Geotechnical Data Report Colorado Springs Southwestern Region Engineering Geology Study

Yeh Project No.: 217-130

April 18, 2019

Prepared for:

City of Colorado Springs Attn: Tyra Sandy, P.E. 30 S. Nevada Avenue, Suite 401 Colorado Springs, CO 80901

Prepared by:

Yeh and Associates, Inc. 627 Elkton Dr. Colorado Springs, CO 80907

> Phone: 719-434-1643 Fax: 303-781-9583



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Prepared by:

Hai Ming Lim, P.E. Project Manager

Reviewed by:

John Duffy, P.G., C.E.G.

Senior Project Specialist



her and the

Richard D. Andrew, P.G. Vice president

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1. PURPOSE AND SCOPE OF STUDY

The purpose of the Colorado Springs Southwestern Region Engineering Geology study is to compile available data pertaining to existing geotechnical reports, geologic mapping, terrain data, LiDAR data, satellite data, aerial photography, and existing infrastructure into a searchable and scalable digital database. Based on an evaluation of the existing data, a field and subsurface investigation plan was developed which included the installation of groundwater and slope movement monitoring instrumentation. The information contained in the digital data base and monitoring program is intended to be referenced by engineering professionals for the evaluation of future development and the existing facilities. The study was conducted with oversight by the City of Colorado Springs (COS) and Colorado Springs Utilities (CSU) and the guidance and support of the Colorado Geological Survey (CGS). No comparative or interpretive analysis of the information developed for the study presented herein and, in the database, has been made by the delivery team.

This report presents a summary of the data collected, reviewed, and organized in the database developed by Yeh and Associates (Yeh) for the Engineering Geology Study in two areas in the southwestern portion of Colorado Springs along the base of Cheyenne Mountain. Due to the complex geology, poor quality bedrock, topography, existing slope failures, ground water conditions, and site grading, this region has experienced numerous landslides events. Existing landslides range from large, prehistoric to historical, complex nested landslides to recent shallow landslides of various types.

The study areas recently experienced episodes of heavy precipitation (e.g. 1999, 2004, 2013, 2015), leading to the reactivation of existing slides and the development of new landslides. Extended periods of heavy precipitation coupled with late winter/early spring snowmelt (natural seasonal fluctuation) are known to elevate the groundwater system and increase the potential for slope instability.

Multiple geotechnical studies have been performed over the years to evaluate the possible causes of the ground movement. These studies led to the installation of various engineering measures designed to mitigate the ground movement. Several publications and mapping studies, such as the web-based Colorado Landslide Inventory Map maintained by the Colorado Geological Survey and the 2003 Colorado Springs Landslide Susceptibility Map (Published by White and Wait), were completed for the subject areas. These publications generally describe the locations and extents of landslides in the area based on field observations and the interpretation of aerial photographs. In addition, numerous geotechnical investigation reports



were prepared for the development of residential and commercial buildings and their related infrastructure. These reports provide a source for some of the pertinent engineering characteristics of the subsurface materials. All of these sources of information that have been generated over the years contain useful data which can be used to evaluate the subsurface conditions in planned developments and individual building sites. <u>The City's goal is to make the existing data more readily available</u>. This engineering geology study presents this information in <u>a comprehensive geographical information system (GIS) geodatabase</u>. ArcGIS was the platform selected to compile and present the database because of the intuitive mapping and analytical tools, and its compatibility with the GIS system currently used by COS and CSU. The GIS database (geodatabase) can be queried for existing test hole information, geotechnical reports, the classification and locations of the existing landslides, landslide features and geologic conditions within the study area.

The engineering geology study was divided into 3 tasks as summarized below:

Task 1- Existing data compilation and initial catalog of landslide hazards;

Task 2- Field reconnaissance;

Task 3- Geotechnical investigation, data report and installation of monitoring equipment.

A discussion of the services performed in each task and summary of the results and findings are presented in the following sections of this report.

2. AREAS OF STUDY

Two separate areas, located in the southwest portion of Colorado Springs, were included in this study and identified as Area 1 and Area 2. These two subject areas are presented together on Figure A-1, Site Location Plan, and individually on Figures A-3 and A-4 in Appendix A. Area 1 is located in southern portion of the study region, and Area 2 is in the northern portion of the study region. In general, Area 1 is bounded to the south by Cheyenne Mountain State Park, to the west by Cheyenne Mountain and Cheyenne Mountain Air Force Station, to the north by the Broadmoor Golf course, and to the east by Highway 115. In general, Area 2 is bounded to the south by Stratton Open Space, to the west by Cheyenne Mountain and Gold Camp Road, to the north by Bear Creek Park, and to the east by South 8th Street.

3. GEOLOGICAL SETTING AND SITE CONDITIONS

Several geologic maps, site-specific mapping performed by various engineering firms, and landslide susceptibility maps were utilized as the base geology information in the GIS



geodatabase. The definitions and descriptions of the geologic setting were based primarily on two sources: "Geologic map of the Colorado Springs Quadrangle, El Paso County, Colorado" by Christopher J. Carroll and Timothy A. Crawford in Year 2000, and the "Geologic map of the Cheyenne Mountain Quadrangle, El Paso County, Colorado" by Peter D. Rowley, John W. Himmelreich, Jr., Donald H. Kupfer, and Christine S. Siddoway in Year 2003. The geologic units within the study areas are presented in Figure A-2, Geologic Unit Map in Appendix A.

Based on these maps, the major geologic units in Area 1 are as follows:

- Bedrock Units: Pikes Peak granite (Ypp) and Granodiorite (Xgd) near the base of Cheyenne Mountain, and Pierre Shale (Kp) within the eastern portion of Area 1, below the colluvial and alluvial deposits units.
- Colluvial deposits: Colluvium (Qc), Landslide deposits (Qls and Qlsr) along the eastern portion, and portion of the northern section of Area 1.
- Alluvial deposits: Sheetwash (Qsw) are primarily located along the northern section and the eastern portion of Area 1. Pediment gravel 2 (Qg2) is located near the mid-section of Area 1.
- Alluvial fan deposits: Older fan deposits (Qfo, Qfo1, Qfo2, Qfy), older fan and rockfall deposits (Qfro) are located mostly on the western portion, and southern portion of Area
 1. All of These units are located between Cheyenne Mountain and the colluvial and alluvial deposits.

Based on these maps, the major geologic units in Area 2 include the following:

- Bedrock Units: Pierre Shale (Kp) on the eastern portion of Area 2, and below the colluvial and alluvial deposit units.
- Colluvial deposits: Colluvium (Qc) located in the northwest portion of the Area 2.
- Alluvial deposits: Pediment gravel (Qg1, Qg2, Qg3) located near the mid-section and eastern portion of the Area 2, and Sheetwash deposits (Qsw) located on the eastern portion of Area 2.
- Alluvial fan deposits: Older fan deposits (Qfo) located at the western part of Area 2.

The Ute Pass Fault trends in a south to north direction and is located near the base of Cheyenne Mountain, west of the two study areas. In general, both Areas 1 and 2 are sloping to the east. Area 1 represents the majority of the lower elevations located in the northern and



southern sections. The mid-section of Area 1 is generally higher in elevation. Area 2, in general, slopes towards the southeast.

4. PROJECT TASKS

As mentioned above, the services provided for this project have been divided into three tasks. The details of each task are discussed below.

4.1 Task 1

Task 1 included collecting the existing available data, reviewing it for usefulness and accuracy, categorizing the data, and an initial cataloging of the data within a GIS geodatabase. The sources of the data included COS, CSU, CGS, United States Geological Survey (USGS), Pikes Peak Regional Building Department (PPRBD), public publications, and other various geological maps. The data collected, reviewed, cataloged and included in the GIS geodatabase is summarized in Table 1.

Source	Data	Notes
	Study area boundaries	
	City limits	
	Open drainage	
	Land use	Open space, residential areas, commercial areas, etc.
	Parcels	
	Storm inlets	
	Storm basins	
	Storm sewer lines	
City of Colorado Springs	Storm manholes	
	Storm outlets	
	Aerial photos	Year 1998,1999, 2005, 2007, 2010, 2011, 2012, 2014 and 2016
	LiDAR Contours Maps	NAVD29, NAVD88
	LiDAR Hillshade Images	Shaded relief images created from contour maps
	Various geotechnical reports	Available reports and design for residential development and slope stabilization repair.
Colorado Geological Survey	Various geotechnical reports	Available reports reviewed by CGS for residential development

Table 1. Summary of Database Sources



Source	Data	Notes
	DinSAR for Area 1	Ground movement monitoring using satellite images. Performed for Area 1 only.
	USGS Cheyenne Mountain 24k geology map	
	USGS Colorado Springs 24k geology map	
	USGS Manitou Springs 24k geology map	
	Steeply dipping bedrock	
	Recorded landslides	Includes landslide susceptibility map, slides recorded by consultants, slides interpreted from available data.

After collecting, reviewing and cataloging the data, the information was organized into discreet sortable fields, including the data from the various geotechnical reports. The data obtained from the geotechnical reports is summarized and presented in the following fields:

- Test borings and test pits performed by geotechnical engineering consultants with the data that was further organized by depth of boring and depth to bedrock;
- Groundwater monitoring wells (however, only a limited amount of information was available in many of the reports);
- Observed seeps and springs as described in the reports;
- Cross sections used for slope stability analysis performed by various consultants;
- Landslide fissures and other slope features as described in the reports;
- Mapped geologic setting as described in the reports.

The final GIS geodatabase includes a compilation of existing geotechnical reports, where the borehole locations were digitized and geo-referenced along with the surficial geology/soil maps included in this study. The borehole points can be queried in ArcGIS, a GIS program, or related map viewers for subsurface characteristics, provided that they are available in each of the specific geotechnical reports. Other boring point data in the Geotech Borings dataset does not presently have attributed subsurface data but both datasets are relationally linked to a pdf copy of the original geotechnical report embedded into the geodatabase.



4.2 Task 2

After the preliminary GIS geodatabase was constructed, the data was used to identify areas of interest that were prioritized for the field review in Task 2. The field review included mapping of the observed general geological features, landslide features, and the location of seeps. These features where located in the areas that were readily accessible to the field personnel. Satellite based ground movement monitoring was also performed from Year 2015 to 2018 using the "Synthetic Aperture Radar Interferometry Method" (InSAR- SeueeSAR[™]).

The field reconnaissance focused on the following areas on interest:

- Recent or ancient landslide features, e.g. headscarps or bulging toes of landslides.
- Previously recorded landslide areas.
- Land movement observed from LiDAR, DinSAR or documented in the previous geotechnical studies.
- Potential landslides areas, e.g. steep slopes, soft clay formations, springs and seeps.
- Features that may indicate ground movement, e.g. large and long cracks in pavement, settlement on roadway.
- Field verification of existing mapped geology and soil units.
- "To be verified" areas identified during the data review process.

The field reconnaissance and site mapping were recorded with a portable handheld Global Positioning System (GPS) unit with an accuracy of approximately 10 feet. This unit interacted directly with the GIS base maps and database on a portable tablet providing real time field verification. The data was used to confirm the areas of interest and used to develop the scope for Task 3. Since the data was used for verification of the existing data only, they are not included in the GIS database.

Additionally, Yeh partnered with TRE Altamira (TRE) to perform the InSAR- SqueeSAR analysis to monitor the ground movement in both Areas 1 and 2, for the period beginning in November 2014 and ending in March 2018. The SqueeSAR analysis was performed using Sentinel satellite images. The analysis utilized a Rapid Motion Tracking (RMT) algorithm to process the satellite image and develop the relative vertical and east-west movements of the ground. For the purpose of this study, the relative vertical and east-west movements of the ground are calibrated to the NAD 1983 datum. The results of the SqueeSAR are presented electronically and incorporated into the GIS geodatabase.



4.3 Task 3

Task 3 included the geotechnical investigation, installation of monitoring equipment, preparation of the data report, and updates to the GIS geodatabase. After the completion of Tasks 1 and 2, the database was used to evaluate the locations of the geotechnical borings and monitoring instrumentation. The borings were identified based on the past and present recorded landslides, potential of reactivation or future landslides, benchmark for establishing the geological comparisons, and features that require further study including steep slopes, springs or seeps, and areas of potential future development where geotechnical investigation data is lacking. A total of 21 borings were identified, however, two borings were eliminated due to limited access.

4.3.1 Field Exploration Program and Instrumentations

The field exploration included sixteen (16) borings performed with a truck mounted drill rig. The drilling was competed initially with both CME-55 and CME-75 drilling rigs. The borings were advanced with 6 to 10 inches outside diameter hollow-stem auger through the pavement, native soil, and bedrock. The total depth of each of the borings is presented in Table 2.

Soil and bedrock samples were typically obtained at 5 feet intervals in the test borings. Samples were recovered using both Standard Penetration Test (SPT), Modified California barrels (MCal), and Shelby tube samplers. Additionally, a continuous dry core sampler was used to collect the material in between the sampling depth where applicable.

The SPT is a 1.375-inch inside diameter (ID) standard split barrel sampler. Recorded penetration resistance measurements (N-values) were obtained by driving a Standard Penetration Sampler into the subsurface materials with a 140-pound automatic hammer falling 30 inches. The Penetration Resistance (N-value) of a SPT is a useful index to the consistency and relative density or hardness of the materials encountered.

The Modified California Sampler is a 2.5-inch outside diameter (OD), 2.0 inch ID (1.95 inch ID with liners), split barrel sampler with internal liners, as per ASTM D3550. The Modified California Sampler drive length is 12 inches and "Penetration Resistance" refers to the sum of all blows.

The Shelby tube sampling procedure utilizes a thin-walled, steel tube with a sharp cutting edge that is pushed hydraulically into the bottom of the boring to obtain relatively undisturbed samples of cohesive or moderately cohesive soils.



The continuous dry core sampler is a 4-inch ID, split barrel, hollow sampler. The sampler is attached to the drilling head inside the hollow stem and extended slightly beyond the bottom of the hollow stem auger. When the hollow stem auger is cutting through the formation, the sampler will be pushed into the material and collect the material that will be drilled through by the auger. The samples collected are considered as disturbed but are suitable for visual evaluation of the subsurface material and provide a sample for laboratory index testing (moisture content, Atterberg limits). This type of sampler is suitable for soil and soft bedrock (e.g. claystone and soft shale bedrock).

Groundwater level observations were recorded at the completion of drilling, and on a monthly basis for test holes that were utilized for groundwater monitoring. Three types of groundwater monitoring methods were installed for this project. For shallow borings where groundwater was not anticipated, a "poorman" piezometer was installed. This instrumentation utilizes 2-inch outside diameter PVC pipes that were slotted in-house using regular PVC couplers to connect the pipes. For deeper borings where inclinometers were not planned, a 2-inch outside diameter standpipe piezometer manufactured specifically for groundwater monitoring were installed. These pipes were specially manufactured pipes that have a specific number of slots, and allow the pipes to connect firmly through the threads on each end of the pipes. The standpipe piezometers are stronger and maintain the integrity of the well throughout the boring depth. Silica sand and grout were used to fill the annular space and the plug around the pipes, respectively in accordance with Colorado Groundwater Association specifications. For deeper borings where inclinometers were planned, a vibrating wire (VW) piezometer was used to measure groundwater levels. The VW piezometer is used to measure depth to groundwater and corresponding pore pressure by measuring the pressure changes in the sensor. The VW piezometers were tied to the exterior of the piezometer, and a special grout mix was prepared to backfill the annular space around the inclinometers. The grout provides the stiffness required for inclinometer installations, and at the same time, allows the permeation of groundwater to enable the VW piezometer to measure groundwater depth. The observed groundwater depths/elevations are summarized in Table 2.

In selected borings, 2-inch outside diameter inclinometer casings were installed to monitor the rate and depth of potential ground movement. Grooves along the interior of the casing guide the inclinometer probe and gyroscopes inside the probe measure relative tilt in the probe/casing as it translates down and up the casing. Following the installation of the inclinometer casing, initial profiles of the casing were measured. The initial casing profile is used as a benchmark to compare future readings and changes the casing profile relative ground movement. The



available initial readings and the subsequent readings for the inclinometers installed are presented in Appendix D.

The locations of the borings were measured and recorded using a handheld GPS with an accuracy of approximately 10 feet. The borings were then plotted on the contour map to estimate the elevation of the borings.

Borings	DepthsInclinometerG.W.(ft)Depth (ft)Monitoring(ft)Depth (ft)Type andDepth (ft)Depth (ft)		G.W. Readings	Notes	
B1-4 100 100'		VW Piezometer @ 100'	86' @ C.O.D. 47' @ 9-27-18 11' @ 11-9-18 42' @ 12-13-18		
B1-5	49		Poorman @ 50'	Dry @ C.O.D. 13.2' @ 7-30-18 13' @ 9-27-18 13.5' @ 11-9-18 13' @ 12-13-18	
B1-6	40	40'	Standpipe @ 40'	Dry @ C.O.D. 4' @ 7-30-18 N/A @ 9-27-18 3.5' @ 11-9-18 2' @ 12-13-18	
B1-7	32		N/A	N/A	No instrumentation due to drilling refusal.
B1-8	100	100'	VW Piezometer @ 100'	Dry @ C.O.D. Dry @ 7-30-18 83.5' @ 9-27-18 85.5' @ 11-9-18 84' @ 12-13-18	
B1-11.1	105	105'		43' @ 9-27-18 80' @ 11-8-18 45' @ 12-12-18	
B1-11.2	105	105	VW Piezometer Dry @ C.O.D. @ 105' 43' @ 9-27-18		
B1-12	50		Poorman @ 50'	Dry @ C.O.D. 37.6' @ 7-30-18 36' @ 9-27-18 36.5' @ 11-9-18 35' @ 12-13-18	
B1-14	25		Poorman @ 25'	Dry @ C.O.D.	No instrumentation due to drilling refusal.
B1-16	84		Standpipe @ 60'	23' @ C.O.D. 22.6' @ 7-30-18 23' @ 9-27-18 24' @ 11-9-18	

Table 2. Summary of Field Exploration and Instrumentation¹



Borings	Depths (ft)	Inclinometer Depth (ft)	G.W. Monitoring Type and Depth (ft)	G.W. Readings	Notes
				26' @ 12-13-18	
B1-19	75	75'	VW Piezometer @ 75'	Dry @ C.O.D. Dry @ 7-30-18 7.5' @ 9-27-18 7' @ 11-9-18 8' @ 12-13-18	
B2-1	91		Poorman @ 90'	Dry @ C.O.D. 63' @ 9-27-18 64' @ 11-9-18 64' @ 12-13-18	
B2-5	101	100'	VW Piezometer @ 100'	Dry @ C.O.D. 44' @ 9-27-18 46' @ 11-9-18 47.5' @ 12-13-18	
B2-7	100	100'	VW Piezometer @ 100'	Dry @ C.O.D. 68' @ 9-27-18 67.5' @ 11-9-18 67.5' @ 12-13-18	
B2-8	50	50'	VW Piezometer @ 50'	Dry @ C.O.D. 22' @ 9-27-18 22' @ 11-8-18 23' @ 12-13-18	
B2-11	34		Poorman @ 30'	Dr @ C.O.D. Dry @ 7-30-18 31' @ 9-27-18 30' @ 11-9-18 27' @ 12-13-18	

¹ Depths rounded to the nearest whole number. Borings B1- represent borings in Area 1, Borings B2- represent borings in Area 2. The readings are updated monthly. Refer to the GIS database for the latest readings. C.O.D.= Completion of Drilling

4.3.2 Laboratory Testing

The soil and bedrock samples collected during the subsurface exploration were transported to the Yeh laboratory in Colorado Springs. Samples were examined, and a laboratory testing program was developed to evaluate the engineering properties of the subsurface materials. These engineering properties represent the soils in undrained and drained (peak and residual strengths) conditions. Selected soil and bedrock samples were tested to evaluate their engineering properties, using the following tests:

- natural moisture content
- in-situ dry density



- grain size analysis
- Hydrometer test
- Atterberg limits
- Unconfined compression test
- Direct shear test
- Consolidated-undrained triaxial test with pore pressure measurements

The test results are shown on the boring logs and are included in Appendix C. USCS and AASHTO soil classifications for the claystone and shale bedrock presented in the Summary of Laboratory Test Results in Appendix C represent the soil classification of the processed samples for lab testing.

4.4 Continuous Monitoring

A continuous monitoring plan was established to collect the data from the groundwater monitoring devices and the inclinometers installed within Areas 1 and 2 on a monthly basis for a period of 1 year after the installation was completed. The data will be reviewed, interpreted and incorporated into the GIS database until the continuous monitoring is completed. These instrumentations may be left in place or removed as directed by the City of Colorado Springs when the continuous monitoring is completed.

In addition to the continuous monitoring of the instruments, SqueeSAR analysis, based on the satellite imagery, will occur at a 6-month interval for a total length of 12 months. The results of the SqueeSAR will also be incorporated into the GIS database as the information is obtained.

4.5 GIS Database User Guideline

The User Guideline provides a background of the project, general information on the searchable data fields within the geodatabase and the procedures for accessing the data. The GIS geodatabase and User Guideline can be accessed from City of Colorado Springs GIS website at:

https://coloradosprings.maps.arcgis.com/home/signin.html

5. LIMITATIONS

This report was prepared for the exclusive use by the City of Colorado Springs and its designated agencies. Within the limitations of the scope, schedule, and budget, the work presented in this report was performed in accordance with generally accepted principles and



practices in this area at the time this report was prepared. Yeh and Associates makes no other warranty, either express or implied.

The findings presented in this report are based upon data obtained from test borings and instrumentation at indicated locations, field observations, laboratory testing, our understanding of project area, and other sources of information referenced in this report. It is possible that subsurface conditions may vary between or beyond the locations of the test borings. The nature and extent of subsurface variations may not become evident until excavation is performed. Variations in the data may also occur with the passage of time

The scope of work of this study did not include hazardous materials sampling or environmental sampling, investigation, or analysis. In addition, we did not evaluate the site for potential impacts to natural resources, including wetlands, endangered species, or environmentally critical areas.



A-1: SITE LOCATION PLAN A-2: AREA 1 AND 2 GEOLOGIC MAP A-3: AREA 1 BORING LOCATION PLAN A-4: AREA 2BORING LOCATION PLAN





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AREA 1 AND 2	
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Appendix B

GEOTECHNICAL BORING LOGS





Project:

COS Engineering Geology Study

Shelby Tube

Project Number: 217-130

Modified California Sampler

(2.5 inch OD, 2.0 inch ID)

Legend for Symbols Used on Borehole Logs Sample Types



Standard Penetration Test (ASTM D1586)

Auger Cuttings

Lithology Symbols (see Boring Logs for complete descriptions)

Rock Core



Lab Test Standards

Moisture Content	ASTM D2216
Dry Density	ASTM D7263
Sand/Fines Content	ASTM D421, ASTM C136,
	ASTM D1140
Atterberg Limits	ASTM D4318
AASHTO Class.	AASHTO M145,
	ASTM D3282
USCS Class.	ASTM D2487
(Fines = % Passing	#200 Sieve
Sand = % Passing # #200 Sieve)	4 Sieve, but not passing

Other Lab Test Abbreviations

	pН	Soil pH (AASHTO T289-91)
	S	Water-Soluble Sulfate Content (AASHTO T290-91,
/I C136,		ASTM D4327)
	Chl	Water-Soluble Chloride Content (AASHTO T291-91,
		ASTM D4327)
	S/C	Swell/Consolidation (ASTM D4546)
	UCCS	Unconfined Compressive Strength (ASTM D2166)
	R-Value	Resistance R-Value (ASTM D2844)
	DS (C)	Direct Shear cohesion (ASTM D3080)
ssing	DS (phi)	Direct Shear friction angle (ASTM D3080)
	Re	Electrical Resistivity (AASHTO T288-91)
	PtL	Point Load Strength Index (ASTM D5731)

Notes

1. "Penetration Resistance" on the Boring Logs refers to the uncorrected N value for SPT samples only, as per ASTM D1586. For samples obtained with a Modified California (MC) sampler, drive depth is 12 inches, and "Penetration Resistance" refers to the sum of all blows. Where blow counts were > 50 for the 3rd increment (SPT) or 2nd increment (MC), "Penetration Resistance" combines the last and 2nd-to-last blows and lengths; for other increments with > 50 blows, the blows for the last increment are reported.

2. The Modified California sampler used to obtain samples is a 2.5-inch OD, 2.0-inch ID (1.95-inch ID with liners), split-barrel sampler with internal liners, as per ASTM D3550. Sampler is driven with a 140-pound hammer, dropped 30 inches per blow.

3. "ER" for the hammer is the Reported Calibrated Energy Transfer Ratio for that specific hammer, as provided by the drilling company.

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	Co	nsult	ting E	Engine	eers & Sci	entist	S	Project Number: 217-130		Boi	ring l	Vo.:	B1-4	Ļ	
Boring Boring Drilling Driller: Drill Ri Hamm	Began Compl Metho Auther g: CME	: 6/2 eted: d(s): ntic D 5 75	1/201 7/3/2 Hollov Contir vrilling	2018 w-Sten nuous	n Auger / Sampler raulic), ER:	95%		Total Depth: 100.3 ft Ground Elevation: 6329.0 ft Coordinates: Lat: Long: Location: N38.77279, W104.84290 Logged By: L. Southerland Einal By: M Lim			Sym	V II Nool Doth	Veathonclinat Night V Groo ∑ 86.0	er Notes: S tion from H Vork: undwater L	Sunny, Hot oriz.: Vertical .evels:
		Ţ	Ro	ock	Soil Sam	oles		· ······ _ , · ···· _ ····			Da	te Atter	7/3/1 rberg	8	- -
^{20-19.GLB} 4/19/19 Elevation (feet)	Depth (feet)	Sample Type/ Advancement Metho	Recovery (%)	RQD (%)	Blows per 6 in	Penetration Resistance	Lithology	Material Description	Moisture Content (%)	Dry Density (pcf)	Fines Content (%)	Liquid Limit	Plasticity si	AASHTO & USCS Classifi- cations	Field Notes and Other Lab Tests
IBKAKY 2-2	-		31					0.0 - 13.5 ft. fat CLAY, brown, moist, stiff.							
	-	X	90		5-7	12									
- 6320	10-	×	90		6-10	16		- brown with gray below 10.5'	21.0	93.1	95.1	51	30	A-7-6 (31) CH	-
CKUP 2018	-	Î	100		14-16	30		13.5 - 19.5 ft. WEATHERED							
EMPLATE (BA	-		88					CLAYSTONE , gray and brown, soft, moist, high plasticity.							
- 6310 	20-	Ť	<u>100</u>		43-50/5"	50/5"		19.5 - 26.0 ft. CLAYSTONE , gray and brown, medium hard, moist, high plasticity.	_ 15.0						
U 2015 YEH A	-	Ă	0		47-50/3"	50/3"		26.0 - 100.3 ft. SHALE gray, moderately	13.9	120.0	98.0	_51_	32	A-7-6 (34) CH	
6300 - 6300	30-				<u>∖ 50/5"</u> ,	(50/5)		weathered, medium hard, damp.							
	-		0												
	-		59		<u>∖ 50/5"</u> ,	r <u>50/5</u> "/									
	40-		73		\	/ <u>~0//4</u> "									
00KING LOG 2015 211-130					<u>50/4</u> ",	(50/4') (50/3')									45.0 ft - Possible shell fragments in bottom of liner, bagged



	Y	eh a	and	As	sociate	s, Ir	NC.	Project COS Engine	erin	g Ge	eolo	gy S	Study	,	PAGE 1 of 1
	Co	nsult	ing E	ngine	eers & Sci	entist	s	Project Number: 217-130		Во	ring l	No.:	B1-5	;	
Boring Boring Drilling Driller: Drill Ric	Began Compl Method Auther g: CME	: 5/3 eted: d(s): ntic D = 75	1/2018 5/31/ Hollov Contir rilling	3 v-Sten nuous \$	n Auger / Sampler	050/		Total Depth: 49.3 ft Ground Elevation: 6106.0 ft Coordinates: Lat: Long: Location: N38.77815, W104.83655 Logged By: L. Southerland			(Sym Dep	۱ ۱ ۱ ۱ ۱ ۱ ۵ ۵ ۱ ۵ ۵ ۱ ۱ ۱ ۱ ۱ ۱ ۱ ۱ ۱	Weath nclinat Night V dwater	er Notes: S ion from Ho Vork: Levels: No	t Observed
Hamme	er Type	: Au	Iomau	c (nya		95%		Finai By: M. Lim			Da	te	-		-
Elevation (feet)	Depth (feet)	Sample Type/ Advancement Method	Recovery (%)	RQD (%)	Blows per 6 in	Penetration 800 Resistance	Lithology	Material Description	Moisture Content (%)	Dry Density (pcf)	Fines Content (%)	Liquid Limit	Plasticity stiu	AASHTO & USCS Classifi- cations	Field Notes and Other Lab Tests
1								-0.0 - 0.5 ft. 6" ASPHALT.							
	-		8					light brown, wet to moist, medium stiff to very stiff							
8-					1-4	5		101 ₂ 0un.	25.6	96.9	90.1	63	44	A-7-6 (43)	
- 6100	-		43												
	10-		100						20.4	104.3	94.7	50	31	A-7-6 (32) CH	
	-	X			9-19	28		- olive brown below 11'.							
	-		100		15.00	27		14.0 - 19.5 ft CLAYSTONE grav	-						
- 6090	-	Î	100		15-22	37		medium hard.							
	20-	Ц Ц			30-50/5"	50/5"		19.5 - 49.3 ft. SHALE , gray,							
	-				~ 50/6" /	-50/6"/-		weathered, soft to medium hard.							
- 6080	-	{{													
	30-	Ł			50/6"	- <u>50/6</u> "/									
_	-	5]			<u>∖ 50/5"</u> /	- 50/5"⁄r									
6070	-														
	40-	P }			50/5"	50/5"									
- 6060	-	R			∖ <u>5</u> 0/5" /	τ <u>ου/5</u> "/									
					\ 50/4" /	50/4"/		Bottom of Hole at 49.3 ft.							

		Ye	eh a	and	As	sociate	s, Ir	NC.	Project COS Engine	eerin	g Ge	eolo	gy S	study	,	PAGE 1 of 1
'		Cor	nsult	ing E	ngine	eers& Sci	entist	S	Project Number: 217-130		Bo	ring l	Vo.:	B1-6	i	
	Boring Boring Drilling	Began Compl Methoo	: 6/1 eted: d(s):	/ 2018 6/4/2 Hollo\	2 018 w-Sten	n Auger /			Total Depth: 40.3 ft Ground Elevation: 6192.0 ft Coordinates: Lat: Long:				١	Veathe nclinat	er Notes: S	Sunny, Clear oriz.: Vertical
	Ū		()	Contir	nuous	Sampler			Location: N38.77082, W104.83466				1	Night V	Vork: 🗌	
	Driller:	Auther	ntic D	rilling								(Groun	dwater	Levels: No	ot Observed
	Drill Rig	: CME	75						Logged By: L. Southerland			Sym	bol oth	-		
	Hamme	er Type	: Au	tomati	c (hyd	raulic), ER:	95%		Final By: M. Lim			Da	te	-		
	_		/ ethod	Ro	ock	Soil Sam	oles					nt	Atte Lir	rberg nits		_
0-19.GLB 4/19/19	Elevatior (feet)	Depth (feet)	Sample Type Advancement Me	Recovery (%	RQD (%)	Blows per 6 in	Penetration Resistance	Lithology	Material Description	Moisture Content (%	Dry Densit (pcf)	Fines Conte (%)	Liquid Limit	Plasticity Index	AASHTO & USCS Classifi- cations	And And Other Lab Tests
Z-Z 7									0.0 - 0.6 ft. ASPHALT.	-						
JS LIBKAR	-6190	_		6					0.6 - 19.0 ft. fat CLAY , dark brown, moist, stiff, granitic gravels, some iron concretions.							
-105			X			4-6	10		- Sand seams @ 5'.							
-19) - CUPY		_		100												
2018-09-		10-		88		0.50/2"	50/2"									
	-6180		2			9-50/2	50/2		- brown below 11', presence of cobbles and large boulders.							12.5 ft - Auger
EMPLATE		_	\$													initial boring due to large boulders, relocated to north
DCIATES T		_	ł													side of cul-de-sac
		20-							19.0 - 35.0 ft. CLAYSTONE , dark gray, medium hard, moist.	1						
J 2015 YE	-6170	_		26												
-1.5.		-				10.20	19	7								
C LLC			$\widehat{}$			19-29	40	7								
LCK L				100				$\overline{\mathcal{A}}$								
2901						50/5"	50/5"	$\mathbb{Z}_{\mathcal{T}}$								
ט צוצ		30-	Þ			50/5"	+ <u>50/5</u> "/									
	- 6160]}					/ _/								
SIUL	0100		1					$\overline{\mathcal{A}}$								
0.50		-						$\overline{7}$								
0 9 9		-	\square			50/6"	<u>+50/6"</u> /		35.0 - 40.3 ft. SHALE , dark gray, moderately weathered, medium hard,							
20			$\left\{ \right\}$						fissile , moist.							
17-130			$\left\{ \right\}$													
115 2		40-	\mathcal{E}			∖ 50/4" ,	- 50/4"/		Bottom of Hole at 40.3 ft.							
BURING LUG 2	- 6150															

		eh a	and	As	sociate	s. Ir	NC.	Project COS Engine	eerin	g Ge	eolo	gy S	study	1	PAGE 1 of 1
	Co	nsult	ing E	ngine	eers & Scie	entist	s	Project Number: 217-130		Bo	ring l	No.:	B1-7	,	
Boring Boring Drilling	Began Compl Metho	: 6/5/ eted: d(s):	2018 6/5/2 Hollov Contir	018 v-Sten	n Auger / Sampler			Total Depth: 32.0 ft Ground Elevation: 6439.0 ft Coordinates: Lat: Long: Location: N38.76111, W104.83202				/ 	Veath nclinat Night V	er Notes: S ion from H Vork: 🔲	Sunny, Clear oriz.: Vertical
Driller:	Auther	ntic D	rilling								(Groun	dwate	Levels: No	ot Observed
Drill Ri	g: CME	E 75						Logged By: L. Southerland			Sym	bol oth	-		
Hamm	er Type	: Aut	omati	c (hyd	raulic), ER:	95%		Final By: M. Lim	1	1	Da	te	-		
_		/ ethod	Ro	ock	Soil Samp	oles					nt	Atte Lin	rberg nits		
Elevation (feet)	Depth (feet)	Sample Type Advancement Me	Recovery (%	RQD (%)	Blows per 6 in	Penetration Resistance	Lithology	Material Description	Moisture Content (%	Dry Density (pcf)	Fines Conte (%)	Liquid Limit	Plasticity Index	AASHTO & USCS Classifi- cations	Field Notes and Other Lab Tests
								0.0 - 0.3 ft. 4" ASPHALT.							
	-		49					brown and dark brown, medium plasticity, damp, loose to medium dense.							
					4-7	11									
	-		68												
61-60-0	-							- cobbles @ 8'.						A 2 6 (1)	
5-6430	10-		100		0.47	05			7.1	107.9	24.4	29	16	SC	
	-	Î	46		8-17	25		11.0 - 21.0 ft. clayey SAND trace of large gravel layers, brown, moist, medium dense to dense.							
	-	\mathbf{X}			16-9-18	27			8.3		45.3	39	20	A-6 (5) SC	
	-		34												
6420	20-	\boxtimes			10-13-34	47									
- -	20		100				$\overline{\langle f \rangle}$	21.0 - 32.0 ft. GRAVEL and cobbles with	-						
	-							boulders, brown, very dense.							
	-	}			50/6"	50/6"									
6410	30-	$\left \right\rangle$			22-50/4"	50/4"	0.00								
deor		K					<u>y</u> öq	Bottom of Hole at 22.0 ft							32.0 ft - Auger
															refusal possibly in boulders, terminated @ 32'.
- 6400															

		Ye	eh a	and	As	sociate	s, Ir	NC.	Project COS Engine	erin	g Ge	eolo	gy S	tudy	/	PAGE 1 of 2
	Δ	Coi	nsul	ting E	ngine	eers& Scie	entist	s	Project Number: 217-130		Во	ring l	Vo.:	B1-8	8	
Во	oring	Began	: 6/7	/2018					Total Depth: 100.3 ft				V	Veath	er Notes: C	Clear, Hot
Bo	oring	Compl	eted	: 6/8/2	2018				Ground Elevation: 6297.0 ft				l	nclinat	tion from H	oriz.: Vertical
Dri	illing	Method	d(s):	Hollo	<i>w</i> -Sten	n Auger /			Coordinates: Lat: Long:							
				Contir	nuous	Sampler			Location: N38.76729, W104.83394				۱ -	light V	Vork:	
Dri	iller:	Auther	ntic D	Drilling								(Svm	<u>Groun</u>	dwater	r Levels: No	ot Observed
Dri	ill Rig	: CME	275		. ///		05%		Logged By: L. Southerland			Dep	oth	-	-	-
На	mme	r Type	: Au	tomati	c (hyd	raulic), ER:	95%		Final By: M. Lim			Da	te	-		-
	_		/ thod	Ro	ock	Soil Samp	oles					ιt	Atter Lin	berg nits		
/ ¹⁹	Ĵ.	î, th	Type ht Me	%)	(%	Playes	ion Ce	ogy		ure t (%	nsity f)	ontei)		/	AASHTO	Field Notes
eVa	(fee	Jep (fee	nple	/ery	6) 0	per	etral star	thol	Material Description	<i>loist</i> nten	y De	es Co (%	fuid mit	sticity dex	Classifi-	Other Lab
B.GLB	i	_	Sai	00	RQ	6 in	ene			° °	þ	Fine	L C	Plas	cations	Tests
-20-1			Ă	Ř												
ARY 2		_		0					0.5 - 14.0 ft. fat CLAY, brown and gray,							
			IJ			01.10	10		moist, hard to stiff, iron concretions, possible calcareous infilling.							
ő_			$\hat{\Box}$			21-19	40									
	200	_		100												
	290	_														1000-0210pcf
-19) -		10-		85						24.5		95.0	54	35	A-7-6 (36) CH	0000=0219psi
18-09			X			4-6	10									
UP 20				100												
BACK		_	\mathbf{X}			13-28	41		14.0 - 20.0 ft. CLAYSTONE, gray -							
ATE (I		_		100				Z,	brown to gray, medium hard, moist, possible calcareous infilling.							
74W	280	_						Z-								
		20-		_100_		19-35	54			17.0	112.8		48	30	A-7-6 (33)	
		20	$\widehat{\Box}$						20.0 - 44.0 ft. SHALE , dark gray, moderately weathered, medium hard, high							
I ASS(_		50					plasticity.							
5 YEH		_				50/6"	50/6"/									
J 201		_		44												
65 – 61 E	270	_														
- POR						50/6"	50/6"/									
OR R		30-		100												
DGSF		_		100												
NGLO		_				50/6"	50/6"/									
BOR		_	5													
6	260		5													
		_	R													
		40	+			ر50/5" ر	5 0/5"/									
S GE		-	5													
		-	K							-						
217-10						34-20	54	É7	44.0 - 48.0 π. CLATSIONE , black, predominantly decomposed, hard, moist,	12.4	<u>99</u> .7	100.0	79	56	A-7-6 (65)	
6-012	250			100				É7	high plasticity, possible landslide deposits.						<u> </u>	
002		_	Η			50/5" _/	50/5"/		48.0 - 100.3 ft. SHALE, dark gray,	1						
SING		50 —		100					moderately weathered, medium hard, fissile damp, high plasticity.							
BOF				100					- possible perched water zone from							



		Υe	eh a	and	As	sociates	s, Ir	IC.	Project COS Engine	eerin	g Ge	eolo	gy S	tudy	,	PAGE 1 of 2
		Cor	nsult	ing E	ngine	eers& Scie	entist	S	Project Number: 217-130		Во	ring l	No.:	31-1	1.1	
	Boring	Began	: 7/2	/2018					Total Depth: 100.3 ft				V	Veath	er Notes: S	Sunny, 80 °F
	Borina	- IamoD	eted:	7/2/2	018				Ground Elevation:				h	nclinat	ion from H	oriz.: Vertical
	Drilling	Methor	d(s).	Hollov	w-Sten	n Auger /			Coordinates: Lat: Long:							
	Drining	mouno	u(0).	Contir		Samplor			Location:				Ν	liaht V	Vork. 🗌	
	Drillori	Author	atia D	rilling	luous	Gampler			Location.					Cro		avalar
	Driller.	Auther		ming								Svm	bol	 ⊈		evels.
	Drill Rig	I: CME	: /5						Logged By: L. Southerland			Dep	oth	63.0	ft .	
	Hamme	er Type	: Au	tomati	c (hyd	raulic), ER:	95%		Final By: M. Lim			Da	te	7/5/1	8	
ſ			ро	Ro	ock	Soil Samp	oles						Atter	berg		
	Ę		/eth	(%			⊂ ə	N			ity	tent	Lin	nits		Field Notes
9/19	et)	et)	ent	y ('	(%)	Blows	atio		Material Description	nt (ens cf)	Sont ()	_	ty	& USCS	and
3 4/1	(fe	(fe	cem	ver	D	per	etra ista	itho	Material Description	Mois	م ا	es (quid	stici dex	Classifi-	Other Lab
9.GLE	Ш		Sa	0 CO	RO	6 in	en			⁻ ö	ā	ц	μ	Pla	cations	lests
20-19			Ă	Re			ם נג									
3 Υ 2-				~					0.0 - 9.0 ft. clayey SAND with decomposed granite gravel layers brown							
BRAF				0					to red, damp, medium dense.							
JS LI						7-11	18									
СС			Ĥ													
.GD		-		60												
COP		_														
9) - (6			\mathbf{X}			6-6	12		9.0 - 13.5 ft. sandy lean CLAY, brown,	-						
-09-1		10-							damp, stiff.							
2018		-		83												
KUP						0.0	10		12 E 21 0 ft condu CDAVEL	4						
BAC			Â			8-8	10	•	decomposed granite with clay layers,							
ATE (-		35					brown to gray, damp, dense.							
MPL																
S TE						33-17	50									
IATE		20-														
soc		_		53					21.0 - 34.0 ft. clayey SAND with gravel,							
EH AS									reduish brown, damp, medium dense.							
15 YE		-	\frown			11-8	19									
J 20		-		69												
T.GP.				00					- dark brown below 27'.							
POR						No record	No									
RE		30-					record									
S FO				80												
LOG																
SING			M			8-13	21	6Ô	34.0 - 59.0 ft. GRAVEL and cobbles,	1						
BOR		_		77				$\tilde{\mathbf{D}}$	decomposed granite with clay seams, brown and red, moist medium dense to							
γdυ								RO	very dense.							
C ST		-	5[$\dot{9}$								
LOGI		40-	K			50/15"	50/15	\dot{b}								
GEO			K				<u> [2/11</u>]	Kö								
SOC			$ \mathcal{V} $					[90]								
130_(-	1)}					$\dot{\mathbf{b}}$								
217-			15			<u> 50/1.5" /</u>	50/1.5	<u>B</u> .O.								
015			ſςĹ					[90]								
0G 2		-	K					0.01								
NG L		50-	U2			40.07	10	ßŏ								
ORIF			\frown			13-35	48	90								
ш							L	いじん		_	1	l				1

		Y	′e	ha	and	As	sociate	s, Ir	NC.	Project COS Engine	eerin	g Ge	eolo	gy S	tudy	,	PAGE 2 of 2
		С	on	sult	ing E	ngine	ers& Scie	entist	s	Project Number: 217-130		Во	ring l	Vo.:	B1-1	1.1	
				poq	Ro	ck	Soil Samp	les					t	Atter	berg		
	Elevation (feet)	Depth		Sample 1 ype/ Advancement Met	Recovery (%)	RQD (%)	Blows per 6 in	Penetration Resistance	Lithology	Material Description	Moisture Content (%)	Dry Density (pcf)	Fines Conten (%)	Liquid Limit	Plasticity Index	AASHTO & USCS Classifi- cations	Field Notes and Other Lab Tests
JDY BORING LOGS FOR REPORT.GPJ 2015 YEH ASSOCIATES TEMPLATE (BACKUP 2018-09-19) - COPY.GDT COS LIBRARY 2-20-19.GLB 4/19/19	Eleva	60 ∑ 70 80 90			100 100 100 100 100 100		BIOWS per 6 in 50/5" / 40-50/4" 50/6" / 50/6" / 50/6" / 50/4" / 50/4" /	50/4" 50/4" 50/6" 50/6" 50/6" 50/6" 50/4" 50/4" 50/4"		Material Description 34.0 - 59.0 ft. GRAVEL and cobbles, decomposed granite with clay seams, brown and red, moist, medium dense to very dense. (continued) 59.0 - 66.0 ft. CLAYSTONE, dark gray with brown, hard, moist. 66.0 - 100.3 ft. SHALE, dark gray, moderately weathered, medium hard, fissile moist to damp. - hard below 78'. Battem of Hala at 100.2 ft	Moist	Dry De	Fines Co	Timir 47	Plasticity Plasticity Index	A-7-6 (27) CL	Other Lab Tests
BORING LOG 2015 217-130_COS GEOLOGIC STUL							\ <u>50</u> /4" /	- <u>50/4</u> '/		Bottom of Hole at 100.3 ft.							

	Y	eh a	andAs	soci	ate	s, Inc.	Project COS En Name:	ginee	ring	g Ge	eolo	gy S	study	1	PAGE 1 of 3
	Co	nsult	ing Engin	eers &	k Sci	entists	Project Number: 217-130			Bo	ring I	Vo.:	B1-1	1.2	
Boring	Began	: 8/16	5/2018				Total Depth: 105.3 ft					١	Neath	er Notes: S	Sunny, Clear, 80
Boring	Comp	leted:	8/17/2018				Ground Elevation: 6258.0 ft					c	F		
Drilling	Metho	d(s):	Hollow-Ster	m Aug	er		Coordinates: Lat: Long:					I	nclinat	ion from He	oriz.: Vertical
Driller:	Authe	ntic D	rilling				Location: N38.75727, W104.82343	3				1	Night V	Vork: 🗌	
Drill Rig	g: CME	E 75									(Groun	dwate	· Levels: No	ot Observed
Hamme	ər Type	e: Aut	omatic (hyd	draulic)	, ER:	95%	Logged By: L. Southerland				Sym	bol			
							Final By: M. Lim				Dep	te	-	-	
		pot	Soil Sam	ples								Atte	rberg		
u (/pe/ Meth		L 8	gy			و	a (%)	sity	itent	LII		AASHTO	Field Notes
/ati	eet)	le T) nent	Blows	atic	00		Material Description	it i	ent	Den: ocf)	Cor %)	ч с	×äty	& USCS	and
	ľa €	Samp	per 6 in	neti	Lif			M	Sont))	ines (Lim	astic Inde	cations	Tests
5 — 8		Adva	0 111	Pe Re						_	Ē	_	⊡		
17-7 1					<u></u>	_ <u>0.0 - 0.3 ft.</u> T	TOPSOIL with grass rootlets.								
	-	٢J				0.3 - 10.0 ft. clay seams	. poorly graded SAND with gravel and decomposed granite gravels reddish								
	-	1				brown, damp	ip, loose.								
3-6255	-	K													
<u> </u>	-	K													
3	5 -		3-4	7											
- (8)	-	\square													
	-	۱													
6250	-	ſζ													
	-	17													
	10-	X	6-10	16		10.0 - 20.0 ft	ft. poorly graded SAND, with clay layer	rs							
	-	\square				brown, damp	ip, medium dense.								
	-														
6245		ſ													
	15-	5													
		\mathbb{N}	5-5-5	10											
	_	ĥ													
R 6240	_	ſζ													
	_	5													
	20-	H				00 0 05 0 8									
	-	X	4-7-8	15		20.0 - 25.0 π very stiff.	r. sandy lean CLAY, dark brown, mois	7	7.7		30.4	32	15	A-2-6 (1) SC	
	-													-	
2 6235		$\left \left\{ \right\} \right $													
		51													
	25-	K	~ -			25.0 - 39.0 #	ft noorly graded SAND with								
	-		6-1	13		decomposed	ed granite gravels, reddish brown, mois	st,	1.9		11.7	24	1	A-2-4 (0)	
		5				meaium den	nse.								
6230	-	K													
Š-	-	$ \mathcal{V} $													
	30-	РY				- dark brown	n below 30'.	-						A-1-h (0)	
		\square	6-6-9	15				2	2.5		10.4	23	5	SW-SC	
	-	H													
6225	-														
	-	אן													
ō		$ \mathcal{E} $		1	1							J	1		





	Ye	eh a	and	As	sociate	s, Ir	IC.	Project COS Engine	eerin	g Ge	eolo	gy S	study	,	PAGE 1 of 1
	Co	nsult	ting E	ngin	eers& Sci	entist	s	Project Number: 217-130		Во	ring l	No.:	B1-1	2	
Boring	Began	: 6/6	/2018					Total Depth: 49.5 ft				١	Neath	er Notes: S	Sunny, Hot, Clear
Boring	Compl	eted:	6/6/2	018				Ground Elevation: 6128.0 ft				I	nclinat	ion from H	oriz.: Vertical
Drilling	Metho	d(s):	Hollov	v-Sten	n Auger /			Coordinates: Lat: Long:							
		()	Contin	nuous	Sampler			Location: N38.76286. W104.82186				1	Night V	Vork: 🗌	
Driller:	Auther	ntic D	rillina					,				Groun	dwater	· Levels: No	ot Observed
Drill Rid	a. CME	75	5					Logged By: I Southerland			Sym	ibol			
Hamme	er Type	· Au	tomati	c (hvd	raulic) FR [.]	95%		Final By: M Lim			Dep	oth	-	-	
								· ····			Da	te	-		
_		/ thod	Ro	OCK	Soli Samp	bies				_	nt	Lir	nits		
t)	E 🕀	Type t Me	%)	()		c o) go		line %) (Inter			AASHTO	Field Notes
fee	lee lee	ple 7	ery	6) (Blows	tan		Material Description	oistu itent	pcf Der	s Cc (%)	it nic	icity ex	& USCS Classifi-	Other Lab
		Sam) N	g	6 in	enel	Li		ΩĞ	Dry	ine	Liqu	last	cations	Tests
2.81-		Adv	Sec.	œ		ግ ኤ					ш		<u>а</u>		
			_					\0.0 - 0.3 ft. 4" ASPHALT .	1						
			47				\///	0.3 - 14.0 ft. lean CLAY with gravel, gray, moist, stiff to very stiff							
					6-8	14									
3															
- -			58												
6120	_					47		tura nasta in complex 🔿 🖓							
- (e	10				8-9	1/		- tree roots in sampler @ 8.							
	10-		20												
	-														
	_		83						17.8	110.3	90.0	47	33	A-7-6 (30)	UCCS=14017psf
					6-12	18		14.0 - 24.0 ft. lean CLAY , light brown with orange, moist, very stiff.						CL	
<u>-</u>	-	\square	100		-										
6110	-		100		6 12	19									
_ 	20-	Î			0-12	10									
	20		95												
-	-														
<u>-</u>	-		67				K	24.0 - 27.0 ft poorly graded GRAVE	15.0	111.2	62.7	37	24	A-6 (12)	
6102		\succ			50/2"	50/2"	\circ \circ	light brown, moist, very dense.							1
2			100				$\frac{1}{2}$	27.0 40.0 # CLAVSTONE alive	-						
6100	-				10-29	39	7	medium hard to hard.							
	30-						7								
E			70				$\frac{1}{7}$								
	-				0.4 =0.40	= 0 (0)	$\frac{1}{7}$								
	-				21-50/6"	50/6"	7								
	_		100				\angle								
							\angle								
- 6090	-	$\mathbf{ imes}$			25-50/5"	50/5"	7								
	40-						<u> </u>	40.0 - 50.0 ft. SHALE dark grav	-						
	_		100					moderately weathered, medium hard.							
3					50/5"	-50/5"									
	-	\square	100												
	-	ſζ													
	_	17													
		K			50/5"	50/5"									
						20137		Bottom of Hole at 49.5 ft.	-						
2															

Yeh and Associates, Inc.								Project COS Engineering Geology Study Name:							PAGE 1 of 1
	Co	nsult	ting E	ngin	eers& Sci	entist	S	Project Number: 217-130	Boring No.: B1-14						
Boring Began: 6/18/2018								Total Depth: 25.0 ft		Weather Notes: Overcast, 60 F					
Boring	Compl	eted:	6/18/	2018				Ground Elevation: 6109.0 ft	Inclination from Horiz.: Vertical						oriz.: Vertical
Drilling Method(s): Hollow-Stem Auger /								Coordinates: Lat: Long:							
Continuous Sampler								Location: N38.75436, W104.82055 Night Work:							
Driller: Authentic Drilling									Groundwater Levels: Not Obs					ot Observed	
Drill Rig: CME 75								Logged By: L. Southerland			Symbol				
Hamme	Hammer Type: Automatic (hydraulic), ER: 95%							Final By: M. Lim	By: M. Lim Depth						
		g	Ro	ock	Soil Samples							Atte	rberg		
Elevation (feet)	Depth (feet)	Sample Type/ Advancement Meth	(%) (%)	RQD (%)	Blows per 6 in	Penetration Resistance	Lithology	Material Description	Moisture Content (%)	Dry Density (pcf)	Fines Content (%)	Liquid Limit	Plasticity Index	AASHTO & USCS Classifi- cations	Field Notes and Other Lab Tests
			ĽĽ.					_ 0.0 - 0.5 ft. 6" ASPHALT.							
-	-		0					0.5 - 18.0 ft. fat CLAY , gray and brown, moist, medium stiff to very stiff.							
6105					3-4	7		- iron staining @ 3.5'.							
	5 -				0 1	·									
	-		65												
- 6100 -	- 10-		100												
-	-				6-10	16		- with gravels below 10.5'.	15.3	108.8	71.2	50	32	A-7-6 (21) CH	
-	-		100												
-	-		100												
6095	-	\mathbf{X}			10-15	25									
	15		100												
6090	_		0		50/6"	50/6"	7	18.0 - 25.0 ft. CLAYSTONE , gray mottled with brown, hard, calcite infilling,							
i –	20-						4	iron staining, concretions.							
	-		83												
6085	-				32-50/5"	50/5"									
	-25		0				7	Bottom of Hole at 25.0 ft.							25.0 ft - Refusal at
- - - 6080															25', possible large boulders
- 6075															
		eh	and	As	sociate	s. Ir	IC.	Project COS Engine	eerin	g Ge	eolo	gy S	Study	/	PAGE 1 of 2
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	Co	nsul	ting E	ngin	eers & Sci	entist	s	Project Number: 217-130		Bo	ring	No.:	B1-1	6	
Boring Boring Drilling	J Bega J Comp J Metho	n: 6/1 Dieted Dd(s):	8/2018 : 6/19 Hollov	3 / 2018 w-Ster	n Auger / Sampler			Total Depth: 83.5 ft Ground Elevation: 6334.0 ft Coordinates: Lat: Long:				/ 	Weath nclinat	er Notes: tion from H Vork: □	Sunny, 70F oriz.: Vertical
Driller:	Authe	entic E	Drilling	10000	oumpion								Gro	undwater L	evels:
Drill Ri	g: CM	E 75	•					Logged By: L. Southerland			Sym	nbol	∑		
Hamm	er Typ	e: Au	tomati	c (hyd	raulic), ER:	95%		Final By: M. Lim			De Da	oth Ite	24.0 6/18/	π 18	
		pou	Ro	ock	Soil Sam	ples	-				+	Atte	rberg		
Elevation (feet)	Depth (feet)	Sample Type/ Advancement Metl	Recovery (%)	RQD (%)	Blows per 6 in	Penetration Resistance	Lithology	Material Description	Moisture Content (%)	Dry Density (pcf)	Fines Conten (%)	Liquid Limit	Plasticity Index	AASHTO & USCS Classifi- cations	Field Notes and Other Lab Tests
7-7 1 2							0 ¥	0.0 - 0.5 ft. 6" ASPHALT.							
			0					clay, reddish brown, damp, medium dense							
6330					8-8	16		lo dense.							
		-	32					- approxiamtely 1' of clay layer @ 5'.							
		\square					°								
- (61-6	10-	17			9-10	10		9.0 - 19.0 ft. clayey SAND, reddish	00	123 1	37.6	32	18	A-6 (2)	-
0-8L0		\square			9-10	13		brown, medium plasticity, damp, medium dense.	5.5	120.1	57.0	52	10	SC	
		1)}													
6320					7-11	18									
		7													
 		-]}													
	20-				12-21	33	0 0 0 0	19.0 - 28.0 ft. poorly graded GRAVEL, reddish brown damp medium dense	1						
ASSU		H						· · · · · · · · · · · · · · · · · · ·							
	∇	K					0								
	-				10-14	24									
		H					000								
		H						28.0 - 59.0 ft. clayey SAND trace of							
P-	30-				11-15	26		gravels, reddish brown, low plasticity, damp, medium dense to dense.	9.6	119.8	18.7	29	14	A-2-6 (0)	
		-17							9.7						
6300		H													
					9-13	22									
]{[
		17													
1 2 2	40-				17-22	39									
5 <u>-</u> R		-{[
6290		11													11000 700maf
G102					17-19	36			9.7						occo=iacha
		5													
		K													



	Ye	eh a	and	As	sociate	s, Ir	NC.	Project COS Engine	erin	g Ge	eolo	gy S	Study	1	PAGE 1 of 2
	Coi	nsult	ting E	ingine	eers& Sci	entist	S	Project Number: 217-130		Bo	ring l	Vo.:	B1-1	9	
Boring Boring Drilling	Began Compl Methoo	: 6/4 eted: d(s):	/ 2018 6/4/2	2 018 w-Sten	n Auger /			Total Depth: 75.0 ft Ground Elevation: 6245.0 ft Coordinates: Lat: Long:				١	Veathe nclinat	er Notes: S ion from Ho	Sunny, Clear oriz.: Vertical
		()	Contir	nuous	Sampler			Location: N38.76896, W104.83405				1	Night V	Vork: 🗌	
Driller:	Auther	ntic D	rilling								(Groun	dwater	Levels: No	ot Observed
Drill Rio	g: CME	75						Logged By: L. Southerland			Sym	bol oth	-	-	
Hamme	er Type	: Aut	tomati	c (hyd	raulic), ER:	95%		Final By: M. Lim	1	1	Da	te	-		-
		/ ethod	Ro	ock	Soil Sam	oles					nt	Atte Lin	rberg nits		
CO-TU-GLB 4/19/19 Elevation (feet)	Depth (feet)	Sample Type Advancement Me	Recovery (%	RQD (%)	Blows per 6 in	Penetration Resistance	Lithology	Material Description	Moisture Content (%	Dry Densit) (pcf)	Fines Conter (%)	Liquid Limit	Plasticity Index	AASHTO & USCS Classifi- cations	Field Notes and Other Lab Tests
								0.0 - 0.3 ft. 4" ASPHALT. /	-						
	_		63					stiff.							
	-	X			13-20	33									
6240	_		45												
- (91-19) -	_							7.0 - 17.0 ft. fat CLAY trace of gravels, brown and olive gray, moist, very stiff, with							
207	10-		100		13 20	22		some non concretions.	15.7	100.4	04.2	53	20	A-7-6 (31)	
	-	Î	100		13-20				10.7	103.4	54.2	55	23	<u> </u>	
		\downarrow			7 4 4	01									
≝ 21 – 6230					7-14	21									
OCIAI			100												
	_							17.0 - 35.0 ft. CLAYSTONE , brown and dark brown, predominantly decomposed,							
			100					firm to medium hard, moist to wet, medium to high high plasticity.				49	27		
	20-	\mathbf{X}			13-22	35									
	_		100												
NOT 2		X			8-16	24									
90-9020 90-9020 90-9020	_		100						27.9	94.5		56	34	A-7-6 (35) CH	
	-														
	20	\mathbf{X}			12-23	35									
	30-		95												
	-														
130_0	-	X			18-28	46			16.7		98.8	49	28	A-7-6 (31)	
-/12 5019 51/- - 6210	-		88				Ϋ́ Ζ Ζ Ζ,	35.0 - 54.0 ft. CLAYSTONE , dark gray, medium hard to very hard, moist, medium to high plasticity.						<u> </u>	
					33-50/3"	50/3"	\angle								
29							-/-								



		Υe	eh a	and	As	sociate	s, Ir	NC.	Project COS Engine	erin	g Ge	eolo	gy S	tudy	/	PAGE 1 of 2
		Cor	nsult	ing E	ngin	eers& Scie	entist	S	Project Number: 217-130		Bo	ring l	No.:	B2-1		
	Boring	Began	5/1	6/2018	3				Total Depth: 90.5 ft				V	Veath	er Notes: S	Sunny, warm
	Boring	Compl	eted:	5/16/	2018				Ground Elevation: 6537.0 ft				h	nclinat	ion from H	oriz.: Vertical
	Drilling	Method	d(s):	Hollov	w-Sten	n Auger /			Coordinates: Lat: Long:							
				Contir	nuous	Sampler			Location: N38.82031, W104.87654				١	Night V	Vork: 🗌	
	Driller:	Vine L	abora	atories									Groun	dwatei	⁻ Levels: No	ot Observed
	Drill Rig	: CME	55						Logged By: S. White			Sym	nbol	_		
	Hamme	er Type	: Aut	tomati	c (hyd	raulic), ER:	90%		Final By: M. Lim			Da	te	-		_
	_		/ thod	Ro	ock	Soil Samp	oles					nt	Atter Lin	rberg nits		
/19	ition st)	ft ft	Type nt Me	(%	(%	Plowe	tion	ogy		ure it (%	f)	ontei)		/	AASHTO	Field Notes
4/19,	eva (fee	Jep (fee	nple	/ery) 0	per	etral star	thol	Material Description	Aoist nten	y De	ss Co (%	fuid mit	ticit) dex	Classifi-	Other Lab
9.GLB	Ξ		Sai dvanc	eco/	RQ	6 in	Pene			≥ °	à	Fine	L C	Plas	cations	Tests
2-20-1			Ă	Å					0.0 - 0.7 ft. 4" ASPHALT over 4" base							
RARY	_	_							0.7 - 13.0 ft. silty SAND with gravels,]						
S LIBF	_			86					dense, decomposed granite, occasional							
Ö	_	_							2" granite clasts.							
γ.GD		_				15-15	30									
- COF	- 6530	_		100												
9-19)	_	10														
2018-0	_	10-	X			10-11-13	24									
KUP:	_	_														
E (BAC		_		100					13.0 - 25.0 ft. clayey SAND , brown with orange, medium plasticity, damp, medium							
PLATE	_		\times			10-11-13	24		dense.	2.6		44.3	31	17	A-6 (3)	
S TEM	-6520		\square												<u> </u>	
IATES	_	_		57												
SSOC		20-	\checkmark			6-7-6	13									
ҮЕН А	_	_	\bigcirc	100		010	10									
2015 \	-			70												
GPJ	_		\searrow			6-5-7	12		25.0. 34.0 ft silty SAND with gravels	-						
- INO	- 6510	_	\bigcirc						brown with orange, damp, medium dense.							
R REI	0310	-														
SS FC	_	30-														
G LOC	_	00	imes			8-10-13	23			0.4		12.0	NV	NP	A-2-4 (0)	
ORIN	_	_		100												
JDYE		_		100					34.0 - 50.0 ft. sandy lean CLAY with	-						
IC S II	_		\times			10-8-8	16		variable amounts of gravel and sand, brown, damp, very stiff to hard.							
DLOG	- 6500		Ĩ						, , , ,							
S GE	_			91												
30_CC	_	40-	\searrow			11-13-13	26									
217-15			\square													
2015	-			100												
LOG	_					0.0.0	47									
RING	- 6490		\bigtriangleup			୪-୨-୪	17									
D D D	0.00							V////								



ſ		Ye	eh a	and	As	sociate	s, Ir	IC.	Project COS Engine Name:	eerin	g Ge	eolo	gy S	tudy	1	PAGE 1 of 2
		Cor	nsult	ting E	ngine	eers & Sci	entist	S	Project Number: 217-130		Во	ring l	Vo.:	B2-5	5	
	Boring	Began	: 5/2	9/2018	3				Total Depth: 100.5 ft				V	Veathe	er Notes: F	Partly Cloudy
	Boring	Compl	eted	5/31/	2018				Ground Elevation: 6227.0 ft				l	nclinat	ion from H	oriz.: Vertical
	Drilling	Method	d(s):	Hollov	w-Sten	n Auger /			Coordinates: Lat: Long:							
				Contin	nuous	Sampler			Location: N38.81538, W104.85350				١	Night V	Vork: 🗌	
	Driller:	Auther	ntic D	rilling								(Groun	dwater	Levels: No	t Observed
	Drill Rig	: CME	75						Logged By: L. Southerland			Der	bol oth	-		_
	Hamme	er Type	: Au	tomati	c (hyd	raulic), ER:	95%		Final By: M. Lim			Da	te	-		-
			poq	Ro	ock	Soil Samp	oles					t	Atter	berg		
61/61/t	vation eet)	epth eet)	ple Type/ ment Met	ery (%)	(%)	Blows	ration tance	lology	Material Description	bisture tent (%)	Density (pcf)	s Conter (%)	iid iit	city ∋x	AASHTO & USCS Classifi-	Field Notes and Other Lab
-19.GLB	Ele (†		Sam Advance	Secove	RQD	6 in	Penet Resis	Lith		Con	Dry	Fines	Ligu	Plasti Inde	cations	Tests
7 Z-ZL	_			<u> </u>		<u> </u>		////	\0.0 - 0.3 ft. 4" ASPHALT.	-						
BRAR		-		14					0.3 - 12.0 ft. lean CLAY trace of gravel, gray - brown, moist, stiff to very stiff, iron							
	-	_	\mathbf{H}			4-6	10		concretions.							
	-	_														
PY.G	-6220			90												
)- (_	_				8-13	21									
-09-19	_	10-														
2018-		_		100					12.0 - 17.0 ft. fat CLAY olive grav	-						
d N	-	_				9-19	28		moist, very stiff.	20.4	107.3	97 4	51	34	A-7-6 (35)	
= (BA(-		$\widehat{\prod}$									••••	•	0.	CH	
ЧЧ	-6210			100					17.0 - 33.0 ft CLAYSTONE olive brown	4						
LEM	_	_	$ \cup $			20-43	63	7	and gray, medium hard to very hard,							
AIES		20-	$\widehat{\Box}$			2010		$\overline{/}$	moist.							
SOC	-	_						7								
EH A	-					30-50/5"	50/5"	\mathbb{Z}_{p}								
015 Y	-		Î			30-30/3	30/3	\mathbb{Z}_{p}								
5PJ 2	- 6200	-		100				$\mathbb{Z}_{\mathcal{F}}$								
DRI .C		_				07 50/01	50/0"			10.4	-		40	00	A 7 C (22)	
REP	-	30-				37-50/6	50/6	/		13.1	-		49	30	A-7-6 (32) CL	
5 FOR	-	_		100												
-OG	-					50/48	50/4	/	33.0 - 100.5 ft. SHALE , gray to dark	-						
RING	-	_				/	20/4 /		gray, hard to very hard, fissile , damp.							
N BO	- 6100	-		36												
STUL	0130	_				50/48	50/48									
OGIC	-	40-				50/4"/	<u>50/4</u> '/									
- EOL	-			94												
cos	-															
-130	_					\50/4" /	50/4"/									
112 0		-		83												
3 201	-6180	_														
бГО	-	E0				50/4"/	50/4"/									
NIXO NIXO	-	50-		100												
чL							1			1	1					



		ΙYe	eh a	and	As	sociate	s, Ir	IC.	Project COS Engine	erin	g Ge	eolo	gy S	tudy	,	PAGE 1 of 2
	X.	Со	nsult	ing E	ngine	eers& Sci	entist	S	Project Number: 217-130		Bo	ring l	Vo.:	B2-7	,	
Во	ring	Began	6/1	9/2018	3				Total Depth: 100.2 ft				V	Veath	er Notes: S	Sunny, 90 F
Во	ring	Compl	eted:	6/20/	2018				Ground Elevation: 6266.0 ft				l	nclinat	ion from H	oriz.: Vertical
Dri	lling	Method	l(s):	Hollov	v-Sten	n Auger /			Coordinates: Lat: Long:							
				Contir	uous	Sampler			Location: N38.81183, W104.85411				١	Night V	Vork: 🗌	
Dri	ller:	Auther	ntic D	rilling								(Groun	dwater	Levels: No	t Observed
Dri	ll Rig	: CME	75						Logged By: L. Southerland			Sym	bol			
На	mme	er Type	: Aut	omati	c (hyd	raulic), ER:	95%		Final By: M. Lim			Dep	oth te	-	-	-
-			q	Ro	ock	Soil Sam	oles						Atter	berg		
Ģ			letho	(%				>			۲ <u>۲</u>	ent	Lin	nits		Field Notes
atio	et)	et)	ent N	y (º	(%)	Blows	ation Ince	bolo	Material Description	sture nt (%	ensi cf)	Conte 6)		ţ	& USCS	and
	(fe	De (fe	ample	ver	D D	per	etra ista	itho	Material Description	Mois	D ğ Z	es (%	quid imit	stici	Classifi-	Other Lab
Щ а			Sa dvan	eco	RO	6 in	en Res			- ŭ	ā	Fin		Pla	Cations	Tests
L-0Z-			Ā	Å					0.0 14.0 ft candy CRAVEL raddiah							
				40				٥.Qd	brown, dry, medium dense to loose.							
								0.0 0.0								
3-		-	X			10-10	20	ەن ن								
- 62	260	-						0.0 0.0								
9. YHU				24				ە:Co								
5 								0.0 0.0								
-15		10-	\checkmark			3-5-2	7	٥Ċ٩								
- 18		-	दी					0.0. 0.0.1								
			Śζ					¢.⊖°								
			Ł						14.0 - 19.0 ft. lean CLAY , gray - brown, moist medium stiff]					A 7 6 (30)	15.0 ft presence
≝⊢62	250	-	\land			3-5-2	7			11.8		97.2	46	29	CL	of boulders @ 15', auger refusal in 2
		-		100												previous borings
2		20-				00.04	54	<i>—</i>	19.0 - 39.0 ft. CLAYSTONE, gray,	-						
AUCIA		20				23-31	54	Ź	medium hard, medium plastcity, moist, waxy.							
ASSA –		-		100				ZŹ	Calcareous infilling @ 22'.							
<u>_</u>		_						Ź,					44	24		
6	240	_	\mathbf{X}			20-33	53	Z,								
[49]	_ 10			100				ZŹ								
						25-32	57	ΣŹ								
Ц Х –		30-						\square	- possible bentonite seam @ 29'.							
		_		95				\square								
LOG			IJ			00.01	4.4	\Box								
SNIX N						20-24	44	\angle								
G 26/262	230	-		98				\square								
		_							Possible perched water zone from							
		10	\sim			<u>√</u> 50/5" _/	[50/5]"/		38.5-44'.	5.8						38.5 ft - possible perched water zone
		40-		83					moderately weathered, hard to very hard,							from 38.5'-44'
		-							tissile , medium to high plasticity.							
5 9 -						50/4"/	50/4"									
	220															
	22U			89												
12		-				50/F"	-50/5"									
		50 -				00/3										
BOR				93												

	<u>Y</u>	eh	and	As	sociate	s, Ir	NC.	Project COS Engine	eerin	g Ge	eolo	gy S	tudy	/	PAGE 2 of 2
	Co	nsul	ting E	ngine	eers& Sci	entist	S	Project Number: 217-130		Во	ring l	Vo.:	B2-7	•	
		pod	Ro	ock	Soil Sam	ples					ıt	Atter Lin	rberg nits		
Elevation (feet)	Depth (feet)	Sample Type/ Advancement Met	Recovery (%)	RQD (%)	Blows per 6 in	Penetration Resistance	Lithology	Material Description	Moisture Content (%)	Dry Density (pcf)	Fines Conter (%)	Liquid Limit	Plasticity Index	AASHTO & USCS Classifi- cations	Field Notes and Other Lab Tests
					50/6"	50/6"		39.0 - 100.2 ft. SHALE , dark gray, moderately weathered, hard to very hard,							
- 6210			82		<u></u>			fissile , medium to high plasticity. <i>(continued)</i>							
9/19					→ 50/4 "	d-50/4"/						46	29	A-7-6 (30) CL	
-19.GLB 4/1	60-		89		(
12-2		H			50/6"	,50/6"/									
6200 -			87												
Y.GUI	70-	Ħ			<u>√</u> 50/5"	(<u>50/5</u> "/									
19) - COP			87												
					∖50/4"	/† <u>50/4</u> "/									
			94												
	80-	Ħ			50/5"	7 <u>50/5</u> "/									
			85												
- I					∖50/4"	/ 5 0/4"/									
[∦] ⊢6180			96												
G107 C	00-				50/3"	<u>50/3</u> "/									
	90-		85												
		P			∖ 50/4"	(<u>50/4</u> "/									
-6170		łł													
	100	K													
	106				∖ 50/2"	1 <u>50/2</u> "/		Bottom of Hole at 100.2 ft.	1	I			I	ļ	
5 6160															
217-130															
1 2015															

	Y	eh a	andAs	soci	ate	s, Inc.	Project COS Name:	Enginee	ering	g Ge	eolo	gy S	Study	1	PAGE 1 of 1
	Co	nsult	ing Engin	eers&	& Sci	entists	Project Number: 217-13	0		Boi	ring l	Vo.:	B2-8	8	
Boring	Began	: 5/17	7/2018				Total Depth: 50.3 ft					١	Weath	er Notes: S	Sunny
Boring	Compl	eted:	5/29/2018				Ground Elevation: 6178.0 ft					I	Inclinat	tion from H	oriz.: Vertical
Drilling	Metho	d(s):	Hollow-Ster	n Aug	er /		Coordinates: Lat: Long:								
		(Continuous	Samp	ler		Location: N38.81143, W104.8	5246				1	Night V	Vork: 🗌	
Driller:	Vine L	abora	atories								(Groun	dwater	Levels: No	ot Observed
Drill Rig	9: CME	55					Logged By: M. Boyd				Sym	bol			
Hamme	er Type	: Aut	omatic (hyd	raulic)), ER:	90%	Final By: M. Lim				Dep	te	-		
		thod	Soil Samp	les							It	Atte Lir	rberg nits		
Elevation (feet)	Depth (feet)	Sample Type, Advancement Me	Blows per 6 in	Penetration Resistance	Lithology		Material Description	:	Moisture Content (%)	Dry Density (pcf)	Fines Conter (%)	Liquid Limit	Plasticity Index	AASHTO & USCS Classifi- cations	Field Notes and Other Lab Tests
17-7			1-6	10		_0.0 - 0.8 ft. 6	6" ASPHALT over 4" base.								
	-	\bigcirc	3-3-5	8		0.8 - 6.5 ft. le	lean CLAY with gravel, brown, dan	np,							
		\bigotimes	3-4-6	10		Sun.									
5		ĘŻ						-							
	-	\bigtriangleup	7-7-6 5 °	13		65-260ft	loan CLAY olive moist stiff to ve	anv	5.0						
6170	-	\bigcirc	3-4-6	10		stiff.		siy	17 0	-	87.1	42	26	A-7-6 (22)	
- (<u>8</u> 1	10	\bigotimes	7-9-8	17				-	12.3		76.0	40	24	CL A-6 (17)	
-20-20-20-20-20-20-20-20-20-20-20-20-20-	10-	5								-				CL	
	-	ſζ													
	-	L		10				-	00.0	100.1					
- (BA		\bigcirc	5-5 5-7-8	10				-	20.2 17 9	100.1	74 1	45	27	A-7-6 (19)	
S,	-	\bigotimes	010	10				-		-	74.1		21	CL	
<u>-</u> 6160	-	5													
	20-		6-7	13											
		X	5-5-7	12		- brown and	gray to dark brown below 21'.								
DOCH T	-	X	5-6-6	12											
	-		5-9	14											
	-	\square	5-8-13	21		00 0 04 5 6			15.2	Ĩ	96.8	43	27	A-7-6 (27)	
5.		$[\Sigma]$			ÉZ	hard, moist,	, medium plasticity.	um –		Ì					
6150	-	\bowtie	19-27-29	56	É7										
	30-	\bigcirc	11-19	30 58	ĘΖ										
	-	$ \ge $	<u>11-20-30</u> <u>50/5</u> γ	50/5"/		31.5 - 50.3 ft	ft. SHALE, dark gray to black, very	hard,							
2		K				very friable/	/platy.								
	-	5	<u>50/5</u>	50/5 "/											
		$ \mathcal{Y} $	\ <u>50/4</u> *	<u>50/4</u> 7											
6140	-	łł	م 50/4" ر	50/4"/											
		¥		50/5"/											
	40-	K													
2	-	ጘ	ر50/5	 50/5"/											
5 2-	_	5	E0/4"	-E0/4"											
		Л	<u>50/4</u> /	<u>טיש ('4')</u>											
<u>e</u>	-	1)}													
^R 6130	-	ſς													
	50-	5	50//"	5011											
			\ <u>50/4</u> "/	<u>φυ/4</u> '/			Bottom of Hole at 50.3 ft.								

	ΙYe	eh a	andAs	soci	ate	s. Inc.	Project COS Er	nginee	erin	g Ge	eolo	gy S	study	/	PAGE 1 of 1
	Cor	nsult	ting Engin	eers &	& Sci	entists	Project Number: 217-130			Bo	ring l	Vo.:	B2-1	1	
Boring	Began	: 5/1	5/2018				Total Depth: 34.3 ft				<u></u> g.	N N	Veath	er Notes: 0	Clear to P.
Boring	Compl	eted	5/15/2018				Ground Elevation: 6155.0 ft					(Cloudy	,	
Drilling	Metho	d(s):	Hollow-Ster	m Aua	er		Coordinates: Lat: Long:					I	nclinat	tion from H	oriz.: Vertical
Driller	Minal				••								light V		
Driller:	vine L	apora	atories				Location: N38.80914, W104.8508	51					Night V		
Drill Rig	J: CME	55									(<u>Groun</u>	dwate	r Levels: No	ot Observed
Hamme	er Type	: Au	tomatic (hyd	draulic)), ER:	90%	Logged By: R. Desterhouse				Sym	bol			
							Final By: M. Lim					otn to	-		· -
							-				Da		-	i .	
		poq	Soil Samp	ples	-						t	Attei	rberg nits		
- LO		'pe/ Met		E e	∑				e %)	sity	ten			AASHTO	Field Notes
et)	et)	ent y	Blows	atic	Ö		Material Description		stur int (ens cf)	Con %)	_	Ę	& USCS	and
fe l	(fe	nple Sem	per	sta	[권		Material Description		<i>l</i> lois inte	у р) se (°)	mit	stici dex	Classifi-	Other Lab
Ξ	_	Sal /anc	Ġ in	ene					∠ °	ŗ	-ine	드드	las Inc	cations	Tests
		Adv		لم بر							_		<u> </u>		
7-2		12				0.0 - 12.0 ft.	t. lean CLAY, brown, moist, stiff to very	y							
- HA	-	ζl				stiff, presen	nce of organic materials.								
	_	И			V///										
3	_	15													
5		ζL													
5.		X	5-11	16											
6150	5 -	3													
	-	5													
2	_	И													
	_	15													
		5													
	-	X	5-16	21											
∯−6145	10-	\Rightarrow	6 17	22	V///			F	10.0	111 0	05.5	40	33	A-7-6 (34)	
	-	\Leftrightarrow	0-17	23				-	10.0	111.0	95.5	49	- 55	CL`´	
	_	\bigtriangleup	8-15	23											
		\mathbf{X}	12-11-15	26	\approx	12.0 - 15.0 f	IT. WEATHERED CLAYSTONE , olive mposed firm to medium hard moist								
		$\overline{5}$			\approx	calcareous	streaks, rust staining.								
	-	Ń	15-32	47	×										
°2 − 6140	15-				Ň	15.0 - 28.0 f	ft. CLAYSTONE, olive gray to dark								
	-	Х	12-19-30	49		brown, med	dium hard to hard, moist, some sandst	tone							
<u>6</u>	_	Ţ			Ľ,/	interbeds, c	calcareous streaks, rust staining.								
		$\overline{\mathbf{A}}$	26-50/3"	50/3"	ÉZ										
5		\searrow	25-40-50/4"	50/4"	<u> </u>										
	_	$\overline{1}$			ΙŹ-	- crystallized	ed wood chip in sample @ 19'.								
- 6135	20-	5			Z,										
	-	\downarrow													
2-	_	۱J			ĻΖ.										
ב 		5			É,Z										
		\downarrow			\vdash										
			50/6"	50/6"	Γ,										
6130	25-	И			Ζ,										
	-				\vdash										
	_	ςι			É										
		H			ÉZ										
3		}				28.0 - 34.3 f	ft. SHALE, dark gray, medium hard.								
		Ŕ	50/5"	50/5"											
<u>-</u> 6125	30-	K													
7	-	$ \rangle$													
	_	ſί													
3		K													
		$ \rangle$													
<u>s</u>	\vdash		50/4" /	¹ 50/4"/			Bottom of Hole at 34.3 ft.							ļ	<u> </u>
11	1														

Appendix C

LABORATORY TEST RESULTS



	Yeh a	nd As	ssocial	tes, In	<u>c.</u> Sı	umma	ry of l	_abo	orato	ory T	es	t Res	ults				
Project N	lo:	217-130) Pr	oject Na	me: _(COS En	gineerir	ng Ge	ology	Stud	y, C	olorado	o Springs, Colo	rado			
Samp	le Locati	on	Natural	Natural		Gradatior	า	A	tterber	g		Water		Linconf		Classifi	cation
Boring No.	Depth (ft)	Sample Type	Moisture Content (%)	Density (pcf)	Gravel >#4 (%)	Sand (%)	Fines < #200 (%)	LL	PL	ΡI	pН	Soluble Sulfate (%)	% Swell (+) / Consolidation (-)	Comp. Strength (psf)	R-Value	AASHTO	USCS
B1-4	8.5	SH	21.0	93.1			95.1	51	21	30						A-7-6(31)	СН
B1-4	10.5	MC	20.8														
B1-4	19.0	CORE	15.0														
B1-4	23.5	MC	13.9	120.0			98.0	51	19	32						A-7-6(34)	СН
B1-5	4.0	MC	25.6	96.9			90.1	63	19	44						A-7-6(43)	СН
B1-5	9.0	SH	20.4	104.3			94.7	50	19	31						A-7-6(32)	СН
B1-7	8.5	SH	7.1	107.9			24.4	29	13	16						A-2-6(1)	SC
B1-7	13.5	SPT	8.3				45.3	39	19	20						A-6(5)	SC
B1-8	8.5	SH	24.5				95.0	54	19	35				8219		A-7-6(36)	СН
B1-8	19.3	MC	17.0	112.8	0.0	0.0		48	18	30						A-7-6(33)	CL
B1-8	45.0	MC	12.4	99.7	0.0	0.0	100.0	79	23	56						A-7-6(65)	СН
B1-11.1	77.0	CORE	10.8					47	23	24						A-7-6(27)	CL
B1-11.2	20.0	SPT	7.7				30.4	32	17	15						A-2-6(1)	SC
B1-11.2	25.0	MC	1.9				11.7	24	23	1						A-2-4(0)	
B1-11.2	30.0	SPT	2.5		17.0	72.6	10.4	23	18	5						A-1-b(0)	SW-SC
B1-11.2	40.0	SPT	16.6				41.6	30	16	14						A-6(2)	SC
B1-11.2	45.0	MC	16.3				51.3	39	16	23						A-6(8)	CL
B1-12	13.0	SH	17.8	110.3			90.0	47	14	33				14017		A-7-6(30)	CL
B1-12	23.0	SH	15.0	111.2			62.7	37	13	24						A-6(12)	CL
B1-14	10.5	MC	15.3	108.8			71.2	50	18	32						A-7-6(21)	СН
B1-16	9.5	MC	9.9	123.1			37.6	32	14	18						A-6(2)	SC
B1-16	29.5	MC	9.6	119.8			18.7	29	15	14						A-2-6(0)	SC
B1-16	30.0	CORE	9.7														
B1-16	44.5	MC	9.7											796			
B1-16	59.5	MC	19.7	111.1			83.2	50	16	34						A-7-6(28)	СН

	Yeh a	nd As	SSOCIA	tes, In	<u>c.</u> Sı	umma	iry of l	_abo	orato	ory T	es	t Res	ults				
Project N	lo:	217-130) Pr	oject Na	me: _(COS En	gineerir	ng Ge	ology	Stud	y, C	olorado	o Springs, Colo	orado			
Samp	le Locati	on	Natural	Natural		Gradatio	า	A	tterbei	g		Water		Unconf		Classifi	cation
Boring No.	Depth (ft)	Sample Type	Moisture Content (%)	Dry Density (pcf)	Gravel >#4 (%)	Sand (%)	Fines < #200 (%)	LL	PL	ΡI	pН	Soluble Sulfate (%)	% Swell (+) / Consolidation (-)	Comp. Strength (psf)	R-Value	AASHTO	USCS
B1-16	68.5	MC						81	18	63							
B1-19	9.5	MC	15.7	109.4			94.2	53	24	29						A-7-6(31)	СН
B1-19	18.5	SH						49	22	27							
B1-19	24.5	CORE	27.9	94.5				56	22	34						A-7-6(35)	СН
B1-19	33.5	MC	16.7				98.8	49	21	28						A-7-6(31)	CL
B1-19	43.5	MC	14.9	114.7			98.3	49	20	29						A-7-6(31)	CL
B1-19	44.5	CORE															
B1-19	48.5	MC						82	18	64							
B1-19	60.0	MC	18.5	106.9				54	20	34						A-7-6(37)	СН
B2-1	15.0	SPT	2.6				44.3	31	14	17						A-6(3)	SC
B2-1	30.0	SPT	0.4				12.0	NP	NP	NP						A-2-4(0)	
B2-1	50.0	SPT	1.8				12.6	25	13	12						A-2-6(0)	SC
B2-5	13.5	MC	20.4	107.3			97.4	51	17	34						A-7-6(35)	СН
B2-5	28.5	MC	13.1					49	19	30						A-7-6(32)	CL
B2-7	15.0	SPT	11.8				97.2	46	17	29						A-7-6(30)	CL
B2-7	23.5	SH						44	20	24							
B2-7	38.5	MC	5.8														
B2-7	58.0	CORE						46	17	29						A-7-6(30)	CL
B2-8	5.0	SPT	5.0														
B2-8	7.5	SPT	17.0				87.1	42	16	26						A-7-6(22)	CL
B2-8	9.0	SPT	12.3				76.0	40	16	24						A-6(17)	CL
B2-8	14.0	MC	20.2	100.1													
B2-8	15.0	SPT	17.9				74.1	45	18	27						A-7-6(19)	CL
B2-8	25.0	SPT	15.2				96.8	43	16	27						A-7-6(27)	CL
B2-11	10.0	MC	18.8	111.8			95.5	49	16	33						A-7-6(34)	CL



	Yeh and Consulting	Associates, Inc. Engineers & Scientists	ATTERBERG LIMITS	FIGURE
Project No. Drawn By: Checked By:	217-130 Dan Ming	Date: 4/19/2019 Yeh Lab: COS	COS Engineering Geology Study Colorado Springs, Colorado	C - 1



	Yeh and A Consulting E	Associates, Inc.	ATTERBERG LIMITS	FIGURE
Project No. Drawn By: Checked By:	217-130 Dan Ming	Date: 4/19/2019 Yeh Lab: COS	COS Engineering Geology Study Colorado Springs, Colorado	C - 2



Yeh and Associates, Inc. Consulting Engineers & Scientists			ATTERBERG LIMITS	FIGURE
Project No. Drawn By: Checked By:	217-130 Dan Ming	Date: 4/19/2019 Yeh Lab: COS	COS Engineering Geology Study Colorado Springs, Colorado	C - 3



	Yeh and A Consulting E	Associates, Inc.	SIEVE ANALYSIS	FIGURE
Project No. Drawn By:	217-130 Dan	Date: 4/19/2019 Yeh Lab: COS	COS Engineering Geology Study Colorado Springs, Colorado	C- 4
Checked By:	Ming			



	Yeh and A Consulting En	Associates, Inc.	SIEVE ANALYSIS	FIGURE
Project No. Drawn By:	217-130 Dan	Date: 4/19/2019 Yeh Lab: COS	COS Engineering Geology Study Colorado Springs, Colorado	C- 5
Checked By:	Ming			



	Yeh and A Consulting Er	Associates, Inc.	SIEVE ANALYSIS	FIGURE
Project No. Drawn By:	217-130 Dan	Date: 4/19/2019 Yeh Lab: COS	COS Engineering Geology Study Colorado Springs, Colorado	C- 6
Checked By:	Ming			



	Yeh and A Consulting E	Associates, Inc.	SIEVE ANALYSIS	FIGURE
Project No. Drawn By: Checked By:	217-130 Dan Ming	Date: 4/19/2019 Yeh Lab: COS	COS Engineering Geology Study Colorado Springs, Colorado	C- 7



X	Yeh and A Consulting E	Associates, Inc.	SIEVE ANALYSIS	FIGURE
Project No. Drawn By:	217-130 Dan Ming	Date: 4/19/2019 Yeh Lab: COS	COS Engineering Geology Study Colorado Springs, Colorado	C- 8
Спескей ву:	wing			



	Yeh and A Consulting E	Associates, Inc.	SIEVE ANALYSIS	FIGURE
Project No. Drawn By:	217-130 Dan	Date: 4/19/2019 Yeh Lab: COS	COS Engineering Geology Study Colorado Springs, Colorado	C- 9
Checked By:	Ming			



	Yeh and A Consulting En	Associates, Inc.	SIEVE ANALYSIS	FIGURE
Project No. Drawn By:	217-130 Dan	Date: 4/19/2019 Yeh Lab: COS	COS Engineering Geology Study Colorado Springs, Colorado	C- 10
Checked By:	Ming			



	Yeh and L Consulting E	Associates, Inc.	SIEVE ANALYSIS	FIGURE
Project No. Drawn By: Checked By:	217-130 Dan Ming	Date: 4/19/2019 Yeh Lab: COS	COS Engineering Geology Study Colorado Springs, Colorado	C- 11



Vertical Loads were applied for Project Request



Vertical Loads were applied for Project Request







Consolidation Pressures and/or Normal Loads were applied per Project and/or Client Request



Consolidation Pressures and/or Normal Loads were applied per Project and/or Client Request Classification is based on Visual Classification Method Soil

Tested By: E.Arapi/T.Reid





Tested By: E.Arapi/T.Reid

Checked By: Y.Lee

Appendix D

INCLINOMETER RESULTS



Boring B1-4 A-axis Orientation: 25° (A+) to 205° (A-)



Boring B1-6 A-axis Orientation: 105° (A+) to 285° (A-)


Boring B1-8 A-axis Orientation: 331° (A+) to 151° (A-)





Boring B1-11 A-axis Orientation: 175° (A+) to 355° (A-)

Boring B1-19 A-axis Orientation: 35° (A+) to 215° (A-)



Boring B2-5 A-axis Orientation: 100° (A+) to 280° (A-)



CS B2_5 B

Boring B2-7 A-axis Orientation: 140° (A+) to 320° (A-)



CS B2_7 B

Boring B2-8 A-axis Orientation: 175° (A+) to 355° (A-)



Boring KLF-B A-axis Orientation: 160° (A+) to 340° (A-)



Boring KLF-R A-axis Orientation: 160° (A+) to 340° (A-)



Appendix E

PHOTOS OF DRY CORE SAMPLES



				_
Boring No. B1-4	Sam	ple Dep	oths*	
Row 1 Sample Descriptions:	0'-3.5'			
Row 2 Sample Descriptions:	3.5'-8.5'			
Row 3 Sample Descriptions:	8.5'-13.5	5'		
Row 4 Sample Descriptions:	13.5'-18	.5'		
				_





'-130 8/2018	Dry Core Soil Samples	BORING
1L	Deptn: 0'-18.5'	
A	Engine gring Coolegy Study	R1_4
	Colorado Springs, CO	

Poring No. B1 / Sample Dopthe*	
Row 1 Sample Descriptions: 33.5'-38.5'	
Row 2 Sample Descriptions: 38.5'-43.5'	
Row 3 Sample Descriptions:	
Row 4 Sample Descriptions:	





-130	Dry Core Soil Samples	BORING
8/2018	Depth: 33 5'-43 5'	
IL	Deptil: 55.5-45.5	
A		R1_/
	Engineering Geology Study	
	Colorado Springs, CO	

Boring No. B1-6	Sam	nple Dep	oths*
Row 1 Sample Descriptions:	4'-9'		
Row 2 Sample Descriptions:	11'-14'		
Row 3 Sample Descriptions:	14'-19'		
Row 4 Sample Descriptions:	19'-24'		





-130	Dry Core Soil Samples	BORING
8/2018	Dry Core Soll Samples	
L	Depth: 4 -24	
A		R1_6
	Colorado Springs, CO	

Boring No. B1-7	Sam	nple Dep	oths*
Row 1 Sample Descriptions:	0'-3.5'		
Row 2 Sample Descriptions:	3.5'-8.5'		
Row 3 Sample Descriptions:	8.5'-13.5	5'	
Row 4 Sample Descriptions:	13.5'-18.5'	18.5'-23.5'	





-130	Dry Core Soil Samples	BORING
8/2018	Dopth: 0' 22 5'	
IL	Deptil. 0 -23.5	— / —
A	Engineering Coolegy Study	R1_7
	Colorado Springs, CO	

Boring No. B1-8	Sample Dep	oths*
Row 1 Sample Descriptions:	3.5'-8.5'	
Row 2 Sample Descriptions:	8.5'-13.5'	
Row 3 Sample Descriptions:	13.5'-18.5	
Row 4 Sample Descriptions:	18.5'-23.5'	





-130 8/2018	Dry Core Soil Samples Depth: 3.5'-23.5'	BORING
IL A	Engineering Geology Study Colorado Springs, CO	B1-8

Boring No. B1-8	Sample Dep	oths*
Row 1 Sample Descriptions:	28.5'-33.5'	
Row 2 Sample Descriptions:	33.5'-38.5'	
Row 3 Sample Descriptions:	38.5'-43.5'	
Row 4 Sample Descriptions:	43.5'-48.5'	





-130 8/2018 IL	Dry Core Soil Samples Depth: 28.5'-48.5'	BORING
A	Engineering Geology Study Colorado Springs, CO	B1-8

Boring No. B1-	8 Sample Depths*	
Row 1 Sample Description	ons: 48.5'-53.5'	
Row 2 Sample Description	ons:	
Row 3 Sample Description	ons:	
Row 4 Sample Description	ons:	





-130	Dry Coro Soil Samplas	BORING
8/2018	Dry Core Soli Samples	
IL	Depth: 40.5 -53.5	
A		R1_8
	Engineering Geology Study	
	Colorado Springs, CO	

Boring No. B1-1	A Sampl	le Depths*
Row 1 Sample Description	1S: 3.5'-8.5' 8.5	5-13.5'
Row 2 Sample Description	NS: 13.5'-18.5' 18	3.5'-23.5'
Row 3 Sample Description	1S: 23.5'-28.5'	
Row 4 Sample Description	1S: 28.5'-33.5'	





Boring No. B1-11A	Sam	ple Dept	hs*
Row 1 Sample Descriptions:	33.5'-38.5'	50'-52.5'	
Row 2 Sample Descriptions:	60'-63.5'		
Row 3 Sample Descriptions:	63.5'-68.5'		
Row 4 Sample Descriptions:	68.5'-73.5'		





Yeh and Associates, Inc. Consulting Engineers & Scientists

PROJECT NO. DRAWN: DRAWN BY:	217-130 9/18/2018 HML	Dry Core Soil Samples Depth: 33.5'-52.5', 60'-73.5'	BORING
CHECKED BY: FILE NAME:	RDA	Engineering Geology Study Colorado Springs, CO	B1-11A

Boring No. B1-11A	Sam	nple Dep	oths*
Row 1 Sample Descriptions:			
Row 2 Sample Descriptions:	73.5'-78	.5'	
Row 3 Sample Descriptions:	78.5'-83	.5'	
Row 4 Sample Descriptions:			





-130	Dry Core Soil Samples	BORING
8/2018	Denth: 73 5'-83 5'	
L	Deptil: 73.5-05.5	
A		$\mathbf{R1_11}$
	Engineering Geology Study Colorado Springs, CO	אוו-ום

Boring No. B1-12	Sam	ple Dept	hs*
Row 1 Sample Descriptions:	0-3.5'		
Row 2 Sample Descriptions:	3.5'-8.5'		
Row 3 Sample Descriptions:	8.5'-13.5'		
Row 4 Sample Descriptions:	13.5'-18.5'		





Boring No. B1-	2 Sa	mple Dept	:hs*
Row 1 Sample Descript	ons: 18.5'-23.5	1	
Row 2 Sample Descript	ons: 23.5'-28.5	1	
Row 3 Sample Descript	ons: 28.5'-33.5	1	
Row 4 Sample Descript	ons: 33.5'-38.5	1	





Yeh and Associates, Inc. Consulting Engineers & Scientists

PROJECT NO. 217 DRAWN: 9/18 DRAWN BY: HMI CHECKED BY: RDA FILE NAME:

'-130	Dry Core Soil Samples	BORING
8/2018	Denth: 18 5'-38 5'	
1L	Deptil: 10.3 -30.3	
A	Engineering Coolegy Study	R1_12
	Colorado Springo CO	
	Colorado Springs, CO	

Boring No. B1-12	Sam	ple Dep	oths*
Row 1 Sample Descriptions:	38.5'-43	.5'	
Row 2 Sample Descriptions:	43.5'-44	1	
Row 3 Sample Descriptions:			
Row 4 Sample Descriptions:			





-130	Dry Core Soil Samples	BORING
8/2018	Dopth: 29 5' 49 5'	
L	Depth: 30.5 -40.5	— · · · •
A		R1_12
	Engineering Geology Study	
	Colorado Springs, CO	

				-
Boring No. B1-14	Sam	nple Dept	hs*	
Row 1 Sample Descriptions:	3.5'-8.5'			
Row 2 Sample Descriptions:	8.5'-13.5'			
Row 3 Sample Descriptions:	13.5'-18.5'			
Row 4 Sample Descriptions:	18.5'-23.5'			
				_





DRAWN: 9/18/201 Yeh and Associates, Inc. Consulting Engineers & Scientists DRAWN BY: HML CHECKED BY: RDA FILE NAME:

PROJECT NO.	217-130	Dry Core Soil Samples	BORING
DRAWN:	9/18/2018	Dopthy 2 5' 22 5'	
DRAWN BY:	HML	Deptil: 5.5-25.5	
CHECKED BY:	RDA		R1_14
FILE NAME:		Colorado Springs, CO	D 1-14

Boring No. B1-16	Sam	ple Dept	hs*
Row 1 Sample Descriptions:	3.5'-7'		
Row 2 Sample Descriptions:	59.5'-64.5'		
Row 3 Sample Descriptions:	64.5'-68.5'		
Row 4 Sample Descriptions:	68.5'-73.5'		





				_
Boring No. B1-16	Sam	ple Dept	hs*	
Row 1 Sample Descriptions:	73.5'-78.5'			
Row 2 Sample Descriptions:	78.5'-83.5'			
Row 3 Sample Descriptions:				
Row 4 Sample Descriptions:				
				_





DRAWN: 9/1 DRAWN BY: HM CHECKED BY: RD FILE NAME:

PROJECT NO.	217-130	Dry Core Soil Samples	BORING
DRAWN:	9/18/2018	Dopthy 72 5' 92 5'	
DRAWN BY:	HML	Deptil. 73.5-63.5	
CHECKED BY:	RDA		R1_16
FILE NAME:		Colorado Springs, CO	D1-10

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Boring No. B1-19	Sam	nple Deptl	hs*	
Row 1 Sample Descriptions:	0'-3.5'			
Row 2 Sample Descriptions:	3.5'-8.5'			
Row 3 Sample Descriptions:	9.5'-13.5'			
Row 4 Sample Descriptions:	13.5'-18.5'			





Boring No. B1-19	Sample Depths*
Row 1 Sample Descriptions:	18.5'-23.5'
Row 2 Sample Descriptions:	23.5'-28.5'
Row 3 Sample Descriptions:	28.5'-33.5'
Row 4 Sample Descriptions:	33.5'-38.5'





DRAWN: Yeh and Associates, Inc. Consulting Engineers & Scientists DRAWN BY: HM CHECKED BY: RDA FILE NAME:

PROJECT NO.	217-130	Dry Core Soil Samples	BORING
DRAWN:	9/18/2018	Danthi 19 5' 29 5'	
DRAWN BY:	HML	Deptil. 16.5-36.5	
CHECKED BY:	RDA		R1_10
FILE NAME:		Colorado Springs, CO	13

	Boring No. B1-19	Sam	ple Dept	hs*
Ro	w 1 Sample Descriptions:	38.5'-43.5'		
Ro	w 2 Sample Descriptions:	43.5'-48.5'		
Ro	w 3 Sample Descriptions:	48.5'-55'		
Ro	w 4 Sample Descriptions:	55'-60'		





PROJECT NO. 217 DRAWN: 9/18 DRAWN BY: HML CHECKED BY: RDA FILE NAME:

7-130 8/2018 IL	Dry Core Soil Samples Depth: 38.5'-58.5'	BORING
A	Engineering Geology Study Colorado Springs, CO	B1-19

				_
Boring No. B1-19	Sam	ple Dept	hs*	
Row 1 Sample Descriptions:	58.5'-63.5'			
Row 2 Sample Descriptions:	63.5'-68.5'			
Row 3 Sample Descriptions:				
Row 4 Sample Descriptions:				
				_





PROJECT NO. 217 DRAWN: 9/18 DRAWN BY: HMI Yeh and Associates, Inc. Consulting Engineers & Scientists CHECKED BY: RD FILE NAME:

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	MADY	
		DODINO
-130 8/2018 IL	Dry Core Soil Samples Depth: 58.5'-68.5'	
A	Engineering Geology Study Colorado Springs, CO	B1-19

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Boring No. B2-1	Sam	ple Dept	hs*	
Row 1 Sample Descriptions:	50'-55'			
Row 2 Sample Descriptions:	55'-60'			
Row 3 Sample Descriptions:				
Row 4 Sample Descriptions:				
				·





Inc. ists
PROJECT NO. 217-130
DRAWN: 9/18/20
DRAWN BY: HML
CHECKED BY: RDA
FILE NAME:

18	Dry Core Soil Samples Depth: 50'-60'	BORING
	Engineering Geology Study Colorado Springs, CO	B2-1

Boring	g No. B2-5	Sam	ple Depti	hs*
Row 1 Sample	Descriptions:	3.5'-8.5'		
Row 2 Sample	Descriptions:	8.5'-13.5'		
Row 3 Sample	Descriptions:	13.5'-18.5'		
Row 4 Sample	Descriptions:	18.5'-23.5'		





CHECKED BY: RDA FILE NAME:

Engineering Geology Study
Colorado Springs, CO

Boring No. B2-5	Sample Depths*
Row 1 Sample Descriptions:	23.5'-28.5'
Row 2 Sample Descriptions:	28.5'-33.5'
Row 3 Sample Descriptions:	33.5'-38.5'
Row 4 Sample Descriptions:	38.5'-43.5'





Yeh and Associates, Inc. Consulting Engineers & Scientists

DRAWN: 9/18 DRAWN BY: HMI CHECKED BY: RDA FILE NAME:

7-130 8/2018 IL	Dry Core Soil Samples Depth: 23.5'-43.5'	BORING
A	Engineering Geology Study Colorado Springs, CO	B2-5

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Boring No. B2-5	Sam	ple Dept	hs*	
Row 1 Sample Descriptions:	43.5'-48.5'			
Row 2 Sample Descriptions:	48.5'-53.5'			
Row 3 Sample Descriptions:	53.5'-58.5'			
Row 4 Sample Descriptions:	58.5'-63.5'			
				_





CHECKED BY: RD/ FILE NAME:

7-130 8/2018 IL	Dry Core Soil Samples Depth: 43.5'-63.5'	BORING
A	Engineering Geology Study Colorado Springs, CO	B2-5

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Boring No. B2-5	Sam	ple Dept	hs*	
Row 1 Sample Descriptions:	63.5'-68.5'			
Row 2 Sample Descriptions:	68.5'-73.5'			
Row 3 Sample Descriptions:	73.5'-78.5'			
Row 4 Sample Descriptions:	78.5'-83.5'			





DRAWN: Yeh and Associates, Inc. Consulting Engineers & Scientists DRAWN BY: HM CHECKED BY: RD FILE NAME:

PROJECT NO.	ROJECT NO. 217-130 Dry Core Soil Sam		BORING		
DRAWN:	9/18/2018 HML	Dapthy 62 5' 92 5'			
DRAWN BY:		Depth: 63.5-63.5			
CHECKED BY: RDA			R2-5		
FILE NAME:		Colorado Springs, CO	D2-J		

				-
Boring No. B2-7	Sample Depths*			
Row 1 Sample Descriptions:	0'-3.5'			
Row 2 Sample Descriptions:	3.5'-8.5'			
Row 3 Sample Descriptions:	8.5'-13.5'			
Row 4 Sample Descriptions:	13.5'-18.5'			
				-





				_
Boring No. B2-7	Sam	ple Dept	hs*	
Row 1 Sample Descriptions:	18.5'-23.5'			
Row 2 Sample Descriptions:	23.5'-28.5'			
Row 3 Sample Descriptions:	28.5'-33.5'			
Row 4 Sample Descriptions:	33.5'-38.5'			





Yeh and Associates, Inc. Consulting Engineers & Scientists CHECKED BY: RD/ FILE NAME:

PROJECT NO.	217-130	Dry Core Soil Samples Depth: 18.5'-38.5'	BORING
DRAWN:	9/18/2018		B2-7
DRAWN BY:	HML		
CHECKED BY:	RDA	Engineering Geology Study Colorado Springs, CO	
FILE NAME:			
Boring No. B2-7	Sample Depths*		
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Row 1 Sample Descriptions:	38.5'-43.5'		
Row 2 Sample Descriptions:	43.5'-48.5'		
Row 3 Sample Descriptions:	48.5'-53.5'		
Row 4 Sample Descriptions:	53.5'-58.5'		



Sample Depths are estimated based on depths of drilling.



PROJECT NO. 217 9/1 DRAWN: DRAWN BY: HM CHECKED BY: RD FILE NAME:

-130 8/2018	Dry Core Soil Samples	BORING
A	Engineering Geology Study Colorado Springs, CO	B2-7

Boring No. B2-7	Sample Depths*		
Row 1 Sample Descriptions:	58.5'-63.5'		
Row 2 Sample Descriptions:	63.5'-68.5'		
Row 3 Sample Descriptions:	68.5'-73.5'		
Row 4 Sample Descriptions:	73.5'-78.5'		





				_
Boring No. B2-7	Sample Depths*			
Row 1 Sample Descriptions:	78.5'-83.5'			
Row 2 Sample Descriptions:	83.5'-88.5'			
Row 3 Sample Descriptions:				
Row 4 Sample Descriptions:				
				_



