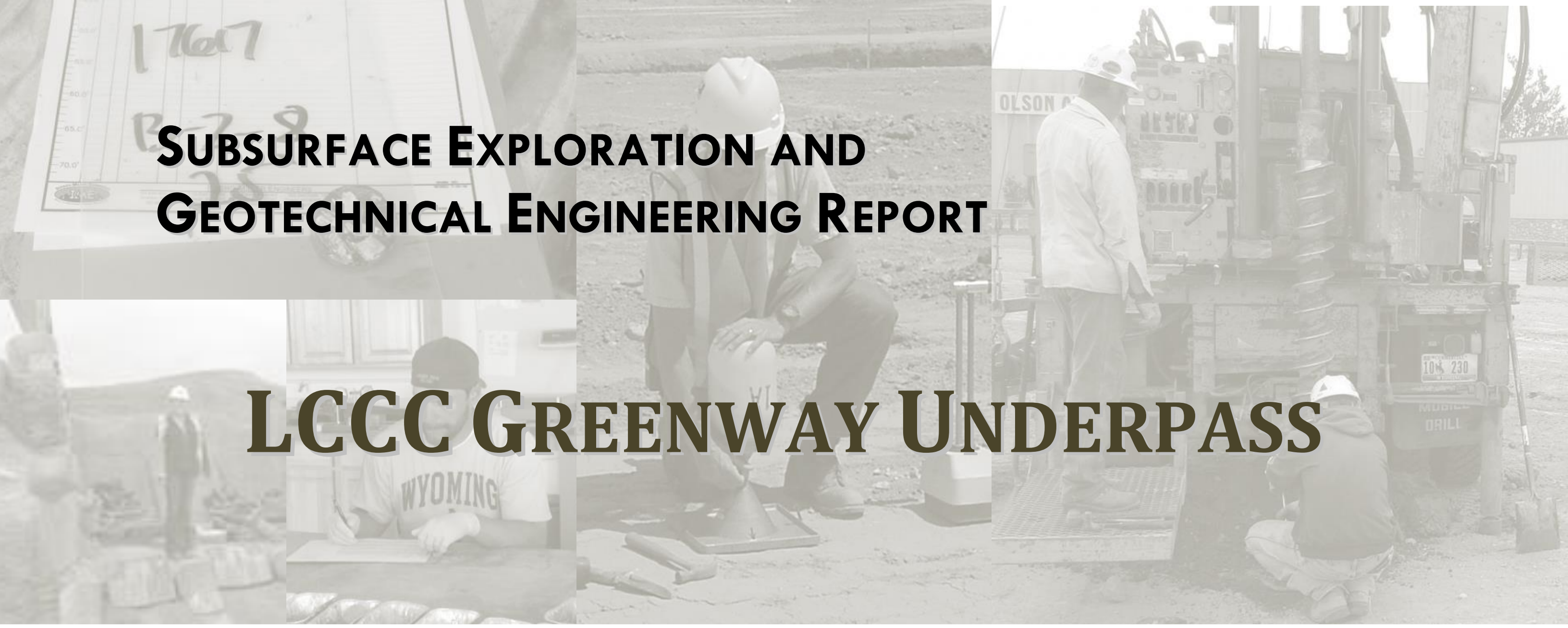
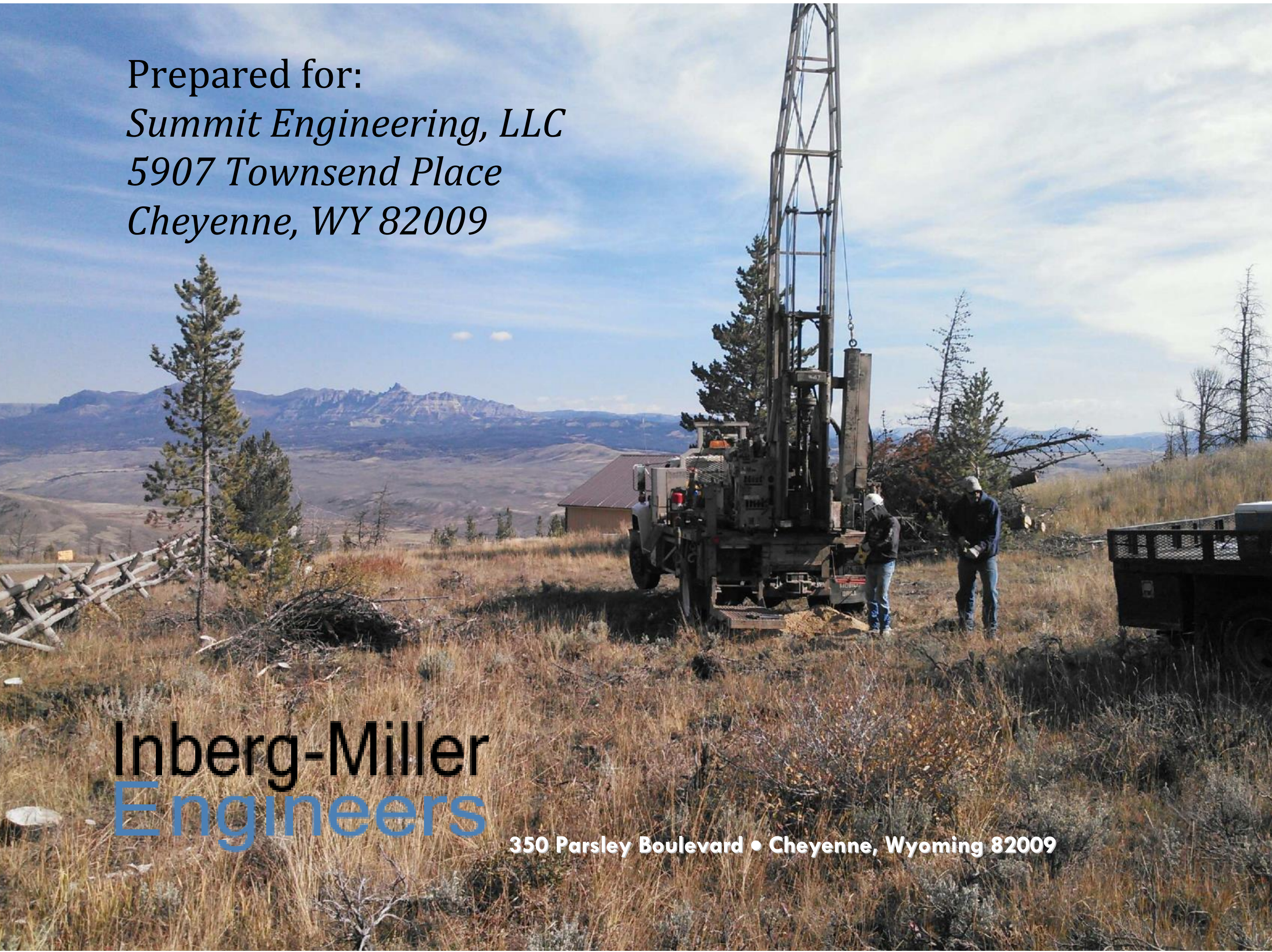


SUBSURFACE EXPLORATION AND GEOTECHNICAL ENGINEERING REPORT

LCCC GREENWAY UNDERPASS

CHEYENNE, WYOMING



Prepared for:
Summit Engineering, LLC
5907 Townsend Place
Cheyenne, WY 82009

Inberg-Miller Engineers

350 Parsley Boulevard • Cheyenne, Wyoming 82009

INBERG-MILLER ENGINEERS
IME
inberg-miller.com

INBERG-MILLER ENGINEERS

Quality Solutions Through Teamwork

December 18, 2019 21067-HX

PDF REPORT EMAILED: darci@summitengineeringwy.com
THIS CONSTITUTES THE ORIGINAL

Ms. Darci Hendon, P.E.
Summit Engineering, LLC
5907 Townsend Place
Cheyenne, WY 82009

RE: SUBSURFACE EXPLORATION AND GEOTECHNICAL ENGINEERING REPORT
LCCC GREENWAY UNDERPASS
CHEYENNE, WYOMING

Dear Darci:

This letter transmits our Subsurface Exploration and Geotechnical Engineering report for the above-referenced project. The work described in this report has been completed in accordance with our Service Agreement dated November 8, 2019.

It has been a pleasure participating in this project. Additional services we could provide include:

- environmental assessment
- civil engineering
- plan and specification review
- surveying
- construction materials testing
- observation of excavations and earthwork

If you have any questions or comments, please contact our office at 307-635-6827.

Sincerely,

INBERG-MILLER ENGINEERS

Taylor Olson

Taylor K. Olson, P.E.
Geotechnical Engineer
tolson@inberg-miller.com

Professional Engineer
TAYLOR K. OLSON
16494
Date 12/18/19
WYOMING

REVIEWED BY:

Derek Baker

Derek J. Baker, P.E., P.G.
Vice President
dbaker@inberg-miller.com

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i

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TABLE OF CONTENTS

APPENDICES

1.0 INTRODUCTION

1.1 EXECUTIVE SUMMARY

Based on information obtained from our subsurface exploration and laboratory testing of recovered samples, it is our opinion that the site is suitable for construction of the proposed LCCC Greenway Underpass project. In general, our subsurface exploration encountered the following strata and conditions:

The ground surface in both borings was covered with dark brown silty sand containing organics to a depth of approximately 1.5 feet. The organic silty sand is underlain in both borings by loose to medium dense, silty to clayey sand extending to termination depths of approximately 26.5 feet. Boring 1 encountered a sand with gravel lense from 7 to 9 feet below existing grade. Groundwater was encountered at depths of 10.6 to 10.9 feet below grade when given time to stabilize.

Specific geotechnical issues that were identified during the course of our subsurface exploration included the following:

1. Groundwater was encountered at depths of 10.6 to 10.9 feet below grade.

2. Excavations will encounter potentially unstable conditions.

3. Soils encountered at underpass bearing depth may be variable and will require subgrade improvement to support the structure. It is reported that the structure will be a 4-sided precast concrete tunnel with dimensions of 20 feet wide by 10 feet tall.

In summary, key geotechnical recommendations that apply to this project include:

1. We anticipate that excavations will likely extend to or near the groundwater table. If possible, the bottom of the tunnel should be kept a minimum of 2 feet above the groundwater table during construction to avoid soft and wet conditions. We anticipate excavations performed below static groundwater level will require dewatering continuously during excavation, construction, and backfilling operations. Due to the potentially significant flow, the dewatering system should be carefully designed and adjusted as needed.

2. OSHA Type C soils will be encountered during excavations and construction. Excavations should not exceed a maximum slope of 1.5H:1V. We do not anticipate excavations will reach 20 feet deep, which would require them to be designed by a professional engineer. However, design of the shoring by a registered structural engineer is recommended due to the conditions encountered, and to minimize the lateral extents of disturbance of College Drive.

3. We recommend that the subgrade to receive the new underpass be scarified to a depth of 12 inches, moisture conditioned, and recompacted to create a uniform bearing surface and to reduce the potential for total and differential settlements. In addition, we recommend that any shallow foundations used for wingwalls of the bridge also be supported on a minimum of 12 inches reconditioned material.

4. Because the historic range of groundwater elevation fluctuation is not known, and even the present groundwater elevation data is available for only a short period of time, there is uncertainty concerning how groundwater may impact use and performance of the tunnel. For this reason, and if time will not permit acquiring adequate groundwater level information, it is imperative that at least a positive passive drainage system be installed below and on the sides of

the tunnel. Further, provision should be made to actively dewater the drainage system via a sump and pump if necessary.

1.2 PURPOSE AND SCOPE OF SERVICE

Inberg-Miller Engineers was requested by Ms. Darci Hendon with Summit Engineering to perform a subsurface exploration and prepare this geotechnical engineering report for the purpose of providing recommendations for the design of LCCC Greenway Underpass. Our specific scope of service is described by our November 8, 2019 Proposal and subsequent Amendments, as applicable.

2.0 CONDITIONS

2.1 SITE DESCRIPTION

The project site is located to the south of the Laramie County Community College, approximately 0.4 miles east of the intersection of East College Drive and Avenue C. The site is bordered to the north by the new Residence Hall and LCCC campus, and south by the future Sweetgrass Development.

2.2 PROJECT CONDITIONS

Project conditions were either provided by Ms. Darci Hendon, or were assumed based on our experience with similar types of construction. It is reported that the structure will be a 4-sided precast concrete tunnel with dimensions of 20 feet wide by 10 feet tall. These conditions are tabulated below and form the basis for recommendations provided within this report. Please contact Inberg-Miller Engineers if conditions differ from those stated.

Column Load Range (kips)	**N/A**
Wall Load Range (kips per foot)	N/A
Tunnel Loads (psf)	300-500
Other Loads:	N/A
Maximum Cut (feet)	15
Maximum Fill (feet)	5
Total Settlement Tolerance (inches)	1
Differential Settlement Tolerance (inches per 50 feet)	0.5

2.3 SOIL/ROCK CONDITIONS

A summary of soil or rock conditions that were encountered and recorded on the logs is provided below. For a more detailed description of conditions refer to the test boring logs presented in Appendix A.

	Topsoil	Silty/Clayey Sand	Sand with Gravel
USCS Classification	--	SM, SC	SP
Density/Consistency	--	Loose to Medium Dense	Medium Dense
Boring Occurrence	Both	Both	B-1
Vertical Limits	0.0’ to 1.5’	1.5’ to 26.5’	7.0’ to 9.0’
Strength	--	Low to Moderate	Moderate
Compressibility	--	Moderate	Low

Permeability	--	Moderate	Moderate to High
Moisture Sensitivity	--	Moderate	Low
Frost Susceptibility	--	Moderate	Low
Shrink-Swell Potential	--	Low	Low
Collapse Potential	--	Low to Moderate	Low

2.4 GROUNDWATER CONDITIONS

A summary of groundwater observations and measurements that were made during the subsurface exploration are provided below. Additional details are documented on the test boring logs presented in Appendix A.

Boring No.	Observed Groundwater Elev. During Drilling (ft B.G.S)	Observed Groundwater Elev. Approx. 2 Hours After Drilling (ft B.G.S.)
1	15.0	10.6
2	20.0	10.9

Groundwater elevations may vary from those encountered during drilling procedures due to numerous reasons such as low soil permeability or impeded drainage.

Groundwater conditions could change with seasonal or long-term changes in climatic conditions and post-construction changes in irrigation and surface water runoff. Generally, developed sites have a significantly greater volume of water available to percolate into the ground due to irrigation and storm water runoff from hard surfaces. Localized, perched groundwater tables may develop above clayey layers, or within the foundation backfill zone. **Based on the time of year, the groundwater elevations observed and reported in this report likely DO NOT represent seasonally high groundwater conditions and should be evaluated accordingly.**

3.0 RECOMMENDATIONS

3.1 SITE PREPARATION AND EARTHWORK

Site Preparation

Stripping Depth	**1.5 feet, or until all organic material is removed**
Proof-Rolling	Tunnel subgrade, fill base, pavement subgrade

1. Proof-rolling should be performed with a wheeled vehicle exerting relatively high soil-contact pressure for the subject area, considering space constraints and access. Examples of suitable equipment include loaded dump trucks or end-loaders carrying a full bucket of soil.
2. Subgrades to receive structures, pavement, or fill material should respond uniformly to loading, and be free of organic materials, protruding rocks, debris, old fill, buried structures, or otherwise soft and compressible soil or material.
3. Weak or yielding subgrades should be repaired as recommended by the geotechnical engineer. Repairs may include soil excavation and replacement, possibly including proper geotextile fabric, depending on circumstances.

Fill and Backfill Materials

Classification	Suitable Materials	Source
Structural Fill	WYDOT Grading W, Envelope A	Imported
Tunnel Fill	Envelope A	Imported
Tunnel Base	WYDOT Grading W	Imported
Pavement Base	WYDOT Grading W	Imported
Pavement Subbase	USCS-SW, SP, GW, GP, SC, GC	On-site
Site Fill	Native Site Soil	On-site

1. Specification for recommended graded materials are as follows:

<table>
<tr><th colspan="2">Structural Fill
Envelope A</th><th></th><th colspan="2">WYDOT Grading W
Crushed Aggregate Base</th></tr>
<tr><th>Sieve</th><th>Percent Finer</th><th></th><th>Sieve</th><th>Percent Finer</th></tr>
<tr><td>1½”</td><td>100</td><td></td><td>1½”</td><td>100</td></tr>
<tr><td>#4</td><td>50-100</td><td></td><td>1”</td><td>90-100</td></tr>
<tr><td>#8</td><td>30-90</td><td></td><td>½”</td><td>60-85</td></tr>
<tr><td>#30</td><td>15-75</td><td></td><td>#4</td><td>45-65</td></tr>
<tr><td>#50</td><td>10-60</td><td></td><td>#8</td><td>33-53</td></tr>
<tr><td>#200</td><td>0-20</td><td></td><td>#200</td><td>3-12</td></tr>
<tr><td colspan="2">Liquid Limit < 40, PI < 15</td><td></td><td colspan="2">Liquid Limit < 25, PI < 3</td></tr>
</table>

Compaction

Below Tunnel	6-inch layers, 95% ASTM D698
Below Pavements and Slabs	8-inch layers, 95% ASTM D698
Trenches	8-inch layers, 95% ASTM D698
Site Fill/landscaped Areas	12-inch layers, 95% ASTM D698

1. Engineered fill should be moisture-conditioned before placement and compaction, with preferred moisture contents ranging from 4 percent below to 2 percent above the optimum moisture content. The contractor’s equipment and procedures should produce a horizontal, uniformly mixed and compacted lift. In-place density and water content of each lift of fill materials should be tested and approved, or as otherwise recommended by the geotechnical engineer.

2. If construction takes place during cold weather, care should be taken to prevent construction on frozen soils. In addition, fill materials should not contain snow and/or ice and should not be placed in a frozen condition.

Temporary and Permanent Slopes

Temporary Fill Slope	3 H: 1 V
Temporary Cut Slope	1.5 H: 1 V
Permanent Fill Slope	3 H: 1 V
Permanent Cut Slope	3 H: 1 V

1. Slopes, whether temporary or permanent, will require careful management of surface water through design and maintenance to protect slopes from saturation.

2. Slopes should be protected from erosion with vegetation, matting or other measures.

3.2 GROUND IMPROVEMENTS

Tunnel and Wingwall Foundations

Location	Below Tunnel and Wingwall Foundations
Scarification and Recompaction Depth and Width	12 inches below bearing elevation, 12 inches outside tunnel perimeter or foundation perimeter
Backfill	Moisture conditioned on-site soils or structural fill
Compaction	6-inch layers, 95% ASTM D 698
Geosynthetic Reinforcement	May be necessary if soft conditions develop

Pavements

Re-constructed pavement sections should be consistent with that of the existing pavement section of East College Drive. Subgrades over buried structures should be prepared with structural fill in accordance with this report.

Geosynthetic reinforcement may be necessary if soft or yielding conditions develop during construction. The geotechnical engineer should be notified if these conditions develop to further refine recommendations for geosynthetic use.

3.3 SHALLOW FOUNDATIONS

Suitable Bearing Strata	Structural fill or reconditioned native subgrade
Bearing Pressure	1,000
Pressure Increase for transient loading	1/3
Minimum Footing Width	
Continuous	18”
Isolated Pad	3’
Total Settlement	1”
Differential Settlement (inches/feet horizontal distance)	0.5”/50’
Potential Heave Conditions	Low
Potential Collapse Conditions	Low to moderate
Embedment	
Exterior Footings	36”

1. Footing and tunnel subgrades should be observed by the Geotechnical Engineer prior to concrete placement, to identify suitable bearing materials, and to observe whether the foundation soils have been properly prepared prior to foundation construction. All loose or soft soils in the footing excavation should be removed from the foundation excavation prior to concrete placement. Footings should not be placed on either uncompacted native soil or uncompacted fill.

3.4 TUNNEL CONSTRUCTION

It is reported that a 4-sided precast concrete tunnel with dimensions of 20 feet wide by 10 feet tall will be installed. The floor of the tunnel acts as a large slab to help support wall loads, backfill on top of the tunnel, and traffic loads from East College Drive.

Base	6” WYDOT Grading W
Subbase	**A minimum of 12 inches of structural fill or reconditioned native subgrade**
Subgrade Modulus (pci)	125
Moisture Vapor Control	Not anticipated
Potential Heave Conditions	Low
Potential Collapse Conditions	Low to moderate

1. The aggregate base course will not provide an effective capillary break for moisture rise to the slab. Soil beneath the aggregate base can be properly prepared native soil or structural fill prepared as described in the Site Preparation and Fill Section above.

2. At the time this report was prepared the finish floor elevation of the tunnel was not provided. We anticipate that excavations will likely extend to or near the groundwater table. If possible, the bottom of the tunnel should be kept a minimum of 2 feet above the groundwater table during construction to avoid soft and wet conditions. We anticipate excavations performed below static groundwater level will require dewatering continuously during excavation, construction, and backfilling operations. Due to the potentially significant flow, the dewatering system should be carefully designed and adjusted as needed.

3. Due to the presence of static groundwater at or just below bottom of pre-cast concrete tunnel elements, we recommend installation of a dead man anchor system for the proposed tunnel. The dead man anchors are intended to resist buoyant forces encountered when groundwater elevations rise above the bottom of tunnel elevation. The dead man anchor system should consist of beams of reinforced concrete that are placed along side of the pre-cast tunnel elements. Straps are then placed over the pre-cast tunnel elements and attached to the anchors. Dead man anchors should be installed according to the pre-cast tunnel element manufacturer’s recommendations.

4. To reduce the potential for surface water to impact bearing soils within the area of the tunnel, installation of a perimeter and underslab drainage system is recommended. The drainage system should be constructed below the tunnel and around the exterior perimeter of the tunnel to quickly and efficiently remove groundwater from the area. The drainage system should be sloped at a minimum 1/8 inch per foot to a suitable outlet providing positive drainage. If daylighting of the drainage system is not feasible, the water should be directed to a sump and pumped out as necessary. The drainage system should consist of a properly sized perforated pipe (minimum 4-inch I.D.), embedded in free-draining gravel, placed in a trench at least 12 inches in width and height. The top 1 foot of backfill around the tunnel should be a low permeability soil. The system should be underlain with a polyethylene moisture barrier, sealed to the tunnel walls, and extended at least to the edge of the backfill zone. The gravel should be encapsulated with drainage fabric prior to placement of remaining foundation backfill.

3.5 RETAINING WALLS

Condition	Native Silty to Clayey Sand	Grading A Fill
Active Lateral Soil Pressure – for structures that can deflect without restraint by other structures. (equivalent fluid unit weight, pcf)	50	40
At-Rest Lateral Soil Pressure - for structures which have significant restraint against deflection. (equivalent fluid unit weight, pcf)	70	60
Passive Lateral Soil Pressure – resistance of soil abutting a structure. (equivalent fluid unit weight, pcf)	310	400
Coefficient of Friction between foundation and underlying soil	0.4	0.5
Soil Density, wet soil (pcf)	125	135

1. All the parameters assume the structure and soils are above the water table. The following parameters do not include a factor of safety. A minimum factor of safety of 2.0 is recommended for horizontal loading.
2. Where possible, foundations should be backfilled and compacted evenly on all sides to prevent horizontal movement. Basement/crawl space walls and retaining walls should be adequately braced prior to backfilling.
3. Surcharge loads, on the uphill side of the wall, due to ground slope, soil stockpiles, equipment, and structures may significantly increase lateral forces on the wall and need to be fully evaluated.
4. Drains should be installed behind retaining walls or other confined areas where surface precipitation and runoff water can collect. Drains should be designed to prevent the build-up of hydrostatic pressures behind the retaining structures due to trapped water.

3.6 SITE DRAINAGE

The ground surface adjacent to the tunnel should be sloped a minimum of 5% away. If the slope adjacent to the tunnel is paved with asphalt or concrete, the slope can be reduced by 2%. Slope the ground surface beyond 10 feet of the tunnel at least 2% away to pavement, ditch or other positive drainage system. Negative drainage and improper management of near-surface water, by not providing an effective grading and drainage design, can result in moisture entering tunnel subgrade soils. Sources of near surface water may include pressurized irrigation and water supply lines, rainwater and snowmelt. Backfill against the tunnel walls should be well compacted to reduce the potential for moisture infiltration.

If water is permitted to accumulate or pond next to the tunnel and penetrate the subgrade soils, larger soil movements may be experienced than those discussed in this report. These increased movements can result in undesirable differential settlements resulting in floor slab cracking and cracking in the overlying College Drive pavement. The estimated settlement values described in this report are dependent on positive drainage throughout the life of the structure and cannot be relied upon if effective drainage is not maintained.

3.7 GENERAL

Inberg-Miller Engineers should review final plans and specifications in order to determine whether the intent of our recommendations has been properly implemented. In addition, we should be retained as the geotechnical engineer and construction materials testing agency to provide the following services:

a. Observe excavations to determine if subsurface conditions revealed are consistent with those discovered in the exploration.

b. Identify if the proper bearing stratum is exposed at proposed foundation and tunnel excavation depths.

c. Observe that foundation excavations are properly prepared, cleaned, and dewatered prior to concrete placement.

d. Test compaction of subgrades and fills.

e. Perform field and laboratory testing of concrete and other materials as required by project specification and/or building code.

3.8 CONSTRUCTION

Excavation Difficulty	Low, conventional earth excavation should be adequate to extend excavations to anticipated depths.
Dewatering Requirements	Potential for significant flow if excavations penetrate static groundwater. If static groundwater is penetrated a dewatering system should be carefully designed and adjusted as necessary so that groundwater is maintained a minimum of 2 feet below the bottom of excavations. **The need for an adequate dewatering system is vital to construction below static groundwater elevation.**
Soil Sensitivity	Moderate, on-site soils may be moisture sensitive and present challenges for subgrade preparation during wet or cold conditions.
OSHA Soil Type	C
Cement Type	Sulfate exposure negligible, no special requirements
Potential for Buried Obstructions	Utilities may be present in the area of construction
Protection of Existing Structures	N/A
Onsite Borrow Soil	Suitable for on-site landscaping.

4.0 TECHNICAL DATA

Our Site and Boring Location Map, Test Boring Logs, and Testing Data (laboratory reports, infiltration, geophysical) are included in Appendix A.

5.0 STANDARD REPORT INFORMATION

Our Standard Report Information, including Terms and Definitions, Field and Laboratory Testing Program, Limitations, and Comments Form are included in Appendix B.

6.0 CLOSURE

This report has been prepared for the exclusive use of our client, Summit Engineering, for evaluation of the site, design, and construction planning purposes of the described project. All information referenced in the Table of Contents, as well as any future written documents that address comments or questions regarding this report, constitute the “entire report”. Inberg-Miller Engineers’ conclusions, opinions, and recommendations are based on the entire report. This report may contain insufficient information for applications other than those herein described. Our scope of services was specifically designed for and limited to the specific purpose of providing geotechnical recommendations for the design of the proposed Greenway Underpass project. Consequently, this report may contain insufficient information for applications other than those herein described.

We caution that this report was not written as a construction contract document, and therefore should either not be incorporated in contract documents or be accompanied by a statement similar to the following:

This report was used during the planning and design of the subject project and is provided in the contract documents for informational purposes only. This report may contain recommendations that were not implemented and terms that conflict with the contract documents, therefore the project plans and technical specifications and not this report should be followed for construction requirements.

We appreciate participating in your project. We can offer services under a separate contract to provide civil or environmental engineering services, review final plans and specifications, perform construction surveying, field and laboratory construction materials testing, and observe excavations, as may be required. Please call us at 307-635-6827 if you have any questions regarding this report.

APPENDIX A

SAMPLE AND DATA COLLECTION INFORMATION

Field-sampling techniques were employed in this exploration to obtain the data presented in the Final Logs and Report generally in accordance with ASTM D420, D1452, D1586 (where applicable), and D1587 (where applicable).

The drilling method utilized in most test borings is a dry-process, machine rotary auger type that advances hollow steel pipe surrounded by attached steel auger flights in 5-foot lengths. This method creates a continuously cased test hole that prevents the boring from caving in above each level of substrata to be tested. Sampling tools were lowered inside the hollow shaft for testing in the undisturbed soils below the lead auger. In some test borings, as appropriate to advance to the desired depth, air or wash rotary drilling methods were utilized. Air or wash rotary drilling methods allow for the extraction of rock core samples.

Samples were brought to the surface, examined by an IME field representative, and sealed in containers (or sealed in the tubes) to prevent a significant loss of moisture. They were returned to our laboratory for final classification per ASTM D2487 methods. Some samples were subjected to field or laboratory tests as described in the text of this report.

Groundwater observations were made in the open drill holes by IME field personnel at the times and dates stated on the Final Logs. Recorded groundwater levels may not reflect equilibrium groundwater conditions due to relatively low permeability of some soils. It must also be noted that fluctuations may occur in the groundwater level due to variations in precipitation, temperature, nearby site improvements, nearby drainage features, underdrainage, wells, severity of winter frosts, overburden weights, and the permeability of the subsoil. Because variations may be expected, final designs and construction planning should allow for the need to temporarily or permanently dewater excavations or subsoil.

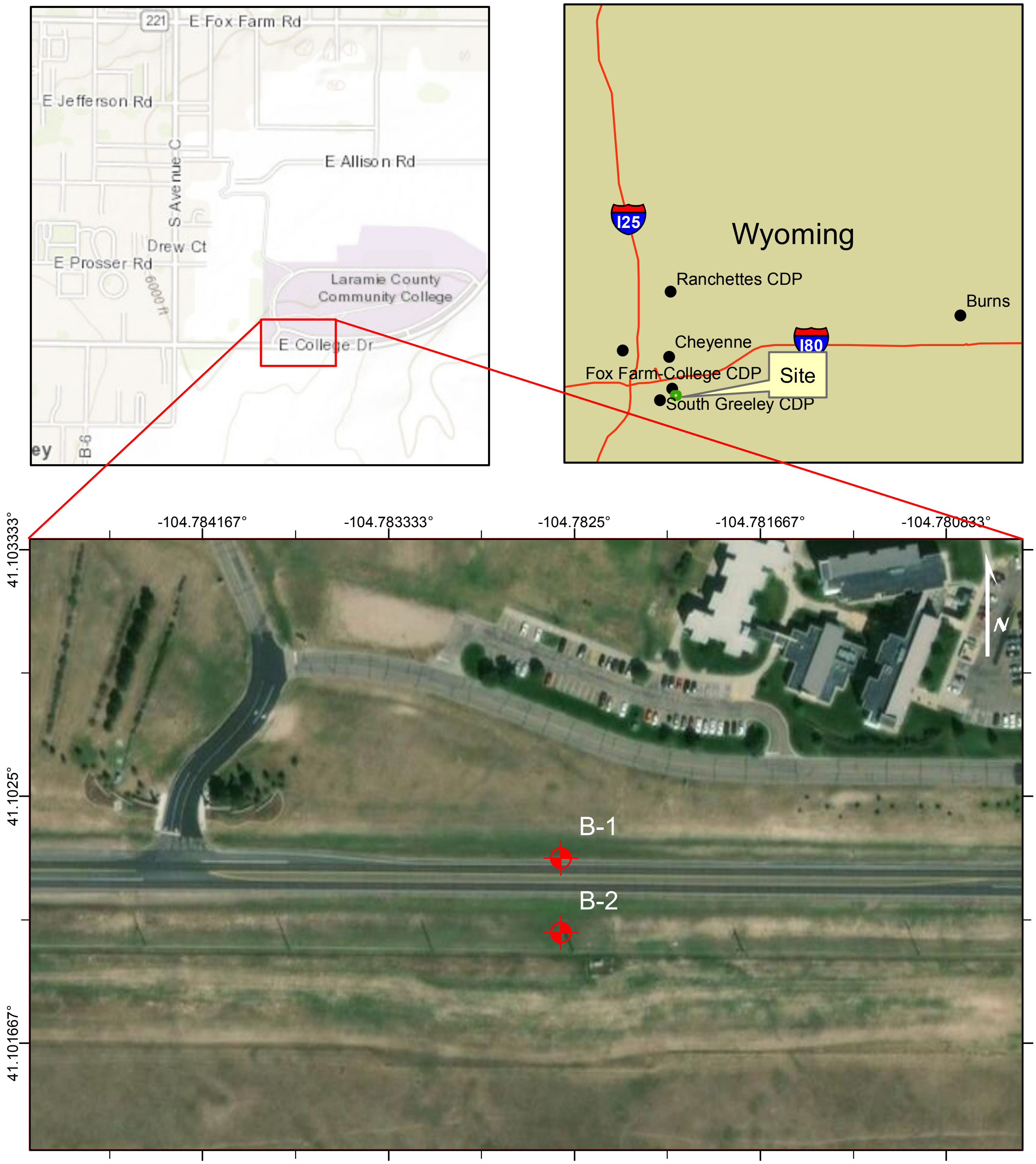
A Final Log of each test pit or boring was prepared by IME. Each Final Log contains IME's interpretation of field conditions or changes in substrata between recovered samples based on the field data received, along with the laboratory test data obtained following the field work or on subsequent site observations. The final logs were prepared by assembling and analyzing field and laboratory data. Therefore, the Final Logs contain both factual and interpretive information. IME’s opinions are based on the Final Logs.

The Final Logs list boring methods, sampling methods, approximate depths sampled, amounts of recovery in sampling tools (where applicable), indications of the presence of subsoil types, and groundwater observations and measurements. Results of some laboratory tests are arrayed on the Final Logs at the appropriate depths below grade. The horizontal lines on the Final Logs designate the interface between successive layers (strata) and represent approximate boundaries. The transition between strata may be gradual.

We caution that the Final Logs alone do not constitute the report, and as such they should not be excerpted from the other appendix exhibits or from any of the written text. Without the written report, it is possible to misinterpret the meaning of the information reported on the Final Logs. If the report is reproduced for reference purposes, the entire numbered report and appendix exhibits should be bound together as a separate document, or as a section of a specification booklet, including all drawings, maps, etc.

Pocket penetration tests taken in the field, or on samples examined in the laboratory are listed on the Final Logs in a column marked “qp". These tests were performed only to approximate unconfined strength and consistency when making comparisons between successive layers of cohesive soil. It is not recommended that the listed values be used to determine allowable bearing capacities. Bearing capacities of soil is determined by IME using test methods as described in the text of the report.

Site Location Map



Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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QUALITY SOLUTIONS THROUGH TEAMWORK

TEST BORING 1

Page 1 of 1

Project: LCCC Greenway Underpass
Location: Cheyenne, WY
41.10229°, -104.78256°
Job No.: 21067-HX
Client: Summit Engineering

ELEVATION	DEPTH (ft)	SOIL DESCRIPTION Surface Elevation (Ft):	GRAPHIC	SAMPLE TYPE RECOVERY	N BLOWS PER Ft 0 50 100	Qp (TSF)	% GRAVEL	% SAND	% -200	WATER CONTENT × PL △—△ LL 0 20 40 60	OTHER TESTS AND NOTES
	0	Medium dense, moist, dark brown, fine to medium, SILTY SAND, with trace roots to 1.5' 1.5		☒	12					22	
		Loose, moist, brown to light brown, fine to medium, SILTY SAND									
	5	7.0		☒	8					13	
		Loose, moist, brown, fine to coarse, SAND, with gravel 9.0									
▽	10	Medium dense, moist to saturated, brown, fine, SILTY SAND, varies to clayey sand		☒	10		0	0	44	24	SM LL= 36 PL= 25 PI= 11
▼	15			☒	13					22	Water Soluble Sulfate - 0 to 50 ppm
	20			☒	18					21	
		Grades less plastic below 22', grades fine to medium									
	25	26.5		☒	19					23	

Remarks:

Date Begun: 11/25/19
Date Completed: 11/25/19
Termination Depth (ft): 26.5
Crew: TKO, MRM
Rig: CME-45
Method: 3 1/4" Hollow Stem Auger
Benchmark/Datum (Ft):

SAMPLE TYPES

☒ Split Spoon

WATER LEVEL OBSERVATIONS

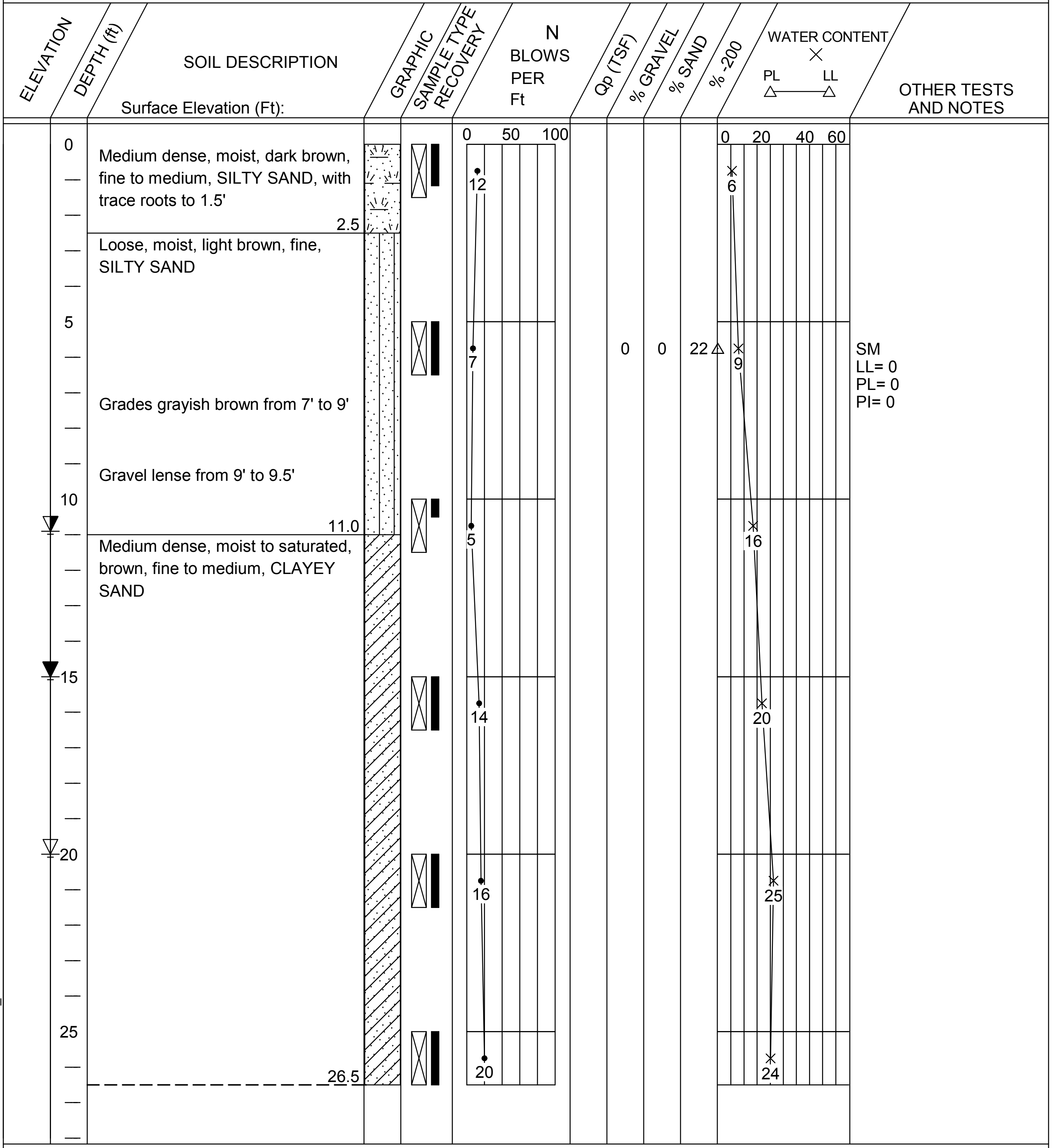
▽ While Drilling (ft)	15
▼ End of Drilling(ft)	15
▼ 2 Hours After Drilling (ft)	10.6

Depth to Cave In (Ft):

INBERG-MILLER ENGINEERS
QUALITY SOLUTIONS THROUGH TEAMWORK

TEST BORING 2

Project: LCCC Greenway Underpass
Location: Cheyenne, WY
41.10204°, -104.78256°
Job No.: 21067-HX
Client: Summit Engineering



DEPTH (ft)	SOIL DESCRIPTION
0 – 2.5	Medium dense, moist, dark brown, fine to medium, SILTY SAND, with trace roots to 1.5'
2.5 – 11.0	Loose, moist, light brown, fine, SILTY SAND Grades grayish brown from 7' to 9' Gravel lense from 9' to 9.5'
11.0 – 26.5	Medium dense, moist to saturated, brown, fine to medium, CLAYEY SAND

DEPTH (ft)	N BLOWS PER Ft	% GRAVEL	% SAND	% -200	WATER CONTENT	OTHER TESTS AND NOTES
0	12				6	
5	7	0	0	22	9	SM LL= 0 PL= 0 PI= 0
10	5				16	
15	14				20	
20	16				25	
25	20				24	

Remarks:

Date Begun: 11/25/19
Date Completed: 11/25/19
Termination Depth (ft): 26.5
Crew: TKO, MRM
Rig: CME-45
Method: 3 1/4" Hollow Stem Auger
Benchmark/Datum (Ft):

SAMPLE TYPES

☒ Split Spoon

WATER LEVEL OBSERVATIONS

▽ While Drilling (ft)	20
▼ End of Drilling(ft)	15
▼ 2 Hours After Drilling (ft)	10.9

Depth to Cave In (Ft):

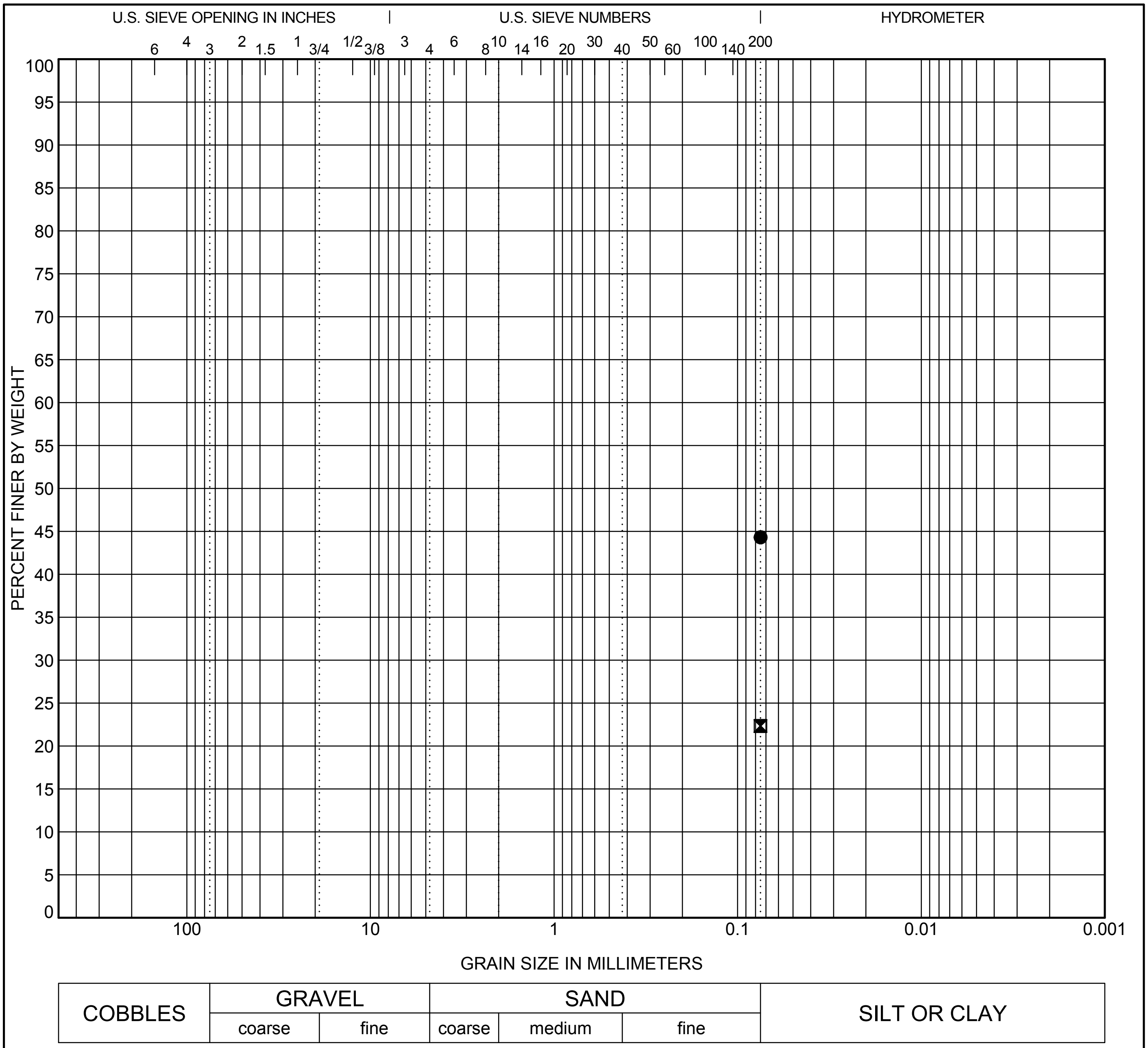
APPENDIX B

LABORATORY TESTING PROGRAM

Soil samples were transported to our laboratory where they were subject to further evaluation, which may include visual classification according to ASTM D2488 or other analysis to determine certain engineering properties. Tests were performed in accordance with the test methods listed below.

Laboratory Test	Test Method
Moisture Content	ASTM D2216
Liquid Limit, Plastic Limit and Plasticity Index	ASTM D4318
Sieve Analysis	ASTM C117
Sieve Analysis with Hydrometer	ASTM D422
Sieve Analysis (200 Sieve only)	ASTM D1140
Water Soluble Sulfate	Comparative
Unconfined Compressive Strength	ASTM D2166
Moisture-Density Relationship (Standard Proctor)	ASTM D698
Moisture-Density Relationship (Modified Proctor)	ASTM D1557
California Bearing Ratio (CBR)	ASTM D1883
Hydraulic Conductivity	ASTM D5084
Minimum Resistivity	AASHTO T288
pH	AASHTO T288
Tube Density	ASTM D2937
Direct Shear	ASTM D3080
Consolidation-Swell	ASTM D2435

Test results that are not displayed on the test boring logs are presented in Appendix B of this report.



Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	**1**	**10.0**	**SILTY SAND(SM)**	**36**	**25**	**11**		
☒	**2**	**5.0**	**SILTY SAND(SM)**	**NP**	**NP**	**NP**		

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**1**	**10.0**	**0.075**				**0.0**	**0.0**	**44.3**	
☒	**2**	**5.0**	**0.075**				**0.0**	**0.0**	**22.3**	

PROJECT: LCCC Greenway Underpass
JOB NO.: 21067-HX
CLIENT: Summit Engineering
TEST METHOD: ASTM D422

PARTICLE SIZE ANALYSES

APPENDIX C

GLOSSARY

Definition of certain words, terms or phrases that are used in this report are provided below, to help the reader to interpret the intent of Inberg Miller Engineers. These definitions:

1. *May differ from other published versions*
2. *Have not been vetted by any organization outside of Inberg-Miller Engineers*
3. *May not present a complete understanding of the term*

The reader is encouraged to seek additional interpretation of important terms and consult with Inberg-Miller Engineers as necessary where discrepancies may be discovered, or a definition has not been provided.

Active Lateral Soil Pressure – Horizontal pressure applied by soil to a wall that sufficiently yields or rotates about its base to allow the full soil shear strength to be mobilized

Allowable End Bearing Pressure – Recommended maximum pressure on soil or rock expressed as load per unit area that can be applied across the full bottom bearing surface of a pier or pile deep foundation within a given settlement tolerance

Allowable Skin Friction – Recommended maximum frictional resistance of soil or rock as load per unit area that can be applied over the vertical side surface of a pier or pile deep foundation within a given settlement tolerance.

Alluvium – Soil that has been transported and deposited in a moving water environment

At-Rest Lateral Soil Pressure - Horizontal pressure applied by soil to a wall or the vertical face of a structure that is restrained from movement and soil is not allowed to deform

Backfill – Soil that is used to replace some or all of soil that was excavated, and is usually subject to material specifications and density requirements

Base – Either 1: the bottom surface of a structure or excavation, or 2: soil or aggregate that is placed immediately below a structure or pavement

Bearing Elevation – A subsurface level where the base of foundations rest and transmit applied load to the soil or rock

Bearing Stratum – A specific soil layer defined by soil description and depth below ground surface, or elevation, to which foundations transmit applied load

Claystone – Consolidated sedimentary bedrock comprised chiefly of clay sized particles

Collapse – Loss of inter-particle soil friction, usually as a result of the effects of excessive moisture or water, and often leading to large subsidence or settlement of supported structures

Colluvium – Soil that has accumulated as a result of gravitional transport, commonly found near the base of slopes

Compaction/Compacted – Process or the result of a process where soil density is increased, soil voids are decreased, and usually resulting in an increased strength and reduced settlement potential

Compressibility – Relative term applied to soil or soil layer to describe how much it may yield to expected applied load or pressure

Conglomerate – A mixture of clay through gravel-size particles, commonly cemented with calcium carbonate

Consistency – Term applied to cohesive soils to describe relative stiffness, often defined by either ASTM D1586 Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils or as indicated by unconfined compressive strength

Continuous Footing – A long narrow footing usually supporting a linear structure such as a wall. Length to width ratio may vary, but is commonly taken as 10.

Contraction Joints – Formed or sawn joints in concrete slabs or pavements used to control crack patterns that result from thermal contraction or shrinkage

Crushed Aggregate Base – Processed gravel at a specified grading and quantity of fractured faces, and sometimes certain durability requirements, that is used below slabs or pavements

Cut – Term applied to the volume or depth of soil that has been excavated to a certain design grade

Cut Slope – Soil or rock slope that results from cut or excavation

Density – The weight of soil for a unit volume, which may be stated in a dry condition, or a moist to saturated condition with weight of water included

Dewatering – Process of removing water from an excavation or lowering the groundwater elevation usually via drains or pumps

Differential Settlement – The difference in subsidence of a soil surface, or structure resting on soil, between two points spaced a certain distance apart

Disturbed Soil – Soil that has been loosened usually as a result of excavation activity, traffic, vibration

Embedment – The portion of a structure buried within a specific stratum, usually measured as a vertical distance

Engineered Fill – Soil that meets a specific gradation criteria and/or other quality requirements and that is placed at a specified thickness and moisture content and compacted to meet certain minimum density requirements, for the purpose of consistently obtaining certain minimum engineering properties for design

Envelope A – Specified gradation criteria that describes reasonably well graded sand and gravel mixtures, with less than 20 percent silt and clay.

ESAL – Criteria that describes traffic loading equivalent to a certain number of passes from an 18 kip single axle

Excavation Subgrade – The bottom of an excavation

Expansion Joints – Joints that are formed in a concrete pavement or slab that allow for thermal expansion of the concrete. Joints are usually filled with an elastic material to prevent entry of foreign particles

Factor of Safety – A multiplier for recommended allowable values that provides a margin for safety against failure, considering uncertainty and risk

Fill – Soil or rock that has been placed to raise the ground surface elevation

Footing/Foundation Subgrade – The surface of soil or rock to receive a structure which is usually a reinforced cast-in-place concrete

Friction Angle – A measure of physical resistance against sliding between soil or rock particles, usually ranging between 0 and 45 degrees

Frost Heave – A phenomenon that occurs in certain soil types where soil-moisture may concentrate and freeze as ice layers, causing upward swelling of the soil

Frost Protection – Any measure used to prevent frost-heave from affecting a structure

Frost Susceptibility – Soil types that are prone to frost heave

Geotechnical Engineer – An engineer trained through education and experience in soil mechanics and earth-structure systems

Grade Beam – A horizontal structural element that spans between foundations which may carry a portion of load from a structure above, but usually doesn't rely upon support from the soil below

Heave – The upward swelling of soil or rock, usually as a result of freezing or moisture adsorption

Helical Screw Pile/Pier – A foundation type that consists of a steel shaft with steel helices welded to the shaft, so that the system will pull itself into the ground when torque is applied

Hydraulic Conductivity – The rate at which water passes through soil under a certain pressure, usually expressed in the units of centimeters per second

Hydrostatic Pressure – The hydraulic pressure at a certain depth below the surface of a water body or water in saturated soil equivalent to the weight of water multiplied by the depth

Isolated Pad Footing – A single footing for the support of a leg, column, stanchion or other vertical structural element

Lifts – Layers of material that are placed as fill, backfill or pavement

Mat Foundation – A large, shallow spread footing that may support any combination of multiple point or area loads

Maximum Allowable Bearing Pressure – The recommended maximum pressure that may be applied to soil or rock, including a factor of safety, within estimated settlement tolerances

Maximum Dry Density – The peak soil density that is determined in a laboratory using a drop-hammer and mold over a range of varying moisture contents, expressed in terms of dry weight per unit volume

Moisture Sensitivity – A characteristic of soil that describes how the strength or compressibility is affected by increasing moisture content

Moisture Vapor Control – A design measure to limit the upward movement of soil moisture, usually through a concrete floor slab resting on the soil

Native Soil – Soil that is present naturally at a subject site

On-Site Fill – Soil used as fill or backfill that originates from a source located at the subject site

Optimum Moisture Content – The moisture content at which the maximum dry density is achieved in laboratory testing

Organic Materials – Matter contained in soil that is subject to decomposition

Overburden – Soil or rock that is present above an ore body, sedimentary bedrock or certain deposit such as gravel

Overexcavation – A process by which usually unsuitable or unwanted soil or rock is removed or excavated below the bottom of a structure or minimum required excavation limits

Passive Lateral Soil Pressure – Available resisting soil pressure when a structure is forced against the soil

Pavement Subbase – A specified soil type, often described by gradation that is placed below base, which in turn supports flexible or rigid pavement

Perched Groundwater – A subsurface condition where water collects above a relatively low permeability stratum

Permeability – The rate at which a liquid or gas may pass through soil, rock or other material

Pile/Pier Cap – A reinforced concrete block designed to distribute load from a structure to multiple deep foundation elements

Proof-Rolling – A process by which a subgrade is subjected to wheel loading to locate relative soft or yielding areas that might be repaired before covering with structures, soil, pavement etc.

Raft Foundation – See Mat Foundation

Residual Soil – Soil that has resulted from the in-place weathering of rock

Rigid Pavement – Usually reinforced or unreinforced Portland cement concrete, which when cured exhibits high compressive strength but is relatively inflexible

Sandstone - Sedimentary bedrock comprised chiefly of sand sized particles

Saturation – A condition where the pores of soil or rock are completely filled with water

Sedimentary Bedrock – Consolidated sediments of clay, silt or sand

Shrink-Swell Potential – Likelihood that soil or rock may increase or decrease in volume, usually as result of water adsorption and indicated by high plasticity index and/or measured response to inundation

Siltstone - Sedimentary bedrock comprised chiefly of silt sized particles

Site Fill – Soil used to raise the grade of all or a portion of a site to a design elevation, exclusive of structures or buildings

Slab Fill – Soil used to fill above the foundation bearing elevation to the bottom of any special subbase or base soil/aggregate that supports a concrete slab-on-grade

Slab Subbase – Soil that meets a specified gradation requirement or other criteria for placement below a base aggregate

Spread Footing/Foundations – A foundation type that usually consists of a reinforced, cast-in-place concrete that is formed in a round, square, rectangle or continuous strip shape for transferring structural loads to the soil and is placed at certain minimum depths for frost protection or confinement

Stripping Depth – The depth below ground surface that unsatisfactory soil or other materials should be removed before placement of engineered fill or structures

Structural Fill – Soil that meets a specified gradation or other quality or strength criteria for the purpose of raising the ground surface elevation or improving bearing conditions to receive a structure

Subgrade – Soil surface or substrate that will receive pavement, structure, engineered fill, backfill etc.

Synthetic Reinforcement – Specially manufactured fabric, usually as a woven or extruded plastic, used for the purpose of forming a composite with soil or aggregate and adding strength

Synthetic Separation - Specially manufactured fabric, usually as a woven plastic or non-woven fibrous plastic, used for the purpose creating a barrier for the migration of fine-grained soil

Topsoil – Soil that contains organic matter, usually as decayed vegetation and roots, in sufficient quantity that it is compressible, moisture sensitive, or subject to settlement with continued decay

Total Settlement – An estimate of the amount of settlement that may occur over the life of a structure as a result of compression of underlying soil due to the pressure imposed by the structure

Transient Loading – Short term loads applied to a structure, such as from seismic force or wind pressure.

Ultimate Bearing Capacity – An estimate of the bearing pressure applied to a soil stratum that would induce shear failure, without consideration of a factor of safety or limiting settlement

Undisturbed Soil – Soil that is allowed to remain in its natural state without changing moisture content or density

Void Form – A concrete form material for casting a structure which provides support long enough for the concrete to complete curing and gain sufficient strength for the structure to support itself, leaving a void when the form disintegrates with weathering and moisture.

Water Table – The surface of groundwater within saturated soil or rock layers

Weathered Bedrock – Native rock formation that has become delaminated or shows evidence of disintegration as determined and defined by the geotechnical engineer to distinguish a certain stratum for the purposes of the report

GENERAL NOTES - LOG OF TEST BORING/TEST PIT

DESCRIPTIVE SOIL CLASSIFICATION

Grain Size Terminology

Soil Fraction		Particle Size	U.S. Standard Sieve Size
Boulders		Larger than 12”	Larger than 12”
Cobbles		3” to 12”	3” to 12”
Gravel:	Coarse	3/4” to 3”	3/4” to 3”
	Fine	4.76mm to ¾”	#4 to ¾”
Sand:	Coarse	2.00mm to 4.76mm	#10 to #4
	Medium	0.42mm to 2.00mm	#40 to #10
	Fine	0.074mm to 0.42mm	#200 to #40
Silt		0.005mm to 0.074mm	Smaller than #200
Clay		Smaller than 0.005mm	Smaller than #200

Plasticity characteristics differentiate between silt and clay

Relative Density

Term	“N” Value*
Very Loose	0-4
Loose	4-10
Medium Dense	10-30
Dense	30-50
Very Dense	Over 50

Consistency

Term	q_u-tons/sq. ft.
Very Soft	0.0 to 0.25
Soft	0.25 to 0.5
Firm	0.5 to 1.0
Stiff	1.0 to 2.0
Very Stiff	2.0 to 4.0
Hard	Over 4.0

*Note: The penetration number, N, is the summation of blows required to effect two successive 6” penetrations of the 2” split-barrel sampler. The sampler is driven with a 140-pound weight falling 30”, and is seated to a depth of 6” before commencing the standard penetration test.

DESCRIPTIVE ROCK CLASSIFICATION

Engineering Hardness Description of Rock

(not to be confused with MOH’s scale for minerals)

Very Soft	Can be carved with a knife. Can be excavated readily with point of pick. Pieces one inch or more in thickness can be broken with finger pressure. Can be scratched readily by fingernail.
Soft	Can be gouged or grooved readily with knife or pick point. Can be excavated in chips to pieces several inches in size by moderate blows of a pick point. Small thin pieces can be broken by finger pressure.
Medium Soft	Can be grooved or gouged 1/16-inch deep by firm pressure on knife or pick point. Can be excavated in small chips to pieces about 1-inch-maximum size by hard blows of the point of a geologist’s pick.
Medium Hard	Can be scratched with knife or pick. Gouges or grooves to ¼-inch deep. Can be excavated by hard blow of a geologist’s pick. Hand specimens can be detached by moderate blow.
Hard	Can be scratched with knife or pick only with difficulty. Hard blow of hammer required to detach hand specimen.
Very Hard	Cannot be scratched with knife or sharp pick. Breaking of hand specimens requires several hard blows of geologist’s pick.

NOMENCLATURE

Drilling and Sampling

SS	--	Split Barrel (spoon) Sampler
N	--	Standard Penetration Test Number, blows/foot*
ST	--	Thin-walled Tube (Shelby Tube) Sampler
DC	--	Thick-wall, ring lined, drive sampler
C	--	Coring
DP	--	Direct Push Sampler
CS	--	Continuous Sampler (used in conjunction with hollow stem auger drilling)
D	--	Disturbed Sample (auger cuttings, air/wash rotary cuttings, backhoe, shovel, etc.)

Laboratory Tests

USCS	--	Unified Soil Classification System (soil type)
W	--	Water Content (%)
LL	--	Liquid Limit (%)
PL	--	Plastic Limit (%)
PI	--	Plasticity Index (LL-PL) (%)
q_u	--	Unconfined Strength, TSF
q_p	--	Penetrometer Reading (estimate of unconfined strength), TSF
γ_m	--	Moist Unit Weight, PCF
γ_d	--	Dry Unit Weight, PCF
WSS	--	Water Soluble Sulfate (%)
Φ	--	Angle of Internal Friction (degrees)
c	--	Soil Cohesion, TSF
SG	--	Specific gravity of soil solids
S	--	Degree of Saturation (%)
e	--	Void Ratio
n	--	Porosity
k	--	Permeability (cm/sec)

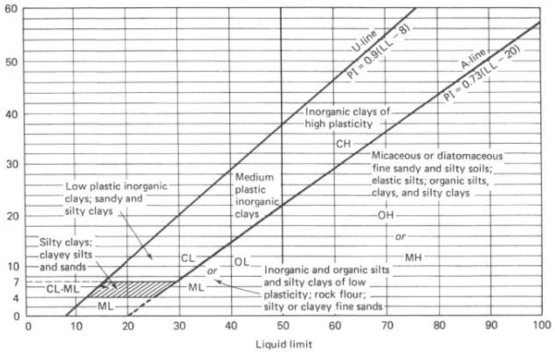
Water Level Measurement

▼	--	Water Level at Time Shown

Note: Water level measurements shown on the boring logs represent conditions at the time indicated, and may not reflect static levels, especially in cohesive soils. The available water level information is given at the bottom of each log.

CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES

ASTM Designation: D2487-69 and D2488-69
(Unified Soil Classification System)

Major Divisions			Group Symbols		Typical Names	Laboratory Classification Criteria			
Coarse-Grained Soils (More than half of material is larger than No. 200 sieve size)	**Gravels** (More than half of coarse fraction is larger than No. 4 sieve size)	**Clean Gravels** (Little or no fines)	GW		Well graded gravels, gravel-sand mixtures, little or no fines	Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows:	Less than 5 % GW,GP, SW, SP More than 12% GM, GC, SM, SC	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{(D_{30})^2}{D_{10}xD_{60}}$ between 1 & 3	
			GP		Poorly Graded gravels, gravel-sand mixtures, little or no fines			Not meeting all gradation requirements for GW	
		Gravels w/ Fines (Appreciable amount of fines)	GM[a]	d	Silty gravels, gravel-sand-silt mixtures			Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
				u					
			GC		Clayey gravels, gravel-sand-clay mixtures			Atterberg limits below "A" line or P.I. greater than 7	
	Sands (More than half of coarse fraction is smaller than No. 4 sieve size)	**Clean Sands** (Little or no fines)	SW		Well-graded sands, gravelly sands, little or no fines			$C_u = \frac{D_{60}}{D_{10}}$ greater than 6; $C_c = \frac{(D_{30})^2}{D_{10}xD_{60}}$ between 1 & 3	
			SP		Poorly graded sands, gravelly sands, little or no fines			Not meeting all gradation requirements for SW	
		Sands w/ Fines (Appreciable mount of fines)	SM[a]	d	Silty sands, sand-silt mixtures			Atterberg limits above "A" line or P.I. less than 4	Limits plotting in hatched zone with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
				u					
			SC		Clayey sands, sand-clay mixtures			Atterberg limits above "A" line or P.I. greater than 7	
Fine-Grained Soils (More than half material is smaller than No. 200 sieve size)	**Silts and Clays** (Liquid limit less than 50)		ML		Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity	**Plasticity Chart**  			
			CL		Inorganic clays of low to medium plasticity, gravelly, clays, sandy clays, silty clays, lean clays				
			OL		Organic silts and organic silty clays of low plasticity				
	Silts and Clays (Liquid limit greater than 50)		MH		Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts				
			CH		Inorganic clays of high plasticity, fat clays				
			OH		Organic clays of medium to high plasticity, organic silts				
	Highly Organic Soils		P_t		Peat and other highly organic soils				

[a] Division of GM and SM groups into subdivision of d and u are for roads and airfields only. Subdivision is based on Atterberg limits; suffix d used when L.L. is 28 or less and the P.I. is 6 or less; the suffix u used when L.L. is greater than 28.

[b] Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. For example: GW-GC, well-graded gravel-sand mixture with clay binder.

Important Information about Your

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply the report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical-engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical-Engineering Report Is Based on a Unique Set of Project-Specific Factors

Geotechnical engineers consider many unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk-management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical-engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light-industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical-engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical-engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, droughts, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ—sometimes significantly—from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations *only* by observing actual subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.*

A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical-engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical-engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical-engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold-prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, many mold-prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical-engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold-prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

Rely, on Your GBA-Member Geotechncial Engineer for Additional Assistance

Membership in the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk confrontaton techniques that can be of genuine benefit for everyone involved with a construction project. Confer with your GBA-member geotechnical engineer for more information.

GBA GEOPROFESSIONAL
BUSINESS
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SUBSURFACE EXPLORATION AND GEOTECHNICAL ENGINEERING REPORT

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