the existing subgrade soils without scarification or recompaction. In this case, we recommend a minimum 6 inches of additional subbase be placed in lieu of subgrade preparation. The soils encountered in our borings are sensitive to disturbance; therefore, the excavation should be completed by a

backhoe with a smooth cutting surface. Construction traffic should not be allowed to travel directly on the exposed soils. We recommend close construction observation by a geotechnical engineer during excavation of subgrade soils prior to placement of subbase soils. Any areas of excessively soft or otherwise unsuitable soils should be corrected before placing aggregate materials. The subbase course should be placed using low ground pressure equipment. Heavy construction traffic should not be allowed to travel on the roadway until the subbase course has been placed.

We recommend the pavement areas be rough graded and then thoroughly proofrolled with a loaded tandem-axle dump truck. Areas where unsuitable conditions are located should be repaired by replacing the materials with properly compacted fill.

4.2.2 Utility Trench Backfill

We recommend the utility trenches be backfilled with soils similar to the surrounding area to reduce the potential for differential frost heave. We recommend all trench backfill below paved areas be placed in loose lift thicknesses of six-inches or less and compacted to a minimum of 95 percent of maximum density as determined by AASHTO T-99. The water content at the time of compaction should be within 3 percent of optimum. Moisture conditioning of the soils would likely be needed to obtain the recommended water content.

Excavations should be performed in accordance with governing safety regulations. All vehicles and soil piles should be kept back from the crest of excavation slopes. The stability of excavation slopes should be reviewed continuously by qualified personnel. The responsibility for excavation safety and temporary construction slopes lies solely with the contractor. Trenches that remain open for an extended period of time should be protected by changes in moisture by covering with plastic sheeting or another suitable method.

4.2.3 Design Recommendations

Estimates of minimum thicknesses for new pavement sections for this project have been based on the procedures outlined in the 1993 Guideline for Design of Pavement Structures by the American Association of State Highway and Transportation Officials (AASHTO-1993). The following minimum thicknesses were estimated based upon the provided traffic loading, variation across the project area, and experience with similar project sites. The table below includes the variables used for our pavement analyses:

Bituminous Pavement Design Parameters	
Design Parameter	**Value**
Design ESALs	1,831,000
Design Life	20 years
Subgrade Support (M_R)	4,350 psi
Asphalt Pavement Coefficient	0.36
Aggregate Base Layer Coefficient	0.10

Bituminous Pavement Design Parameters	
Design Parameter	**Value**
Subbase Layer Coefficient	0.08
Initial Serviceability	4.2
Terminal Serviceability	2.0
Reliability	85%
Standard Deviation	0.49

Portland Cement Design Parameters	
Design Parameter	**Value**
Design ESALs	3,303,000
Design Life	30 years
Subgrade Support (K)	200 pci
Compressive Strength	4,000 psi
Modulus of Elasticity	3,600 ksi
Modulus of Rupture	580 psi
Initial Serviceability	4.5
Terminal Serviceability	2.5
Drainage Coefficient	1.0
Load Transfer ("J" Factor)	2.7
Reliability	95%
Standard Deviation	0.39

4.2.4 Asphaltic Cement Concrete Thickness Design Recommendations

Minimum Recommended ACC Pavement Section Thickness (inches)				
Traffic Area	**Asphalt Pavement [1]**	**Aggregate Base [2]**	**Aggregate Subbase [3, 4]**	**Total Thickness**
Four-lane roadway	6.0	12.0	12.0	30.0

1. We recommend a mix meeting the FAA 43 in Section 430.03 of the NDDOT manual. A tack coat between the lifts is recommended for the asphalt pavements.
2. The base course should meet the requirements of North Dakota 816.03 Class 5. As an alternative, a recycled concrete aggregate meeting the requirements of North Dakota 817 may be used. We recommend the aggregate base course be placed in loose lift thicknesses of 6 inches or less and compacted to a minimum of 98 percent of the Standard Proctor maximum density.
3. The subbase course should meet the requirements of North Dakota 816.01 Class 3. We recommend the subbase course be placed in loose lift thicknesses of 6 inches or less and compacted to a minimum of 98 percent of the Standard Proctor maximum density. We recommend a geotextile fabric, meeting the requirements of NDDOT Section 858 Type R1, be provided between the aggregate base and the subgrade where asphalt pavement is implemented.
4. In lieu of subgrade preparation, an additional 6 inches of subgrade may be placed.

4.2.5 Portland Cement Concrete Thickness Design Recommendations

Minimum Recommended PCC Pavement Section Thickness (inches)					
Traffic Area	**Pavement Type**	**Portland Cement Concrete [1]**	**Aggregate Base [2]**	**Aggregate Subbase [3, 4]**	**Total Thickness**
Four-lane roadway	Doweled jointed plain concrete	9.0	12.0	12.0	33.0

1. 4,000 psi at 28 days, 5 to 7 percent air entrained, and a maximum 0.45 water to cement ratio cement mix PCC pavement is recommended.
2. The base course should meet the requirements of North Dakota 816.03 Class 5. As an alternative, a recycled concrete aggregate meeting the requirements of North Dakota 817 may be used. We recommend the aggregate base course be placed in loose lift thicknesses of 6 inches or less and compacted to a minimum of 98 percent of the Standard Proctor maximum density.
3. The subbase course should meet the requirements of North Dakota 816.01 Class 3. We recommend the subbase course be placed in loose lift thicknesses of 6 inches or less and compacted to a minimum of 98 percent of the Standard Proctor maximum density.
4. In lieu of subgrade preparation, an additional 6 inches of subgrade may be placed.

4.2.6 Pavement Drainage

Pavements should be sloped to provide rapid drainage of surface water. Water allowed to pond on or adjacent to the pavements could saturate the subgrade and contribute to premature pavement deterioration. In addition, the pavement subgrade should be graded to provide positive drainage within the granular base section. Appropriate sub-drainage or connection to a suitable daylight outlet should be provided to remove water from the granular subbase.

4.2.7 Pavement Maintenance

The pavement sections provided in this report represent the minimum recommended thicknesses and, as such, periodic maintenance should be anticipated. Therefore, preventative maintenance should be planned and provided for through an on-going pavement management program. Preventative maintenance activities are intended to slow the rate of pavement deterioration, and to preserve the pavement investment. Preventative maintenance consists of both localized maintenance (e.g. crack and joint sealing and patching) and global maintenance (e.g. surface sealing). Preventative maintenance is usually the first priority when implementing a planned pavement maintenance program. Additional engineering observation is recommended to determine the type and extent of a cost effective program. Even with periodic maintenance, some movements and related cracking may still occur and repairs may be required.

4.3 Signal Foundation

In our opinion, a drilled pier foundation is feasible for support of the traffic signals. Design recommendations for drilled piers are provided in the following paragraphs. The analyses performed for foundation design recommendations is based on soils encountered in boring B-6. This boring was originally planned to be just east of the intersection of Columbia Road and 47th

Avenue South; however, due to nearby underground and overhead utilities, the boring location was moved approximately 45 feet east from the intersection.

4.3.1 Drilled Pier Design Recommendations

We recommend the drilled piers extend well below frost depth to prevent movement from frost action. We further recommend the drilled piers extend to a minimum depth of 12 feet below the final exterior grade.

Soil parameters which may be used in design of the drilled piers are presented in the following table. The values provided in the table are based on our analysis of the existing subsurface conditions and were estimated using generally accepted engineering correlations. The values are based on undisturbed soil conditions. We recommend neglecting the upper 6 feet of soils due to softening during spring thaw. We expect settlement of the drilled piers to be less than one inch.

Depth (feet)	Description and Soil Model Type	Total Unit Weight (pcf)	Effective Unit Weight (pcf)	Allowable Skin Friction (psf)	Allowable End Bearing Pressure (psf)	Internal Angle of Friction (degrees)	Allowable Passive Pressure (equivalent fluid weight, pcf)	Cohesion (psf)
0 – 7	Frost Zone	--	--	Ignore	Ignore	Ignore	Ignore	Ignore
7 – 10	Lean Clay	110 [1]	110 [1]	200	1,200	0	90	600
10 – 25	Fat Clay	113	50	300	2,500	0	125	1,250
25 – 31	Fat Clay	110	48	350	2,000	0	120	1,000

1. Assumed non-buoyant unit weight.

4.3.2 Drilled Pier Foundation Construction Considerations

We anticipate conventional drilling equipment would be able to penetrate the native soils. Temporary casing will be needed during the pier excavation to prevent the sidewall soils from collapsing. We anticipate any groundwater encountered in short term excavations would be controllable by sump pumping.

The geotechnical engineer should be notified if the subsurface conditions differ from those encountered at our test boring locations. We recommend a geotechnical engineer or his representative be on site during construction to observe the drilled pier excavations.

5.0 GENERAL COMMENTS

Terracon should be retained to review the final design plans and specifications so comments can be made regarding interpretation and implementation of our geotechnical recommendations in the design and specifications. Terracon also should be retained to provide observation and

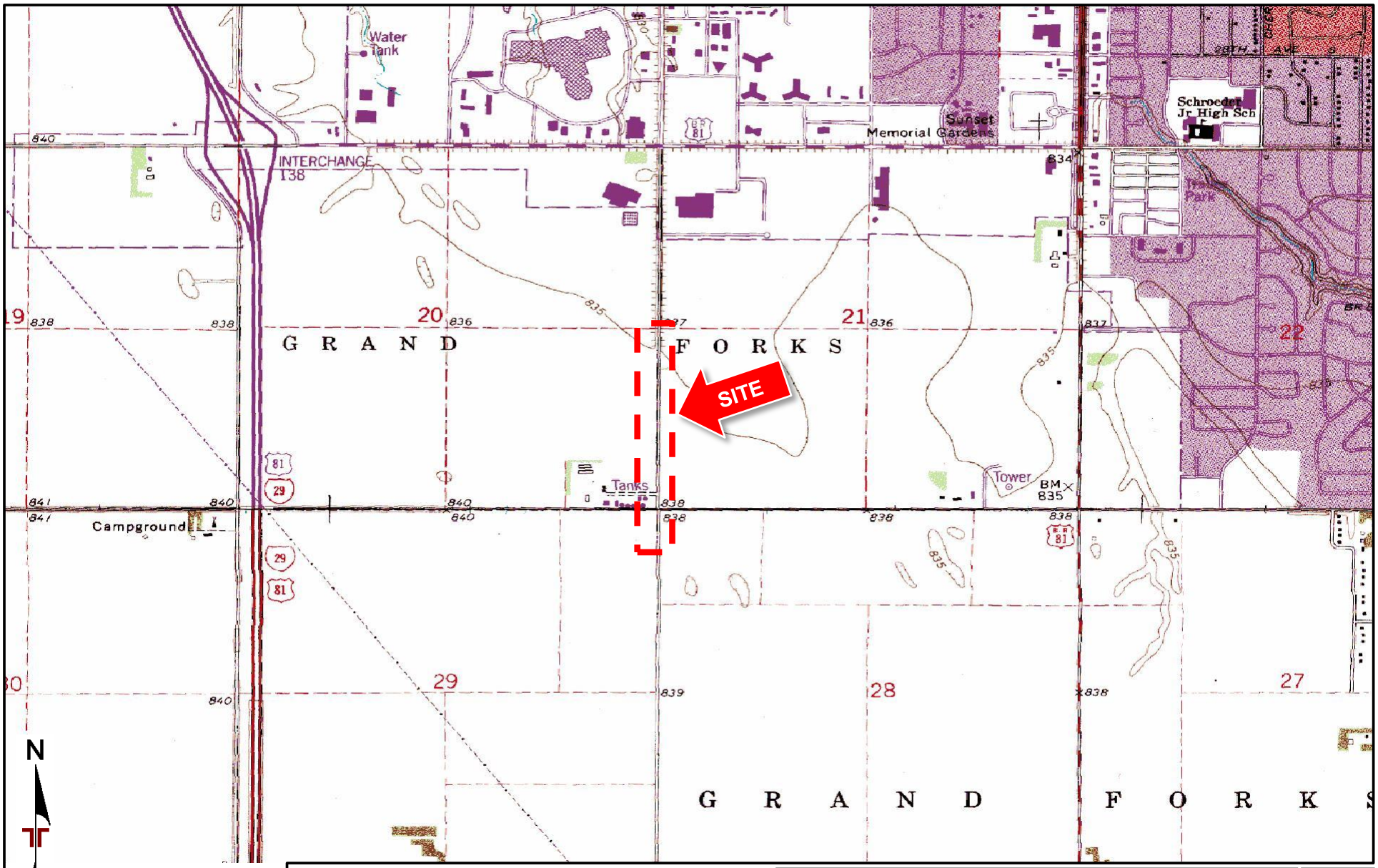
testing services during grading, excavation, foundation construction and other earth-related construction phases of the project.

The analysis and recommendations presented in this report are based upon the data obtained from the borings performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between borings, across the site, 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. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided.

The scope of services for this project 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.

This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either expressed or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless Terracon reviews the changes and either verifies or modifies the conclusions of this report in writing.

APPENDIX A
FIELD EXPLORATION



TOPOGRAPHIC MAP IMAGE COURTESY OF THE U.S. GEOLOGICAL SURVEY QUADRANGLES INCLUDE: GRAND FORKS, ND (1/1/1994) and THOMPSON, ND (1/1/1971).

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

Project Manager:	cdl
Drawn by:	cdl
Checked by:	wro
Approved by:	wro

Project No.	M5145060
Scale:	1:24,000
File Name:	
Date:	1/12/2015

Terracon
1555 N. 42nd St., Unit B
Grand Forks, ND 58203

SITE LOCATION MAP

Proposed Road Reconstruction
South Columbia Road
Grand Forks, North Dakota

Exhibit
A-1

AERIAL PHOTOGRAPHY PROVIDED BY MICROSOFT BING MAPS

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

Project Manager: cdl	Project No. M5145060
Drawn by: cdl	Scale: AS SHOWN
Checked by: wro	File Name:
Approved by: wro	Date: 1/12/2015

Terracon
1555 N. 42nd St., Unit B
Grand Forks, ND 58203

EXPLORATION PLAN

Proposed Road Reconstruction
South Columbia Road
Grand Forks, North Dakota

Exhibit
A-2

Field Exploration Description

Six (6) soil test borings were completed on October 14, 2014. The borings were advanced at the approximate locations indicated on Exhibit A-2. Boring B-6 was originally planned to be just east of the intersection of Columbia Road and 47th Avenue South; however, due to nearby underground and overhead utilities, the boring location was moved approximately 45 feet east from the intersection. The boring locations were laid out in the field by a Terracon representative using a scaled drawing provided by the client and hand-held GPS equipment which is typically accurate within about 20 feet. Ground surface elevations indicated on the boring logs were provided by you. The locations and elevation of the borings should be considered accurate only to the degree implied by the means and methods used to define them.

The borings were drilled with a track-mounted rotary drill rig using 3 ¼ hollow stem to advance the boreholes. Soil samples were obtained using both split-barrel and Shelby tube sampling procedures. In the split-barrel sampling procedure the number of blows required to advance a standard 2-inch O.D., 1-3/8-inch I.D spilt-barrel sampler from 6 to 18 inches of penetration by means of a 140-pound hammer with a free fall of 30 inches is used to obtain the Standard Penetration Test (SPT) or N-value. The SPT is used to estimate the in-situ relative density of cohesionless soils and the consistency of cohesive soils. In the Shelby tube sampling procedure, a thin wall seamless steel tube with a sharp cutting edge is pushed into the soil by hydraulic pressure to obtain a relatively undisturbed sample of cohesive soil.

An automatic SPT hammer was used to advance the split-barrel sampler in the borings performed at this site. A greater efficiency is typically achieved with the automatic hammer compared to the conventional safety hammer operated with a cathead and rope. Published correlations between the SPT values and soil properties are based on the lower efficiency cathead and rope method. This higher efficiency affects the standard penetration resistance blow count (N) value by increasing the penetration per hammer blow over what would be obtained using the cathead and rope method. The effect of the automatic hammer's efficiency has been considered in the interpretation and analysis of the subsurface information for this report.

The samples were tagged for identification, sealed to reduce moisture loss, and taken to our laboratory for further examination, testing, and classification. Information provided on the boring logs attached to this report includes soil descriptions, consistency evaluations, boring depths, sampling intervals, and groundwater conditions.

A field log of each boring was prepared by the drill crew. These logs included visual classifications of the materials encountered during drilling as well as the driller’s interpretation of the subsurface conditions between samples. Final boring logs included with this report represent the engineer's interpretation of the field logs and include modifications based on laboratory observation and tests of the samples.

BORING LOG NO. B-1

PROJECT: Proposed Street Reconstruction South Columbia Road

CLIENT: CPS, Ltd Grand Forks, North Dakota

SITE: 40th Avenue South to 47th Avenue South Grand Forks, North Dakota

LOCATION See Exhibit A-2

Latitude: 47.8817775° Longitude: -97.0667801°

Surface Elev.: 835.8 (Ft.)

DEPTH	ELEVATION (Ft.)	Description	DEPTH (Ft.)	RECOVERY (Ft.)	FIELD TEST RESULTS	LABORATORY TORVANE/HP (psf)	WATER CONTENT (%)
0.4	835.5	**5" ASPHALT**					
		FILL - SILTY SAND WITH GRAVEL, grayish-brown		1.3	8-7-5 N=12		3
				1.2	5-4-2 N=6		3
4.5	831.5	**LEAN CLAY (CL)**, light gray to light brown mottled, ranges from soft to medium stiff, with silt lenses and layers	5	1	2-2-1 N=3		34
7.0	829	**FAT CLAY (CH)**, light gray to light olive-brown mottled, ranges from soft to medium stiff, with silt lenses and layers and iron concretions and staining		1.4	2-1-2 N=3	1500 (HP)	39
			10	1.4	1-2-2 N=4	3000 (HP)	39
				1.5	2-2-3 N=5	2000 (HP)	42
16.0	820		15	1.5	2-3-3 N=6	3000 (HP)	41
		Boring Terminated at 16 Feet					

GRAPHIC LOG | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | UNCONFINED COMPRESSIVE STRENGTH (psf) | DRY UNIT WEIGHT (pcf) | ATTERBERG LIMITS LL-PL-PI | PERCENT FINES

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3 1/4" Hollow-stem auger

Abandonment Method:
Borings reverse augered and patched upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

Not measureable before HSA removal

Terracon
1555 N. 42nd St., Unit B
Grand Forks, North Dakota

Boring Started: 10/14/2014 | Boring Completed: 10/14/2014
Drill Rig: D-90 | Driller: CAS
Project No.: M5145060 | Exhibit: A-4

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL M5145060_COLUMBIAROADRECONSTRUCT.GPJ TERRACON2012.GDT 1/22/15

BORING LOG NO. B-2

PROJECT: Proposed Street Reconstruction South Columbia Road

CLIENT: CPS, Ltd Grand Forks, North Dakota

SITE: 40th Avenue South to 47th Avenue South Grand Forks, North Dakota

LOCATION See Exhibit A-2

Latitude: 47.8801003° Longitude: -97.0668715°

Surface Elev.: 836.3 (Ft.)

DEPTH	ELEVATION (Ft.)	Description	DEPTH (Ft.)	RECOVERY (Ft.)	FIELD TEST RESULTS	LABORATORY TORVANE/HP (psf)	WATER CONTENT (%)
0.4	836	**5" ASPHALT**					
2.2	834	**FILL - SILTY SAND WITH GRAVEL**, grayish-brown		1.4	8-6-5 N=11		3
4.5	832	**FILL - LEAN CLAY (CL)**, gray, medium stiff		1.2	5-3-3 N=6		25
9.5	827	**LEAN CLAY (CL)**, light gray to light brown, soft, with silt seams and lenses and iron staining	5	0.7	2-1-2 N=3		26
				1.5	1-1-2 N=3	3000 (HP)	35
16.0	820.5	**FAT CLAY (CH)**, light gray light olive-brown mottled, ranges from soft to medium stiff, with silt seams and iron concretions and staining	10	1.5	2-3-3 N=6	3000 (HP)	39
				1.4	2-3-3 N=6	4000 (HP)	40
			15	1.5	2-3-4 N=7	3500 (HP)	44

Boring Terminated at 16 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3 1/4" Hollow-stem auger

Abandonment Method:
Borings reverse augered and patched upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

Not measureable before HSA removal

Terracon
1555 N. 42nd St., Unit B
Grand Forks, North Dakota

Boring Started: 10/14/2014 | Boring Completed: 10/14/2014
Drill Rig: D-90 | Driller: CAS
Project No.: M5145060 | Exhibit: A-5

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL M5145060_COLUMBIAROADRECONSTRUCT.GPJ TERRACON2012.GDT 1/22/15

BORING LOG NO. B-3

PROJECT: Proposed Street Reconstruction South Columbia Road

CLIENT: CPS, Ltd Grand Forks, North Dakota

SITE: 40th Avenue South to 47th Avenue South Grand Forks, North Dakota

LOCATION See Exhibit A-2

Latitude: 47.8781936° Longitude: -97.0668417°

Surface Elev.: 837 (Ft.)

DEPTH	ELEVATION (Ft.)	Description	DEPTH (Ft.)	SAMPLE TYPE	RECOVERY (Ft.)	FIELD TEST RESULTS	LABORATORY TORVANE/HP (psf)	WATER CONTENT (%)
0.4	836.5	**5" ASPHALT**						
2.2	835	**FILL - SILTY SAND WITH GRAVEL**, grayish-brown			1.3	10-8-7 N=15		3
7.0	830	**FILL - LEAN CLAY**, light brown to dark gray mottled			1.5	4-5-4 N=9		23
			5		0.9	2-1-1 N=2		36
9.5	827.5	**FAT CLAY (CH)**, light gray to light brown mottled, soft, with silt seams and layers and trace iron concretions			1.4	1-1-1 N=2	1000 (HP)	40
14.5	822.5	**FAT CLAY (CH)**, light gray to light olive-brown mottled, soft, with silt seams and iron concretions and staining	10		1.5	1-1-2 N=3	2000 (HP)	37
					1.5	1-2-2 N=4	2000 (HP)	46
16.0	821	**FAT CLAY (CH)**, gray, soft, with silt seams, trace iron concretions, and trace gypsum deposits	15		1.5	2-1-1 N=2	2000 (HP)	48
		Boring Terminated at 16 Feet						

GRAPHIC LOG | WATER LEVEL OBSERVATIONS | UNCONFINED COMPRESSIVE STRENGTH (psf) | DRY UNIT WEIGHT (pcf) | ATTERBERG LIMITS LL-PL-PI | PERCENT FINES

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3 1/4" Hollow-stem auger

Abandonment Method:
Borings reverse augered and patched upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

Not measureable before HSA removal

Terracon
1555 N. 42nd St., Unit B
Grand Forks, North Dakota

Boring Started: 10/14/2014 | Boring Completed: 10/14/2014
Drill Rig: D-90 | Driller: CAS
Project No.: M5145060 | Exhibit: A-6

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL M5145060_COLUMBIAROADRECONSTRUCT.GPJ TERRACON2012.GDT 1/22/15

BORING LOG NO. B-4

PROJECT: Proposed Street Reconstruction South Columbia Road

CLIENT: CPS, Ltd Grand Forks, North Dakota

SITE: 40th Avenue South to 47th Avenue South Grand Forks, North Dakota

LOCATION See Exhibit A-2

Latitude: 47.8762362° Longitude: -97.0669287°

Surface Elev.: 837.1 (Ft.)

DEPTH	ELEVATION (Ft.)	Description
0.5	836.5	**6" ASPHALT**
2.1	835	**FILL - SILTY SAND WITH GRAVEL**, grayish-brown
7.0	830	**FILL - LEAN CLAY**, light brown to dark gray mottled
9.5	827.5	**FAT CLAY (CH)**, light gray to light brown mottled, medium stiff, with trace silt seams and iron concretions and staining
16.0	821	**FAT CLAY (CH)**, light gray to light olive-brown mottled, ranges from soft to medium stiff, with trace silt seams and trace iron concretions

Boring Terminated at 16 Feet

DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (Ft.)	FIELD TEST RESULTS	LABORATORY TORVANE/HP (psf)	UNCONFINED COMPRESSIVE STRENGTH (psf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
			1.5	9-9-7 N=16			3			
			0.2	4-2-2 N=4						
5			1.2	2-2-1 N=3			30			
			1.3	2-3-2 N=5	3000 (HP)		39			
10			1.3	2-2-2 N=4	2500 (HP)		40			
			1.5	2-2-3 N=5	4000 (HP)		38			
15			1.5	2-2-3 N=5	3000 (HP)		41			

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3 1/4" Hollow-stem auger

Abandonment Method:
Borings reverse augered and patched upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

Not measureable before HSA removal

Terracon
1555 N. 42nd St., Unit B
Grand Forks, North Dakota

Boring Started: 10/14/2014	Boring Completed: 10/14/2014
Drill Rig: D-90	Driller: CAS
Project No.: M5145060	Exhibit: A-7

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL M5145060_COLUMBIAROADRECONSTRUCT.GPJ TERRACON2012.GDT 1/22/15

BORING LOG NO. B-5

PROJECT: Proposed Street Reconstruction
South Columbia Road

CLIENT: CPS, Ltd
Grand Forks, North Dakota

SITE: 40th Avenue South to 47th Avenue South
Grand Forks, North Dakota

LOCATION See Exhibit A-2

Latitude: 47.8743359° Longitude: -97.0668915°

Surface Elev.: 837.7 (Ft.)

DEPTH	ELEVATION (Ft.)	Description
0.5	837	**6" ASPHALT**
2.3	835.5	**FILL - SILTY SAND WITH GRAVEL**, grayish-brown
3.5	834	**FILL - TOPSOIL**, black
4.5	833	**LEAN CLAY (CL)**, gray, medium stiff
9.5	828	**LEAN CLAY (CL)**, light gray to light brown mottled, soft, with silt lenses and layers and iron staining
16.0	821.5	**FAT CLAY (CH)**, light gray to light olive-brown mottled, medium stiff, with trace silt seams and iron concretions and staining

Boring Terminated at 16 Feet

DEPTH (Ft.)	SAMPLE TYPE	RECOVERY (Ft.)	FIELD TEST RESULTS	LABORATORY TORVANE/HP (psf)	WATER CONTENT (%)
		1.3	14-18-17 N=35		4
		1.2	10-4-3 N=7		25
5		1.1	2-2-1 N=3		34
		1.2	2-2-2 N=4	2500 (HP)	36
10		1.3	2-2-3 N=5	4500 (HP)	39
		1.5	2-2-3 N=5	3000 (HP)	40
15		1.5	2-2-3 N=5	4000 (HP)	41

WATER LEVEL OBSERVATIONS; UNCONFINED COMPRESSIVE STRENGTH (psf); DRY UNIT WEIGHT (pcf); ATTERBERG LIMITS LL-PL-PI; PERCENT FINES

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3 1/4" Hollow-stem auger

Abandonment Method:
Borings reverse augered and patched upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

Not measureable before HSA removal

Terracon
1555 N. 42nd St., Unit B
Grand Forks, North Dakota

Boring Started: 10/14/2014 | Boring Completed: 10/14/2014
Drill Rig: D-90 | Driller: CAS
Project No.: M5145060 | Exhibit: A-8

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL M5145060_COLUMBIAROADRECONSTRUCT.GPJ TERRACON2012.GDT 1/22/15

BORING LOG NO. B-6

PROJECT: Proposed Street Reconstruction
South Columbia Road

CLIENT: CPS, Ltd
Grand Forks, North Dakota

SITE: 40th Avenue South to 47th Avenue South
Grand Forks, North Dakota

LOCATION See Exhibit A-2

Latitude: 47.874942° Longitude: -97.0665988°

Surface Elev.: 837.3 (Ft.)

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	RECOVERY (Ft.)	FIELD TEST RESULTS	LABORATORY TORVANE/HP (psf)	UNCONFINED COMPRESSIVE STRENGTH (psf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.5	837									
6" ASPHALT										
2.0	835.5									
FILL - SILTY SAND WITH GRAVEL, grayish-brown			1.3	11-8-6 N=14			3			
FILL - LEAN CLAY, black to light brown			1	6-4-4 N=8			27			
		5	1.1	2-2-2 N=4			28			
7.0	830.5									
LEAN CLAY (CL), light gray to light brown mottled, soft, with silt lenses and layers and iron concretions			1.5	2-1-1 N=2	1500 (HP)		37			
9.5	828									
FAT CLAY (CH), light gray to light brown mottled, stiff, with silt lenses and layers and iron concretions		10	1.5		3000 (HP)	2600	41	80	63-29-34	
12.0	825.5									
FAT CLAY (CH), light gray to light olive-brown mottled, medium stiff, with silt seams and iron concretions			1.5	2-2-3 N=5	3500 (HP)		40			
		15	1.9		3500 (HP)		41			
		20	1.5	2-3-3 N=6	3000 (HP)		49			
24.5	813									
FAT CLAY (CH), dark gray, ranges from soft to medium stiff, with trace silt seams		25	2		2000 (HP)	1630	43	77	70-26-44	
		30	1.5	1-2-2 N=4	2000 (HP)		47			
31.0	806.5									
Boring Terminated at 31 Feet										

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3 1/4" Hollow-stem auger

Abandonment Method:
Borings reverse augered and patched upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

Not measureable before HSA removal

Terracon
1555 N. 42nd St., Unit B
Grand Forks, North Dakota

Boring Started: 10/14/2014 | Boring Completed: 10/14/2014
Drill Rig: D-90 | Driller: CAS
Project No.: M5145060 | Exhibit: A-9

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL M5145060_COLUMBIAROADRECONSTRUCT.GPJ TERRACON2012.GDT 1/22/15

APPENDIX B
SUPPORTING INFORMATION

Laboratory Testing

Samples retrieved during the field exploration were returned to the laboratory for observation by the project geotechnical engineer, and were classified in general accordance with the Unified Soil Classification System described in Appendix C. All classification was by visual-manual procedures.

Representative samples were selected for laboratory analysis. Selected soil samples were tested for the following engineering properties:

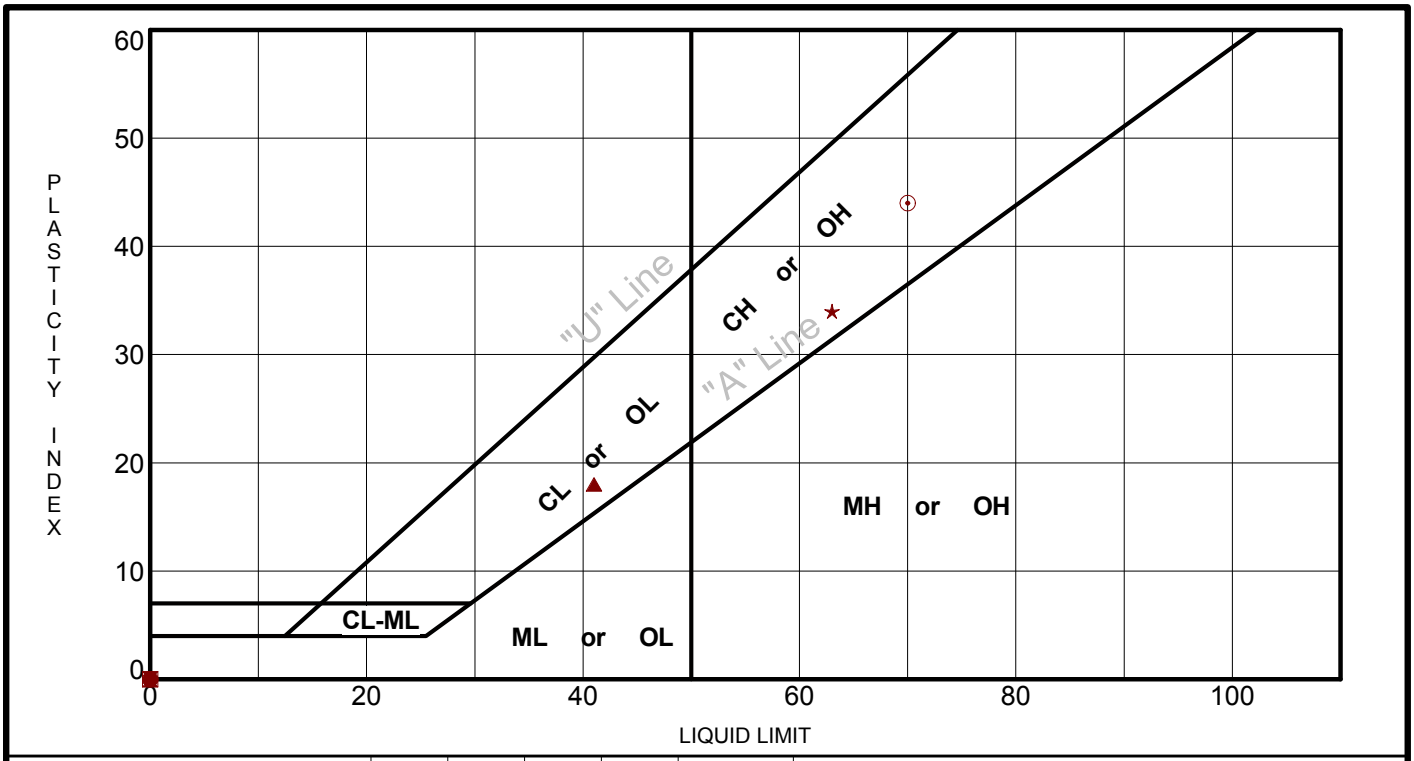
- Water content (ASTM D2216)
- Atterberg limits (ASTM D4318)
- Unconfined compression testing (ASTM D2166)
- Grain size distribution (hydrometer) (ASTM D422)
- Moisture-density relationship testing (AASHTO T-99)
- California bearing ratio testing (ASTM D1883)
- Hand penetrometer

The laboratory test results are found on the boring logs opposite the samples they represent and on the attached laboratory data sheets.

Procedural 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.

ATTERBERG LIMITS RESULTS

ASTM D4318



	Boring ID	Depth	LL	PL	PI	Fines	USCS	Description
●	Bag 1 (B-2)	0.5	NP	NP	NP	13	SM	SILTY SAND with GRAVEL
⊠	Bag 2 (B-3)	0.5	NP	NP	NP	18	SM	SILTY SAND with GRAVEL
▲	Mixed Bag (B-2 & B-3)	0.5	41	23	18	96	CL	LEAN CLAY (CL)
★	B-6	9.5	63	29	34		CH	FAT CLAY (CH)
⊙	B-6	24.5	70	26	44		CH	FAT CLAY (CH)

PROJECT: Proposed Street Reconstruction

SITE: South Columbia Road
Grand Forks, North Dakota

Terracon
1555 N. 42nd St., Unit B
Grand Forks, North Dakota

PROJECT NUMBER: M5145060

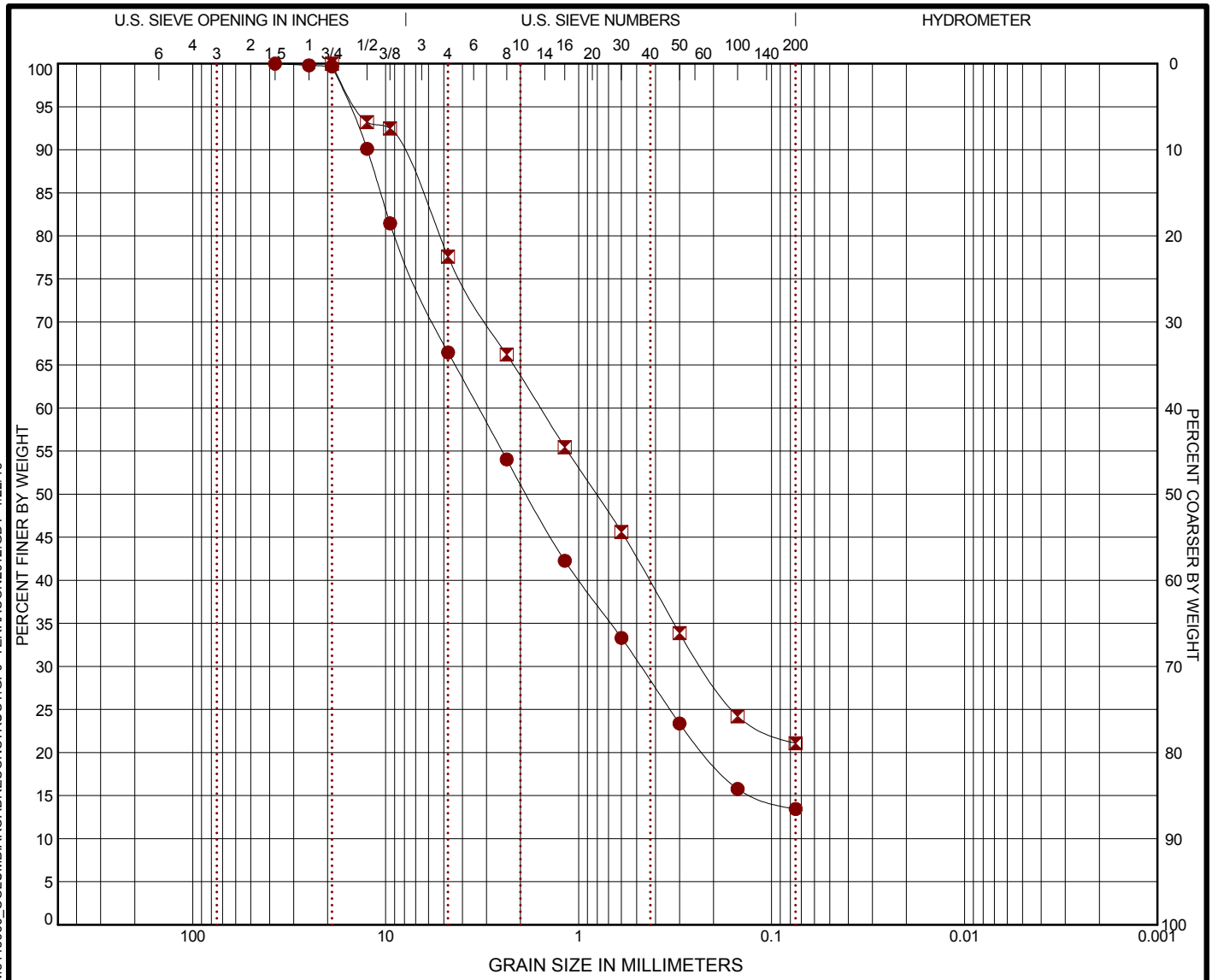
CLIENT: CPS, Ltd
Grand Forks, North Dakota

EXHIBIT: B-2

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. ATTERBERG LIMITS M5145060_COLUMBIAROADRECONSTRUCT.GPJ TERRACON2012.GDT 10/24/14

GRAIN SIZE DISTRIBUTION

ASTM D422



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
●	**Bag 1 (B-2)**	**0.5 - 2.5**	**0.0**	**33.5**	**53.0**		**13.5**		**SM**
⊠	**Bag 2 (B-3)**	**0.5 - 2.5**	**0.0**	**22.4**	**56.5**		**21.1**		**SM**

	GRAIN SIZE		
	●	⊠	
D_{60}	**3.301**	**1.58**	
D_{30}	**0.476**	**0.227**	
D_{10}			
	COEFFICIENTS		
C_C			
C_U			

SIEVE (size)	PERCENT FINER ●	PERCENT FINER ⊠	
3"			
2"			
1 1/2"	100.0		
1"	99.8		
3/4"	99.68	100.0	
1/2"	90.1	93.22	
3/8"	81.46	92.49	
#4	66.47	77.59	
#8	54.04	66.22	
#16	42.28	55.48	
#30	33.31	45.62	
#50	23.38	33.88	
#100	15.78	24.23	
#200	13.45	21.08	

SOIL DESCRIPTION

● SILTY SAND with GRAVEL(SM)

⊠ SILTY SAND with GRAVEL(SM)

REMARKS

●

⊠

PROJECT: Proposed Street Reconstruction
South Columbia Road

SITE: 40th Avenue South to 47th Avenue South
Grand Forks, North Dakota

Terracon
1555 N. 42nd St., Unit B
Grand Forks, North Dakota

PROJECT NUMBER: M5145060

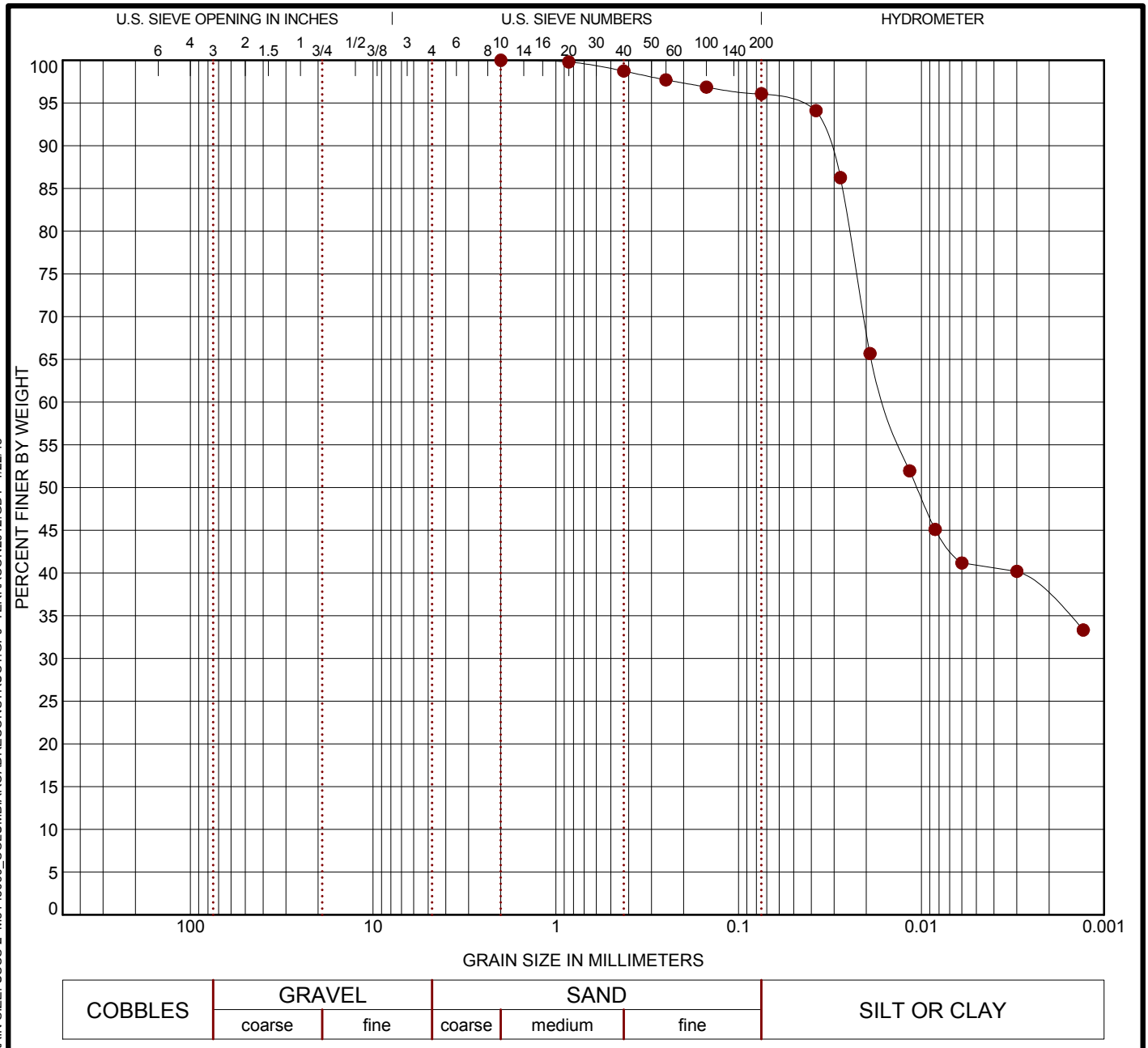
CLIENT: CPS, Ltd
Grand Forks, North Dakota

EXHIBIT: B-3

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: USCS 1 M5145060_COLUMBIAROADRECONSTRUCT.GPJ TERRACON2012.GDT 1/22/15

GRAIN SIZE DISTRIBUTION

ASTM D422



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Boring ID	Depth	USCS Classification	LL	PL	PI	Cc	Cu
Mixed Bag (B-2 & B-3)	0.5	LEAN CLAY (CL)	41	23	18		

Boring ID	Depth	D_{100}	D_{60}	D_{30}	D_{10}	%Gravel	%Sand	%Silt	%Clay
Mixed Bag (B-2 & B-3)	0.5	2	0.016			0.0	3.9	55.2	40.9

PROJECT: Proposed Street Reconstruction
South Columbia Road

SITE: 40th Avenue South to 47th Avenue South
Grand Forks, North Dakota

Terracon
1555 N. 42nd St., Unit B
Grand Forks, North Dakota

PROJECT NUMBER: M5145060

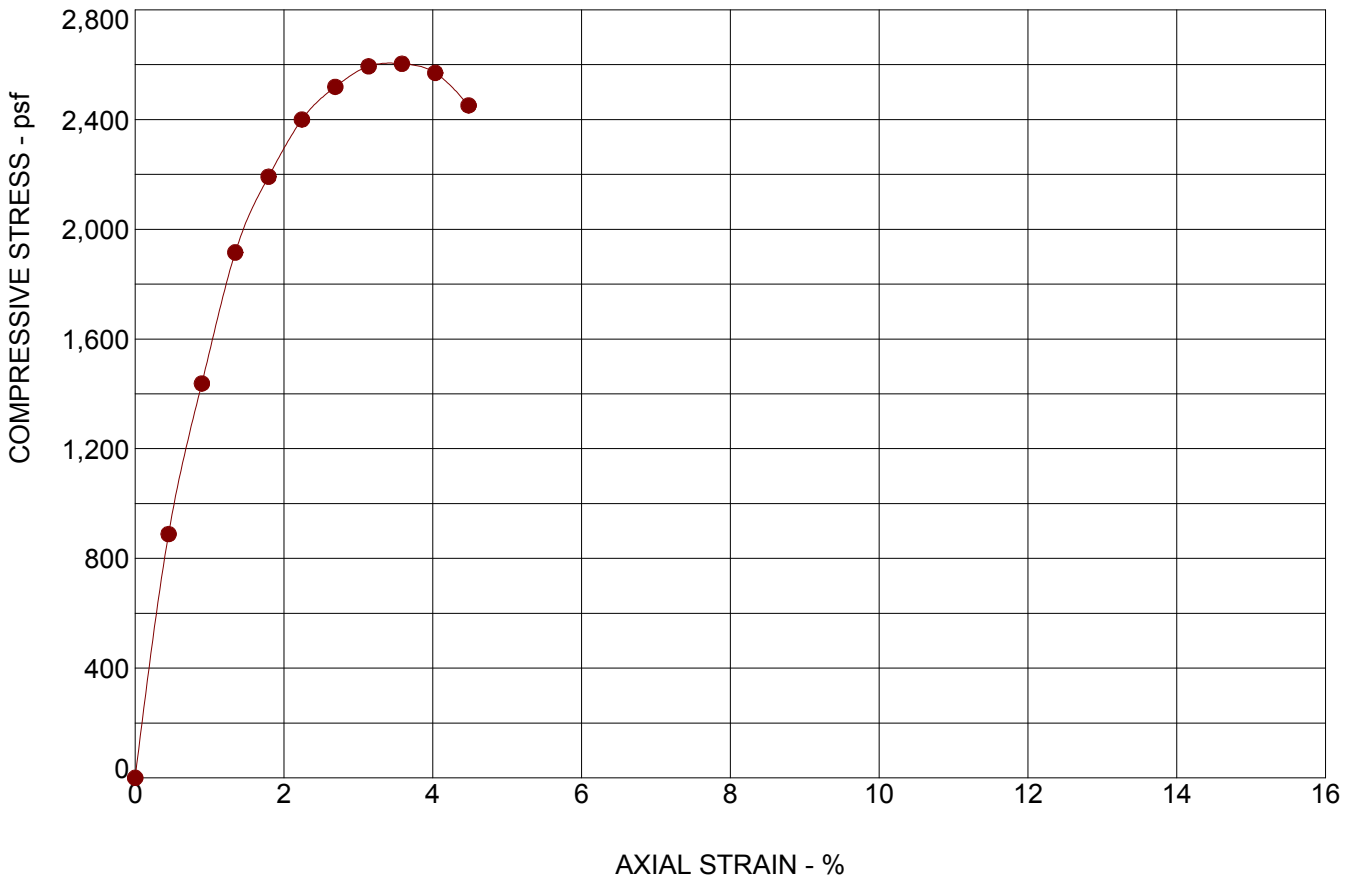
CLIENT: CPS, Ltd
Grand Forks, North Dakota

EXHIBIT: B-3

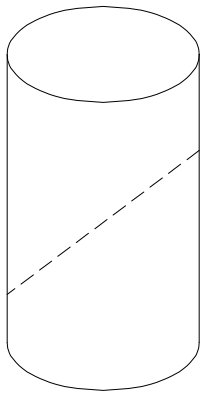
LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: USCS-2 M5145060_COLUMBIAROADRECONSTRUCT.GPJ TERRACON2012.GDT 1/22/15

UNCONFINED COMPRESSION TEST

ASTM D2166



SPECIMEN FAILURE MODE



Failure Mode: Shear (dashed)

SPECIMEN TEST DATA

Moisture Content:	%	41
Dry Density:	pcf	80
Diameter:	in.	2.87
Height:	in.	5.58
Height / Diameter Ratio:		1.95
Calculated Saturation:	%	101.25
Calculated Void Ratio:		1.10
Assumed Specific Gravity:		2.7
Failure Strain:	%	3.59
Unconfined Compressive Strength	(psf)	2604
Undrained Shear Strength:	(psf)	1302
Strain Rate:	in/min	0.1500
Remarks:		

SAMPLE TYPE: Shelby Tube

SAMPLE LOCATION: B-6 @ 9.5 Feet

DESCRIPTION: FAT CLAY (CH)

LL	PL	PI	Percent < #200 Sieve
63	29	34	

PROJECT: Proposed Street Reconstruction South Columbia Road

SITE: 40th Avenue South to 47th Avenue South Grand Forks, North Dakota

Terracon
1555 N. 42nd St., Unit B
Grand Forks, North Dakota

PROJECT NUMBER: M5145060

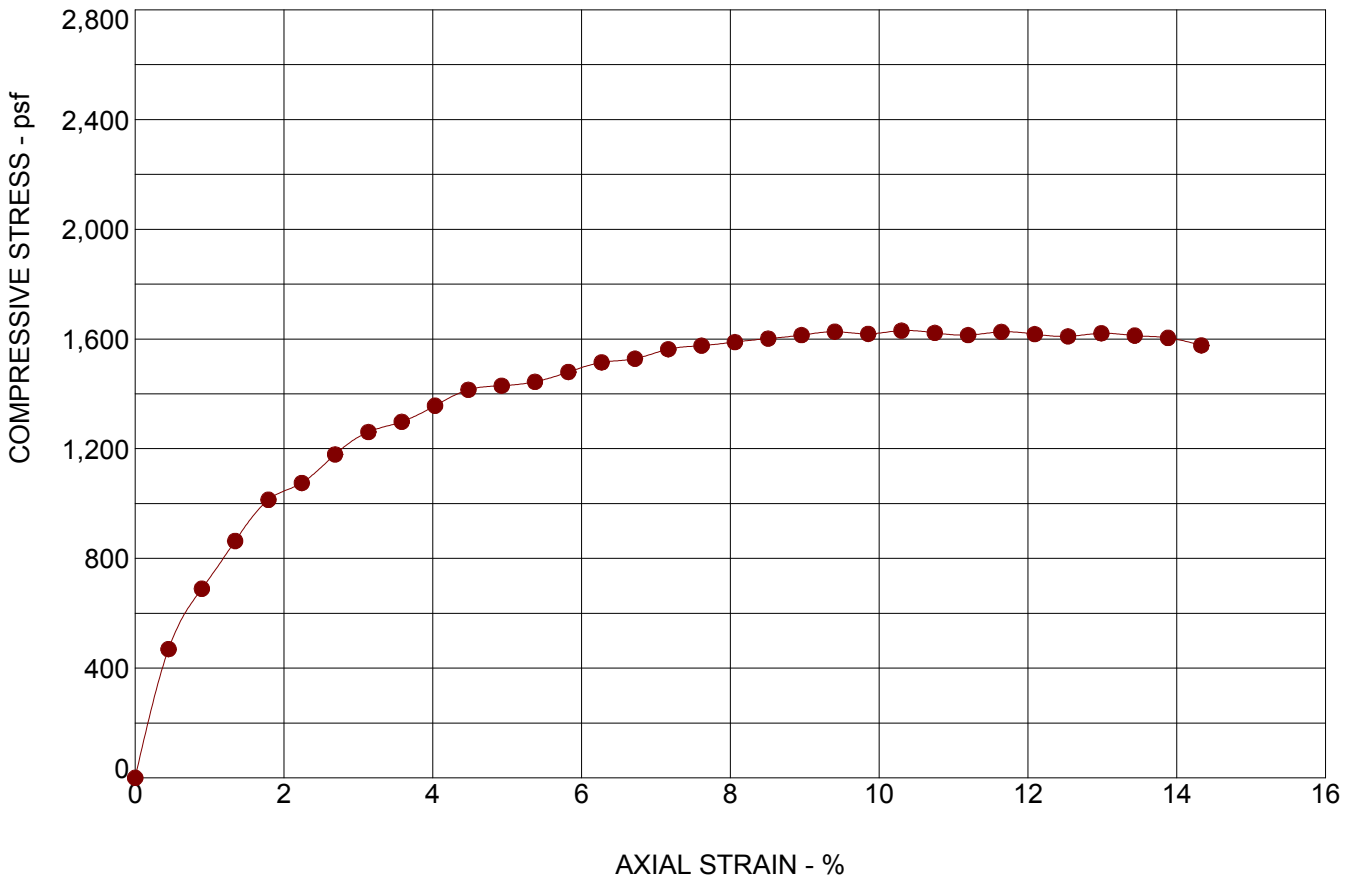
CLIENT: CPS, Ltd
Grand Forks, North Dakota

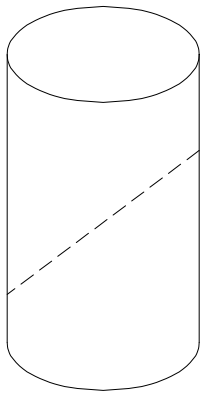
EXHIBIT: B-4

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. UNCONFINED M5145060_COLUMBIAROADRECONSTRUCT.GPJ TEMPLATE UPDATE 3-31-14.GPJ 1/22/15

UNCONFINED COMPRESSION TEST

ASTM D2166



SPECIMEN FAILURE MODE	SPECIMEN TEST DATA		
 Failure Mode: Shear (dashed)	Moisture Content:	%	43
	Dry Density:	pcf	77
	Diameter:	in.	2.86
	Height:	in.	5.58
	Height / Diameter Ratio:		1.95
	Calculated Saturation:	%	98.01
	Calculated Void Ratio:		1.20
	Assumed Specific Gravity:		2.7
	Failure Strain:	%	10.30
	Unconfined Compressive Strength	(psf)	1631
	Undrained Shear Strength:	(psf)	815
	Strain Rate:	in/min	0.1500
	Remarks:		

SAMPLE TYPE: Shelby Tube	SAMPLE LOCATION: B-6 @ 24.5 Feet			
DESCRIPTION: FAT CLAY (CH)	LL	PL	PI	Percent < #200 Sieve
	70	26	44	

PROJECT: Proposed Street Reconstruction
South Columbia Road

SITE: 40th Avenue South to 47th Avenue South
Grand Forks, North Dakota

Terracon
1555 N. 42nd St., Unit B
Grand Forks, North Dakota

PROJECT NUMBER: M5145060

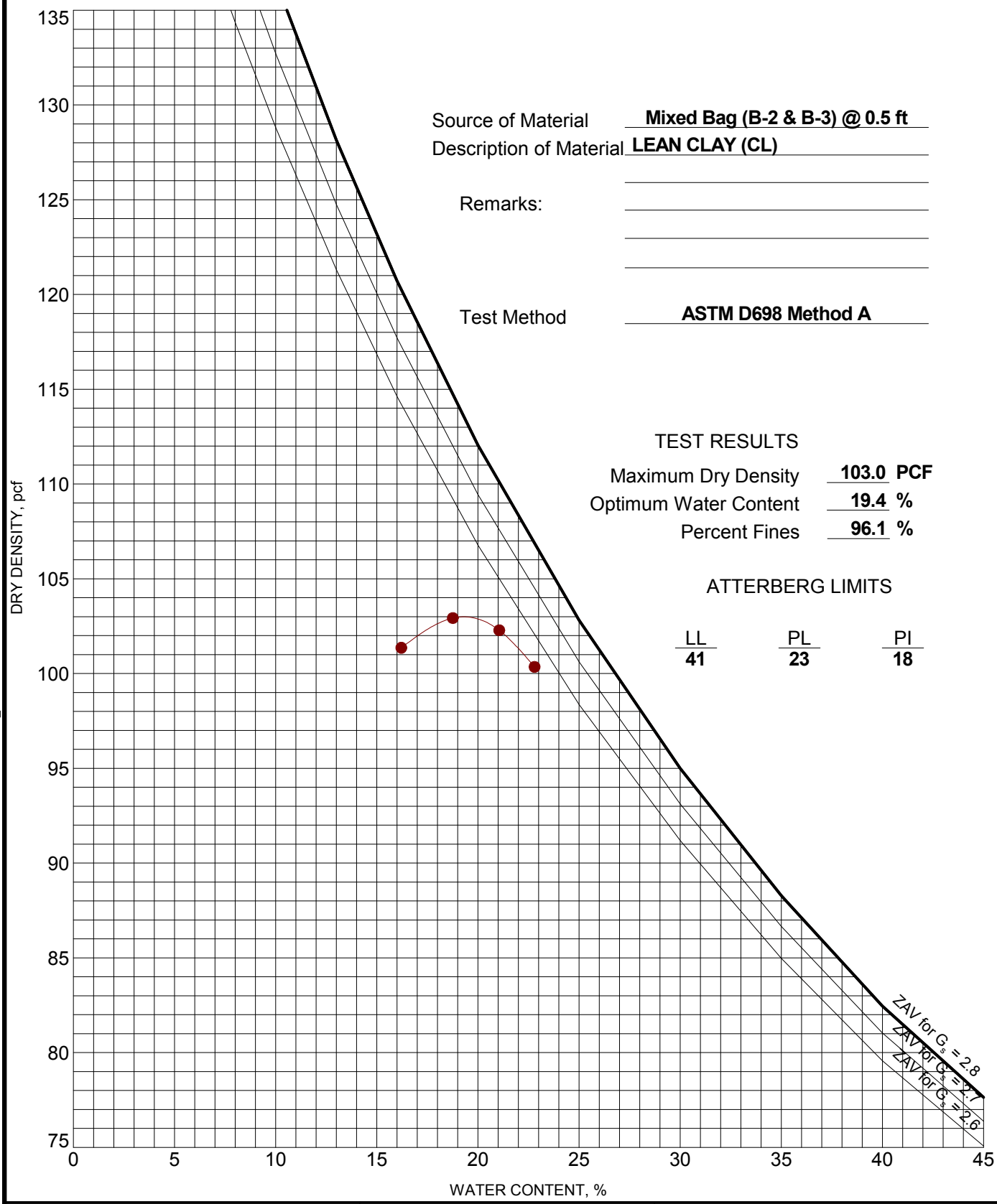
CLIENT: CPS, Ltd
Grand Forks, North Dakota

EXHIBIT: B-5

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. UNCONFINED M5145060_COLUMBIAROADRECONSTRUCT.GPJ TEMPLATE UPDATE 3-31-14.GPJ 1/22/15

MOISTURE-DENSITY RELATIONSHIP

ASTM D698/D1557



Source of Material: **Mixed Bag (B-2 & B-3) @ 0.5 ft**

Description of Material: **LEAN CLAY (CL)**

Remarks:

Test Method: **ASTM D698 Method A**

TEST RESULTS

Maximum Dry Density	**103.0**	**PCF**
Optimum Water Content	**19.4**	**%**
Percent Fines	**96.1**	**%**

ATTERBERG LIMITS

LL	PL	PI
41	**23**	**18**

PROJECT: Proposed Street Reconstruction	Terracon 1555 N. 42nd St., Unit B Grand Forks, North Dakota	PROJECT NUMBER: M5145060
SITE: South Columbia Road Grand Forks, North Dakota		CLIENT: CPS, Ltd Grand Forks, North Dakota
		EXHIBIT: B-6

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. COMPACTION - V2 M5145060_COLUMBIAROADRECONSTRUCT.GPJ TERRACON2012.GDT 10/24/14

California Bearing Ratio of Laboratory-Compacted Soils

Report Number: M5145060
Service Date: 10/24/14
Report Date: 10/28/14
Task:

Client

CPS, Ltd.
Grand Forks, North Dakota

Project

Proposed Street Reconstruction
South Columbia Road
Grand Forks, North Dakota

Project No. M5145060

SAMPLE INFORMATION

Sample Number:	Mixed Bag (B-2 and B-3)	Proctor Method:	ASTM D698 - Method A
Boring Number:	Borings B-2 and B-3	Maximum Dry Density (pcf):	103.0
Sample Location:	n/a	Optimum Moisture:	19.4
Depth:	0.5 to 2.5 feet	Liquid Limit:	41
Material Description:	LEAN CLAY (CL)	Plasticity Index:	18

CBR TEST DATA

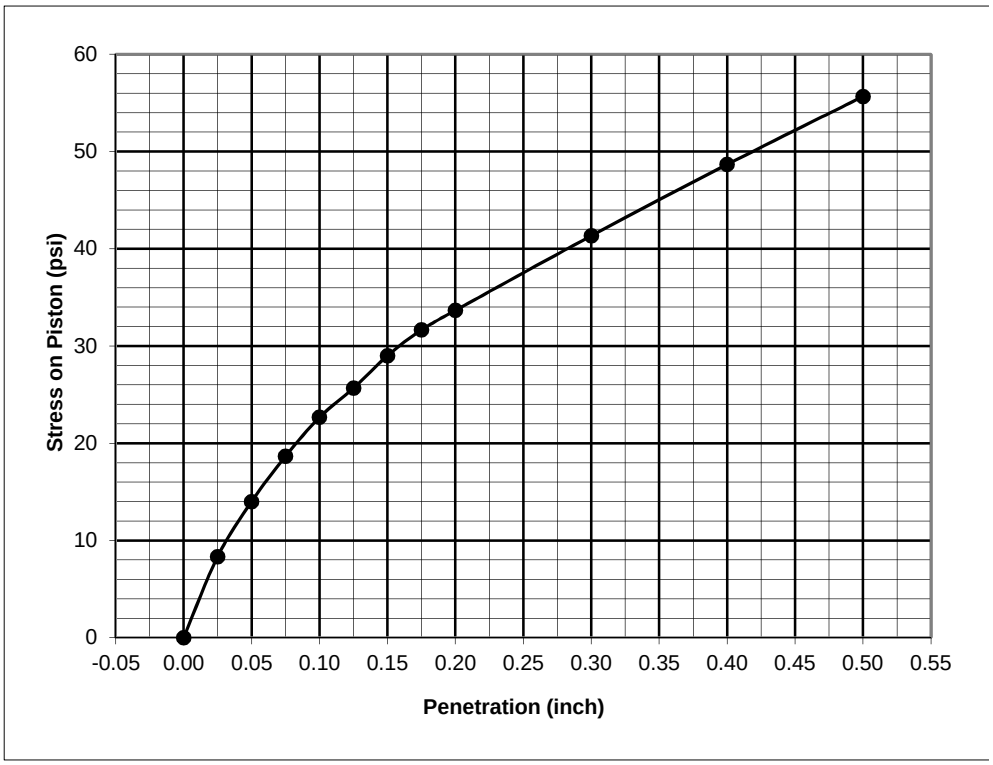
CBR Value at 0.100 inch	**2.3**
CBR Value at 0.200 inch	**2.2**
Surcharge Weight (lbs)	10
Soaking Condition	Soaked
Length of Soaking (hours)	96
Swell (%)	2.6

DENSITY DATA

Dry Density Before Soaking (pcf)	99.2
Compaction of Proctor (%)	96.3

MOISTURE DATA

Before Compaction (%)	16.1
After Compaction (%)	16.5
Top 1" After Soaking (%)	28.1
Average After Soaking (%)	25.3



Comments:
Test Methods: ASTM D1883

Exhibit B-7

by: 2/12/2015 jhn
Checked: 2/12/2015 shs

ESALs Calculations

Design Year	Average Annual Daily Traffic		g = growth rate/year						Growth Factor	
			Base AADT x $(i)^n$=Design AADT **or** (i) = $(\text{Desing AADT/Base AADT})^{(1/n)}$						(F/A,g%,n) or $((1+g)^n-1)/g$	
(n)	AADT Year	AADT	(g)	Round (g)					(GF)	Round (GF)
Base	2014 AADT	6600								
20	2034 ADDT	16500	1.04688	1.047					22.12002	22.12
30	2044 AADT	25500	1.022005	1.022					34.900638	34.9

20 YR Flexible ESALs

	A	B	C	D	E	F	
Vehicle Classification	Base Year AADT 6600 x (B/100)	Vehicle Class % of AADT	ESAL Factors (TF)	Base Daily Esals A x C	Days per Year	Growth Factor (g)	Accumulated Design Year ESALs D x E x F
Passenger Cars	4534	68.7	0.0007	3.17	365	22.12	25,625.76
Panels & Pickups (under 1 ton)	1452	22.0	0.0007	1.02	365	22.12	8,206.21
SU - 2 axle, 4 tire	0	0.0		0.00	365	22.12	0.00
SU - 2 axle, 6 tire	488	7.4	0.25	122.10	365	22.12	985,810.98
SU - 3 & 4 axle	33	0.5	0.58	19.14	365	22.12	154,532.53
TST - 3 axle	0	0.0	0.39	0.00	365	22.12	0.00
TST - 4 axle	33	0.5	0.51	16.83	365	22.12	135,882.05
TST - 5 axle	33	0.5	1.13	37.29	365	22.12	301,072.00
TST - 6 axle	0	0.0	0.78	0.00	365	22.12	0.00
Trucks w/ trailers & buses	20	0.3	0.57	11.29	365	22.12	91,120.91
Twin Trailers	7	0.1	2.4	15.84	365	22.12	127,888.99
check	6600						
TOTAL	**6600**		TOTAL	226.68		**TOTAL ESALs**	**1,830,139.43**

2034 - 20 YR FLEXIBLE ESALs 1,830,139

Exhibit B-8

30 YR RIGID ESALs

Vehicle Classification	A Base Year AADT 6600 x (B/100)	B Vehicle Class % of AADT	C ESAL Factors (TF)	D Base Daily Esals A x C	E Days per Year	F Growth Factor (g)	Accumulated Design Year ESALs D x E x F
Passenger Cars	4534	68.7	0.0007	3.17	365	34.90	40,431.23
Panels & Pickups (under 1 ton)	1452	22.0	0.0007	1.02	365	34.90	12,947.41
SU - 2 axle, 4 tire	0	0.0		0.00	365	34.90	0.00
SU - 2 axle, 6 tire	488	7.4	0.24	117.22	365	34.90	1,493,156.02
SU - 3 & 4 axle	33	0.5	0.85	28.05	365	34.90	357,314.93
TST - 3 axle	0	0.0	0.37	0.00	365	34.90	0.00
TST - 4 axle	33	0.5	0.53	17.49	365	34.90	222,796.37
TST - 5 axle	33	0.5	1.89	62.37	365	34.90	794,500.25
TST - 6 axle	0	0.0	0.8	0.00	365	34.90	0.00
Trucks w/ trailers & buses	20	0.3	0.74	14.65	365	34.90	186,644.50
Twin Trailers	7	0.1	2.33	15.38	365	34.90	195,892.65
check	6600						
TOTAL	**6600**		TOTAL	259.35		**TOTAL ESALs**	**3,303,683.35**

2044 - 30 YR RIGID ESALs 3,303,683

Exhibit B-9

APPENDIX C
SUPPORTING DOCUMENTS

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

SAMPLING

Shelby Tube

Split Spoon

WATER LEVEL

Water Initially Encountered

Water Level After a Specified Period of Time

Water Level After a Specified Period of Time

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.

FIELD TESTS

N	**Standard Penetration Test Resistance (Blows/Ft.)**
(HP)	**Hand Penetrometer**
(T)	**Torvane**
(DCP)	**Dynamic Cone Penetrometer**
(PID)	**Photo-Ionization Detector**
(OVA)	**Organic Vapor Analyzer**

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

LOCATION AND ELEVATION NOTES

Unless otherwise noted, Latitude and Longitude are approximately determined using a hand-held GPS device. The accuracy of such devices is variable. 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		
Descriptive Term (Density)	**Standard Penetration or N-Value Blows/Ft.**	**Descriptive Term (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

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 15
With	15 - 29
Modifier	> 30

GRAIN SIZE TERMINOLOGY

Major Component of Sample	Particle Size
Boulders	Over 12 in. (300 mm)
Cobbles	12 in. to 3 in. (300mm to 75mm)
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)
Sand	#4 to #200 sieve (4.75mm to 0.075mm
Silt or Clay	Passing #200 sieve (0.075mm)

RELATIVE PROPORTIONS OF FINES

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 5
With	5 - 12
Modifier	> 12

PLASTICITY DESCRIPTION

Term	Plasticity Index
Non-plastic	0
Low	1 - 10
Medium	11 - 30
High	> 30

Terracon

Exhibit: C-1

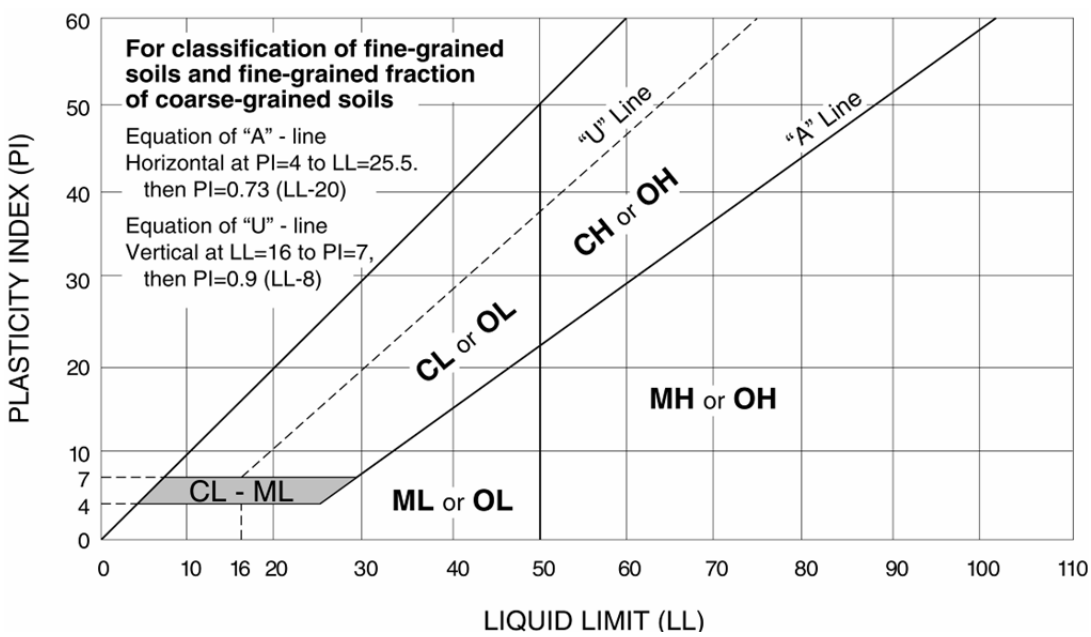
UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]					Soil 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 [C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$ [E]		GW	Well-graded gravel [F]
			$Cu < 4$ and/or $1 > Cc > 3$ [E]		GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH		GM	Silty gravel [F,G,H]
			Fines classify as CL or CH		GC	Clayey gravel [F,G,H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$ [E]		SW	Well-graded sand [I]
			$Cu < 6$ and/or $1 > Cc > 3$ [E]		SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH		SM	Silty sand [G,H,I]
			Fines classify as CL or CH		SC	Clayey sand [G,H,I]
Fine-Grained Soils: 50% or more passes 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	< 0.75	OL	Organic clay [K,L,M,N]
			Liquid limit - not dried			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	< 0.75	OH	Organic clay [K,L,M,P]
			Liquid limit - not dried			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 (75-mm) sieve
[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
[C] 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.
[D] 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

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add "with sand" to group name.
[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.
[H] If fines are organic, add "with organic fines" to group name.
[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.
[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.
[K] If soil contains 15 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" line.
[Q] PI plots below "A" line.



Terracon

Exhibit C-2