GEOTECHNICAL STUDY

Lots 17 and 18 Block 7
Crested Butte, Colorado

Prepared for:

Mr. Daniel Dow
1 Gothic, LLC
10713 Sun Tree Cove
Austin, TX 78730

Project No. 23.6023
July 5, 2023

CMT TECHNICAL SERVICES

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TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

COMMON ABBREVIATIONS AND ACRONYMS

AASHTO .... **American Association of State Highway and Transportation Officials**
ABC .... **aggregate base course**
ACI .... **American Concrete Institute**
ADA .... **Americans with Disabilities Act**
ADSC .... **Association of Drilled Contractors**
AI .... **Asphalt Institute**
APM .... **asphalt paving material**
ASCE .... **American Society of Civil Engineers**
ASTM .... **American Society for Testing and Materials**
AWWA .... **American Water Works Association**
bgs .... **below ground surface**
CDOT .... **Colorado Department of Transportation**
CBR .... **California Bearing Ratio**
CFR .... **Code of Federal Regulations**
CGS .... **Colorado Geological Survey**
CKD .... **cement of kiln dust stabilized subgrade**
CMU .... **concrete masonry unit**
CTB .... **cement treated base course**
deg .... **degree**
EDLA .... **equivalent daily load application**
e_m .... **edge moisture variation distance**
EPS .... **expanded polystyrene**
ESAL .... **equivalent single axle loads**
f’c .... **specified compressive strength of concrete at the age of 28 days**
F_a .... **seismic site coefficient**
FHWA .... **Federal Highway Administration**
FS .... **factor of safety**
F_V .... **seismic site coefficient**
GSA .... **global stability analysis**
GVW .... **gross vehicle weight**
IBC .... **International Building Code**
ICC-ES .... **International Code Council Evaluation Services, Inc.**
IRC .... **International Residential Code**
kip .... **1,000 pounds-force**
km .... **kilometer**
LTS .... **lime treated subgrade**
MDD .... **maximum dry density**
mg/L .... **milligrams per liter**
MGPEC .... **Metropolitan Government Pavement Engineers Council**
mm .... **millimeter**
Mr .... **resilient modulus**
MSE .... **mechanically stabilized earth**
mV .... **millivolts**
NAPA .... **National Asphalt Pavement Association**
N_{DESIGN} .... **design gyrations**
OMC .... **optimum moisture content**

OSHA .... **Occupational Safety and Health Administration**
OWTS .... **onsite wastewater treatment system**
PCA .... **Portland Cement Association**
PCC .... **portland cement concrete**
pcf .... **pounds per cubic foot**
pci .... **pounds per cubic inch**
pH .... **power of hydrogen**
psf .... **pounds per square foot**
psi .... **pounds per square inch**
PT .... **post-tension**
S_s .... **mapped spectral accelerations for short periods**
UBC .... **Uniform Building Code**
USGS .... **United States Geological Survey**

Important Information about This

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.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, you can benefit from a lowered exposure to problems associated with subsurface conditions at project sites and development of them that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed herein, contact your GBA-member geotechnical engineer. Active engagement in GBA exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Understand the Geotechnical-Engineering Services Provided for this Report

Geotechnical-engineering services typically include the planning, collection, interpretation, and analysis of exploratory data from widely spaced borings and/or test pits. Field data are combined with results from laboratory tests of soil and rock samples obtained from field exploration (if applicable), observations made during site reconnaissance, and historical information to form one or more models of the expected subsurface conditions beneath the site. Local geology and alterations of the site surface and subsurface by previous and proposed construction are also important considerations. Geotechnical engineers apply their engineering training, experience, and judgment to adapt the requirements of the prospective project to the subsurface model(s). Estimates are made of the subsurface conditions that will likely be exposed during construction as well as the expected performance of foundations and other structures being planned and/or affected by construction activities.

The culmination of these geotechnical-engineering services is typically a geotechnical-engineering report providing the data obtained, a discussion of the subsurface model(s), the engineering and geologic engineering assessments and analyses made, and the recommendations developed to satisfy the given requirements of the project. These reports may be titled investigations, explorations, studies, assessments, or evaluations. Regardless of the title used, the geotechnical-engineering report is an engineering interpretation of the subsurface conditions within the context of the project and does not represent a close examination, systematic inquiry, or thorough investigation of all site and subsurface conditions.

Geotechnical-Engineering Services are Performed for Specific Purposes, Persons, and Projects, and At Specific Times

Geotechnical engineers structure their services to meet the specific needs, goals, and risk management preferences of their clients. A geotechnical-engineering study conducted for a given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client.

Likewise, geotechnical-engineering services are performed for a specific project and purpose. For example, it is unlikely that a geotechnical-engineering study for a refrigerated warehouse will be the same as one prepared for a parking garage; and a few borings drilled during a preliminary study to evaluate site feasibility will not be adequate to develop geotechnical design recommendations for the project.

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project or purpose;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, the reliability of a geotechnical-engineering report can be affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying the recommendations in it. A minor amount of additional testing or analysis after the passage of time – if any is required at all – could prevent major problems.

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read the report in its entirety. Do not rely on an executive summary. Do not read selective elements only. *Read and refer to the report in full.*

You Need to Inform Your Geotechnical Engineer About Change

Your geotechnical engineer considered unique, project-specific factors when developing the scope of study behind this report and developing the confirmation-dependent recommendations the report conveys. Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the elevation, configuration, location, orientation, function or weight of the proposed structure and the desired performance criteria;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project or site changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept* *responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.*

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface using various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing is performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgement to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team through project completion to obtain informed guidance quickly, whenever needed.

This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, they are not final, because the geotechnical engineer who developed them relied heavily on judgement and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* exposed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a continuing member of the design team, to:

- confer with other design-team members;
- help develop specifications;
- review pertinent elements of other design professionals' plans and specifications; and
- be available whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction-phase observations.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for information purposes only.* To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. This happens in part because soil and rock on project sites are typically heterogeneous and not manufactured materials with well-defined engineering properties like steel and concrete. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include 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 personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually provide environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures.* If you have not obtained your own environmental information about the project site, ask your geotechnical consultant for a recommendation on how to find environmental risk-management guidance.

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, the engineer's services were not designed, conducted, or intended to prevent migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, ***proper implementation of the geotechnical engineer's recommendations will not of itself be sufficient to prevent moisture infiltration. Confront the risk of moisture infiltration*** by including building-envelope or mold specialists on the design team. ***Geotechnical engineers are not building-envelope or mold specialists.***

GEOPROFESSIONAL BUSINESS ASSOCIATION

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1. PURPOSE

1.1 GENERAL

CMT Technical Services - Colorado (CMT) performed a geotechnical study for the proposed residence to be located at Lots 17 and 18 of Block 7 in Crested Butte, Colorado. The study was made to characterize existing subsurface conditions at the site and assist in determining design criteria for planning, site development, foundation systems, interior floor systems, exterior flatwork, surface and subsurface drainage adjacent to structures, and to present other pertinent geotechnical issues. Information gathered during the field exploration and laboratory testing is summarized in Figures 1 through 3 and Appendices A through C. CMT's opinions and recommendations presented in this report are based on data generated during this field exploration, laboratory testing, and its experience.

1.2 SCOPE OF SERVICES

The scope of services performed is detailed in CMT's Proposal Agreement No. SC230202 which was executed on February 17, 2023.

2. SUMMARY OF FINDINGS AND CONCLUSIONS

This section is intended as a summary only and does not include design details. The report should be read in its entirety and utilized for design.

- Subsurface conditions varied in each exploratory location. Subsurface conditions predominantly consisted of silty and clayey sand with cobbles and boulders underlain by sandstone and shale bedrock. Groundwater was encountered at 2.7 feet below grade at the shallowest.
- Changes to the slope and groundwater conditions can potentially destabilize stable soil. Snow avalanche or snow loading is a possibility due to the topography and climate of the area. Rockfall hazard is low, as long as the proposed cuts into rock are stabilized.
- Site grading for the residence will require cuts up to 28 feet and for the garage cuts up to 13.5 feet. These cuts will require slope stabilization. CMT anticipates that soil nails or micropiles will be utilized for slope stabilization.
- The structures will be constructed below the groundwater table. Below grade construction should be provided with a minimum of 8 inches of free draining gravel and a drainboard and the interior slab-on-grade floors be constructed on a minimum of 4 inches of free draining gravel as discussed in Section **18. SUBSURFACE DRAINAGE**.
- The garage will be excavated entirely into the overburden soil. Spread footings are an appropriate foundation system for the garage. The residence will be excavated into a combination of rock and soil. Spread footings are appropriate, but the spread footings should bear on a minimum of 3 feet of structural fill. This will require bedrock to be overexcavated to a depth of 3 feet to accommodate the structural fill.
- Good surface drainage should be established and positive drainage away from the structures, pavement, and other site improvements should be provided during construction and maintained throughout the life of the proposed structures. Below grade areas should be provided with an exterior perimeter subsurface drainage system.

3. SITE CONDITIONS

The site is located at the western end of Gothic Avenue in Crested Butte, Colorado. A vicinity map is shown in Figure 1. The 0.14 acre lot is rectangular shaped with a north-south length of 125 feet and an east-west width of 50 feet. The site is currently undeveloped land. The site was covered in about 3 to 6 feet of snow at the time of CMT's field study. The site is bound by residential development to the north, east, and south, and by a steep undeveloped east-northeast facing hillside to the west. The site is situated on a hill with the approximate toe of the slope on the eastern property boundary. Topography of the site is moderate to steeply sloping to the northeast with an elevation change of about 28 feet. The adjacent slope has a maximum slope angle of about 36 degrees or 4:3 (H:V).

Vegetation onsite could not be observed due to snow cover but is anticipated to consist of native grasses. A shallow spring was observed in the vicinity of Boring B-2 and Exploratory Pit EP-1. Bedrock outcrops were not observed due to the snow cover, but aerial imagery suggests bedrock outcrops may exist on top of the hillside west of the site.

4. PROPOSED CONSTRUCTION

The proposed structure will be a two-story single-family residence with a basement and a detached garage. The residence will have a footprint of about 1,150 square feet and the garage about 600 square feet. The southwestern corner of the basement will require cuts up to 25 feet and northeastern corner will require cuts up to 5 feet. The garage will require cuts up to 13.5 feet. Construction will likely be wood frame, above grade and cast-in-place concrete, below grade. Foundation loads will be relatively light, not exceeding 1,500 pounds per linear foot on walls. CMT assumes the residence will be serviced by offsite wastewater services.

5. GEOLOGIC CONDITIONS

5.1 SURFICIAL DEPOSITS

The "Geologic Map of the Crested Butte quadrangle, Gunnison County, Colorado", prepared for the USGS by Gaskill, et al., dated 1986, indicates that surficial deposits onsite consist of glacial till.

5.2 BEDROCK

The "Geologic Map of the Crested Butte quadrangle, Gunnison County, Colorado", prepared for the USGS by Gaskill, et al., dated 1986, indicates that bedrock onsite consists of sandstone of the Mesa Verde Formation.

EXHIBIT 1. Geology of the area with the site in the approximate center.

6. FIELD EXPLORATION

Subsurface conditions were explored from March 15 through March 17, 2023 by drilling three borings and excavating one exploratory pit at the locations indicated in Figure 2. Borings were drilled about 40 feet deep. Borings were advanced using ODEX within the soil and NX coring in the bedrock. The exploratory pit was completed to a depth of 6 feet using a CAT 308 excavator. Graphical logs of the subsurface conditions observed, locations of sampling, and further explanation of the exploration are presented in the logs contained in Appendix A.

Photo 1. View looking at drilling operations.

Photo 2. View looking at exploratory pit excavation.

7. LABORATORY TESTING

CMT personnel returned samples obtained during field exploration to its laboratory where professional staff visually classified them and assigned testing to selected samples to evaluate pertinent engineering properties. Laboratory tests performed are listed in Table 7.1. Further discussion of laboratory testing and the laboratory test results are presented in Appendix B.

TABLE 7.1. Laboratory Testing Performed

Laboratory Test	To Evaluate
Grain size analysis	Grain size distribution for classification purposes.
Atterberg limits	Soil plasticity for classification purposes.
Water soluble sulfate content	Potential corrosivity of the soil on cementitious material.
Unconfined compressive strength	Undrained shear strength.

8. SUBSURFACE CONDITIONS

8.1 BORING B-1

CMT's Boring B-1 was located in the vicinity of the proposed garage and encountered:

- 19.5 feet of silty and clayey sand with gravel and cobbles and boulders. Boulders were up to 21 inches in dimension.
- 1 foot of a gravelly clay with sand.
- Sandstone and shale bedrock at a depth of 21.5 feet. The upper 2.5 feet of the bedrock was weathered. Bedrock continued for the remaining depth explored of 39 feet.

8.2 BORING B-2

CMT's Boring B-2 was located in the vicinity of the northern portion of the proposed residence and encountered:

- 7 feet of silty and clayey sand with gravel and cobbles.
- 6 feet of a clayey gravel with sand.
- Sandstone and shale bedrock at a depth of 13 feet. The upper 2 feet of the bedrock was weathered. Bedrock continued for the remaining depth explored of 39 feet.

8.3 BORING B-3

CMT's Boring B-3 was located east of the proposed residence and encountered:

- 6 feet of silty and clayey sand with gravel and cobbles.
- 4 feet of a clayey gravel with sand.
- Sandstone and shale bedrock at a depth of 10 feet. The upper 1 foot of the bedrock was weathered. Bedrock continued for the remaining depth explored of 40 feet.

8.4 EXPLORATORY PIT EP-1

CMT's exploratory pit was located in the vicinity of the proposed residence and encountered:

- Less than 1 foot of topsoil.
- 1.5 feet of clayey gravel with sand.
- A silty gravel with sand, cobbles, and boulders for the remaining depth explored of 6 feet. Boulders were up to 24 inches in dimension.
- No bedrock.
- Practical backhoe refusal at a depth of 6 feet.

The subsurface conditions encountered in CMT's borings are reasonably consistent with those described in Section **5. GEOLOGIC CONDITIONS**. These observations represent conditions at the time of field exploration and may not be indicative of other times or other locations.

9. GROUNDWATER

Borings and the exploratory pit were checked for the presence of groundwater during drilling and excavating. Borings were temporarily covered and checked for water 52 to 53 days after drilling. Measurements are summarized in Table 9.1.

TABLE 9.1. Groundwater Measurements

Boring/Pit ID	Drill/Excavation Date	Depth to Water and Date When Measurement was Made	
		Time of study	May 10, 2023
B-1	March 15, 2023	19.5	4.7
B-2	March 16, 2023	10.5	2.7
B-3	March 16, 2023	9.5	5.0
EP-1	March 17, 2023	3.0	N/A*

*Exploratory Pit EP-1 was backfilled upon completion, preventing future groundwater measurements.

Groundwater can be expected to fluctuate and can be influenced by variations in seasons, weather, precipitation, drainage, vegetation, landscaping, irrigation, leakage of water and/or wastewater systems, etc., both onsite and offsite. Discontinuous zones of perched water may exist or develop within the overburden material and/or upper zones of the bedrock. CMT's field explorations were performed during the winter when groundwater levels are usually lowest. Groundwater levels will be higher in the spring and early summer.

10. GEOLOGIC HAZARDS

The following subsections present a cursory review of geologic publications. A detailed geologic hazards assessment was not the focus of CMT's scope of services.

The Geologic Hazards map of Gunnison County indicates that the site is located in an area with no mapped hazards; however, the proposed changes to the slope can potentially create slope stability concerns. High groundwater and radon are also concerns.

10.1 UNSTABLE SLOPES

The slope west of the proposed residence is approximately 36 degrees at its steepest. Changes to the slope and groundwater conditions can potentially destabilize stable soil. Modifications to the slope with cuts and fills in excess of 5 feet will require slope stabilization though soil nails or micropiles in the soil and rock bolting in the bedrock.

Snow avalanche or snow loading is a possibility due to the topography and climate of the area. Rockfall hazard is low, as long as the proposed cuts into rock are stabilized.

10.2 RADON

The U.S. Environmental Protection Agency map of radon zones indicates that virtually all of western Colorado, including Gunnison County, is in Zone 1 (www.EPA.gov/radon/zonemap.html). Although there is no known safe level of radon, Zone 1 is the zone of highest risk for exposure to radon gas (i.e., greater than 4 picoCuries per liter (pCI/L)). The Colorado Geological Survey (CGS) published a report that related geologic setting and building construction with radon levels (CGS 1991 Open-File Report 91-4). Residences with basements had higher levels of radon than residences built on grade, on the same geologic material. The CGS is careful to state that radon potential can vary considerably within the same geologic unit due to the nonuniform distribution of uranium, secondary leaching, and the accumulation of uranium and other radioactive elements into other strata.

Based on levels of radon recorded in existing residences in the region and the presence of rock types that are known to produce radon, it is reasonable to assume that radon emission into buildings is occurring in the Crested Butte area. The EPA, the Colorado Department of Public Health and Environment (CDPHE) Radiation Management Division, and the National Association of Home Builders (NAHB) recommend that all new residences constructed in Zone 1 include radon resistant features. These organizations also recommend that after the building is constructed, radon should be measured and if the results are greater than 4 pCi/L, the system should be upgraded from passive to active (usually by installing a fan). In the EPA publication titled, Building Radon Out: A Step-by-Step Guide on How to Build Radon-Resistant Homes (USEPA Office of Air and Radiation EPA/402-K-01-002, April 2001), three practical and inexpensive alternatives for passive, sub-slab depressurization systems are presented; gravel with vents, perforated pipes, or soil gas collection mats. Recommendations for passive and active design, and construction techniques for reducing radon gas can be found on the EPA radon website www.epa.gov/radon or the CDPHE radon website www.cdphe.state.co.us.hm.rad/radon.

11. GEOTECHNICAL CONSIDERATIONS

11.1 SLOPE STABILIZATION

Site grading for the residence will require cuts up to 28 feet and for the garage cuts up to 13.5 feet. These cuts will require slope stabilization. At the location of the garage, soil was encountered to depth of 21.5 feet. CMT anticipates that soil nails or micropiles will be utilized for slope stabilization. At the location of the residence, soil was encountered to depths of 10 to 13 feet. Soil nails or micropiles will likely be utilized for the depth of the cut in soil and rock bolts for the portion of the cut within bedrock. If the space between the rock cut face and the residence is backfilled, rock bolting will only be necessary to stabilize larger blocks of unstable rock to reduce lateral earth pressures on the foundation walls. CMT assumes that slope stabilization will be designed by others.

Slope stabilization should consider the following in design:

1. Slope retention systems are a permanent, independent system.
2. A subsurface drainage system developed and maintained to prevent build up of hydrostatic loads behind the earth retention system and between the earth retention system and foundation wall.
3. An earth retention system that does not continue to move exerting pressure on the foundation wall. CMT presumes SNW movement will be less than 0.5% of the wall height.
4. Global stability has been accounted for in the earth retention system design.

11.2 HIGH GROUNDWATER

The structures will be constructed below the groundwater table. Below grade construction should be provided with a minimum of 8 inches of free draining gravel and a drainboard and the interior slab-on-grade floors be constructed on a minimum of 4 inches of free draining gravel as discussed in Section **18. SUBSURFACE DRAINAGE**.

12. FOUNDATION RECOMMENDATIONS

12.1 SPREAD FOOTINGS

The garage will be excavated entirely into the overburden soil. Spread footings are an appropriate foundation system for the garage. The residence will be excavated into a combination of rock and soil. Spread footings are appropriate, but the spread footings should bear on a minimum of 3 feet of structural fill. This will require bedrock to be overexcavated to a depth of 3 feet to accommodate the structural fill.

The proposed structure may be founded on conventional spread footings or pad type footings below frost depth in accordance with the following design recommendations:

a) A frost depth of 36 inches should be assumed for this area (Gunnison County Climate Design Criteria).
b) Footings should be designed for a maximum allowable soil bearing pressure of 2,500 psf based on dead load plus full live load.
c) Foundations for the garage should be placed entirely on native soil or structural fill, not a combination of the two. Foundations for the residence should be placed entirely on 3 feet of structural fill.
d) Continuous footings should have a minimum width of 16 inches and isolated pad type footings a minimum dimension of 24 inches. Using the soil pressure recommended above, CMT estimates the maximum settlement for the structure will be on the order of 1 inch, with differential settlement equal to 50% of the total. Footings should be proportioned as much as practicable to reduce differential settlement.
e) Steel reinforcement for continuous concrete foundation walls should be designed to span localized settlements over a distance of 10 feet.
f) Particles larger than 12 inches in dimension should be removed from exposed footing subgrade.
g) Removal of cobbles and/or boulders from the soil at the foundation elevation can result in depressions, which can be backfilled with compacted onsite soil or concrete.
h) All soft or loose soil beneath footing areas should be redensified in place, or removed and replaced with properly compacted structural fill, suitable flow fill, or concrete prior to placement of footing concrete.
i) All footing excavations should be observed by a CMT representative prior to concrete placement to determine if bearing conditions are consistent with those assumed to develop its recommendations.

13. LATERAL EARTH PRESSURES

13.1 FOUNDATION WALLS

Lateral pressures on walls depend on the type of wall, hydrostatic pressure behind the wall, type of backfill material, and allowable wall movements. CMT recommends drain systems be constructed behind walls to reduce the potential for hydrostatic pressures to develop. Where anticipated/permissible wall movements are greater than 0.5% of the wall height, lateral earth pressures can be estimated for an "active" condition. Where anticipated/permissible wall movement is less than approximately 0.5% of the wall height or wall movement is constrained, lateral earth pressures should be estimated for an "at rest" condition. Recommended lateral earth pressures for onsite material are provided in Table 13.1.

The recommended values for lateral earth pressures provided in Table 13.1 are given in terms of an equivalent unit weight. The equivalent unit weight multiplied by the depth below the top of the ground surface is the horizontal pressure against the wall at that depth. The resulting pressure distribution is a triangular shape. These soil pressures are for horizontal backfill with no surcharge loading or hydrostatic pressures. If these criteria cannot be met, CMT should be contacted for additional criteria. The unfactored or ultimate coefficients of sliding resistance between concrete and bearing soil are provided in Table 13.1.

TABLE 13.1. Lateral Earth Pressures and Coefficients of Sliding Resistance for Onsite Material

Backfill Material Type	Equivalent Unit Weight (pcf)			Coefficient of Sliding Resistance
	Active	At Rest	Passive	
Onsite soil	35	55	280	0.70
Free draining gravel	25	40	320	0.80

14. INTERIOR FLOORS

The natural gravelly clay, clayey sand, and clayey gravel soil have potential to swell upon wetting. The clays incorporate the matrix of sand and/or gravel soil with cobbles and boulders. These soil types have a low risk to swell. If movement of the interior floors cannot be tolerated, structural floors should be considered. Cobbles and boulders will be encountered at subgrade elevation. Particles greater than 6 inches in dimension should be removed prior to placing interior floors.

14.1 SLAB-ON-GRADE CONSTRUCTION DETAILS

Slab-on-grade cracking can result from compression of the supporting soil and also from concrete curing stresses. If slab-on-grade floors are chosen, CMT recommends that design and construction of all interior slab-on-grade floors incorporate the following considerations and precautions. These details will not reduce the amount of movement but are intended to reduce potential damage should some settlement of the supporting subgrade take place. The ACI Committee 302, “Guide for Concrete Floor and Slab Construction (ACI 302.R-96)” should be consulted regarding methods/techniques to reduce the occurrence of concrete shrinkage cracks and other potential issues associated with concrete finishing and curing.

a) A vapor barrier is recommended beneath concrete slabs-on-grade that will support equipment sensitive to moisture or will be covered with wood, tile, carpet, linoleum, or other moisture sensitive or impervious coverings. Location of the vapor barrier should be in accordance with recommendations provided by ACI 302.2R-06, “Guide for Concrete Slabs that Receive Moisture-Sensitive Flooring Materials.” Further discussion of vapor barriers is presented in Appendix C.

b) Plumbing beneath slabs should be eliminated, where practicable. Where such plumbing is unavoidable, it should be thoroughly pressure tested during construction for leaks prior to slab placement.
c) Backfill in utility trenches beneath slabs should be compacted as specified in Section **17. STRUCTURAL FILL/BACKFILL SOIL.**
d) Plumbing and utilities that pass through the slab should be isolated from the slabs.

14.2 STRUCTURALLY SUPPORTED FLOORS

A floor system that is supported by the foundation system and has an air or void space (typically a crawlspace) below the floor so that it is not in contact with the underlying soil/bedrock material is considered a structurally supported or structurally suspended floor. If potential movement of slab-on-grade floors and associated cracking/distress are not considered tolerable by the owner, developer, architect, or structural engineer for any reason, a structurally supported floor should be provided.

There are design and construction issues associated with structurally supported floors that must be considered, such as ventilation and lateral loads. Where structurally supported floors are installed, the minimum required air space depends on the material used to construct the floor. Building codes require a clearance space of at least 18 inches above exposed soil if untreated wood floor components are used. Where other support material is used, a minimum clearance space of 8 inches is recommended. This minimum clearance space should be maintained between any point on the underside of the floor system (including beams and plumbing) and the surface of the exposed soil. The minimum clearance between the crawlspace ground surface and the structural floor members and suspended plumbing should be constructed to meet minimum code or recommended clearances.

Where structurally supported floors are used, utility connections, including water, gas, air duct, and exhaust stack connections to floor supported appliances should be capable of absorbing some deflection of the floor. Plumbing that passes through the floor should ideally be hung from the underside of structural floor and not lay on the bottom of the excavation. This configuration may not be achievable for some parts of the installation. It is prudent to maintain the minimum clearance space below all plumbing lines. If trenching below the lines is necessary, CMT recommends sloping these trenches so they discharge to the foundation drain. Penetrations through the foundation wall should allow for at least 4 inches of clearance and/or be provided with flexible connections. The ground surface below the structurally supported floor should be sloped to the perimeter drain.

Control of humidity in crawlspaces is important for indoor air quality and performance of wood floor systems. An engineering professional with expertise in the design and construction of crawlspace humidity control should be contacted.

15. EXTERIOR FLATWORK

Flatwork supported on foundation wall backfill may settle and crack if the backfill is not properly moisture conditioned and compacted.

Exterior flatwork should be isolated from the structures. Exterior flatwork should be expected to move, although measures can be incorporated into construction to limit the movement or effects of the movement. CMT recommends flatwork not be doweled into structure foundations, but rather supported on a haunch to limit settlement. The haunch should extend the full length of the slab.

Exterior flatwork, such as driveways and sidewalks, are normally constructed as slabs-on-grade. Porches and patios are increasingly constructed as structurally supported slabs, which in CMT's opinion, is the most positive means of keeping slabs from moving and adversely affecting the operation of doors or means of egress. CMT recommends that landings and slabs at egress doors, as well as porches and patios, be constructed as structurally supported elements if potential movement cannot be tolerated.

Simple decks that are not integral to the structure and can tolerate foundation movement can be constructed with less substantial foundations. A short pier or footing bottomed below frost depth can be used if movement is acceptable and if acceptable by local building requirements. Use of deeper foundation elements can reduce potential movement. Footings or short piers should not be underlain by wall backfill due to risk of settlement. Inner edges of decks may be constructed on haunches and detailed such that movement of the deck foundations will not cause distress to the structure.

15.1 OVERHANGING ROOFS

Porches, patios, or decks with overhanging roofs that are integral to the structure, such that foundation movement cannot be tolerated, should be constructed with the same foundation type as the structure.

16. EXCAVATIONS

Conventional earthmoving equipment should be adequate to excavate the onsite soil. Boulders and groundwater will be encountered. Excavations that encounter the very hard bedrock may require a jackhammer or other means of fracturing the bedrock to achieve proposed elevations. Loosened bedrock bearing material should be removed. All excavations should be properly sloped and/or braced, and local and federal safety codes observed. Slopes and other areas void of vegetation should be protected against erosion. If temporary shoring is required, a contractor specializing in design and construction of shoring should be contacted.

It is the contractor's responsibility to provide safe working conditions and comply with the regulations in OSHA Standards-Excavations, 29 CFR Part 1926. The following guidelines are provided for planning purposes. Sloping and shoring requirements must be evaluated at the time of construction by the contractor's competent person as defined by OSHA. The geotechnical engineer is NOT the contractor's "competent person" in any circumstance, including but not limited to, by way of default or delegation. OSHA classifications for various material types and the steepest allowable slope configuration corresponding to those classifications are shown in Table 16.1.

TABLE 16.1. Allowable Slope Configuration for Onsite Material

Material Type	OSHA Classification	Steepest Allowable Slope Configuration*
Sandstone bedrock	Stable rock	Vertical
Shale and weathered bedrock	Type A	3/4:1
Fine grained soil	Type B	1:1
Coarse grained soil	Type C	1-1/2:1

* Units horizontal to units vertical. The values shown apply to excavation less than 20 feet in height. Conditions can change and evaluation is the contractor's responsibility.

The classifications and slope configurations in Table 16.1 assume that excavations are above the groundwater table, there is no standing water in the excavations, and there is no seepage from the slope into the excavations, unless otherwise specified. The above classifications and slope configurations assume that the material in the excavations is not fractured, adversely bedded, jointed, nor left open to desiccate, crack, or slough, and are protected from surface runoff. There are other considerations regarding allowable slope configurations that the contractor is responsible for, including proximity of equipment, stockpiles, and other surcharge loads to the excavation. The contractor's competent person is responsible for all decisions regarding slope configuration and safety conditions for excavations.

Excavations should not undermine existing foundation systems of structures or infrastructure, unless they are adequately protected. At a minimum, new excavations should not intersect a line drawn using the steepest allowable slope configuration from Table 16.1 down and away from the bottom edge of the existing foundation systems or bottom edge of infrastructure. If this condition cannot be met, shoring or staged excavations may be required. If shoring is required, a condition survey of the adjacent structures is recommended before construction starts and upon completion of construction. In CMT's experience, condition surveys include, but may not be limited to, photographs of any distress to adjacent structures.

Permanent slopes should be no steeper than 2:1 unless they are supported with earth retention systems and revegetated or otherwise protected from erosion.

17. STRUCTURAL FILL/BACKFILL SOIL

Where fill/backfill soil is necessary, the suitable onsite inorganic soil may be used. At this site, unsuitable material is defined as topsoil, organics, trash, ash, frozen material, hard lumps and clods, and particles larger than 6 inches. Existing onsite fill material can be reused for structural fill/backfill, provided it is free of unsuitable material. If unsuitable material is encountered in the existing fill, it must be removed before the existing fill can be reused as fill/backfill. Recommendations for fill/backfill placement are:

a) Fill/backfill material should be placed in loose lifts and compacted in accordance with Table 17.1.
b) Maximum loose lift thickness shall be 12 inches, depending on the type of equipment used to apply compactive effort and shall be reduced if the specified compaction cannot be obtained with the equipment used.
c) Fill/backfill should not be placed if material is frozen or if the placement surface is frozen.

d) Fill/backfill material should be placed and spread in horizontal lifts of uniform thickness in a manner that avoids segregation.
e) Placement surface should be kept free of standing water, debris, and unsuitable material during placement and compaction of fill/backfill material.
f) Fill/backfill maximum allowable particle size is 6 inches. Do not incorporate oversize material in the fill/backfill that is incapable of being broken down by the equipment and methods being employed to process and compact the fill/backfill. Process and compact material in the lift, as necessary, to produce the specified fill/backfill characteristics. If oversize particles remain in the lift after processing and compacting, remove oversize material to produce a fill/backfill within specified requirements.

TABLE 17.1. Compaction Specifications

Fill Location	Material Type (General)	AASHTO Classification	Moisture Content (%)	Relative Compaction (%)	Compaction Standard
Structural fill (under foundations)	Granular material that is clean to silty	A-1, A-2-4, A-2-5, A-3, A-4, A-5	+/-3% of OMC	≥98%*	Standard Proctor (ASTM D698)
Structural fill (under slabs and flatwork)	Granular material that is clean to silty	A-1, A-2-4, A-2-5, A-3, A-4, A-5	+/-3% of OMC	≥95%*	Standard Proctor (ASTM D698)
Fill in nonstructural areas (e.g., landscaping)	Granular material that is clean to silty	A-1, A-2-4, A-2-5, A-3, A-4, A-5	NA	≥90%*	Standard Proctor (ASTM D698)
	Fine grained material and granular material with plastic fines	A-2-6, A-2-7 A-6, A-7	+/-2% of OMC	≥90%*	Standard Proctor (ASTM D698)

* If fill thickness greater than 15 feet is planned, additional requirements may apply.

17.1 IMPORT FILL

Material imported for structural fill should be tested and approved for use onsite by the project geotechnical engineer prior to hauling to the site. Proctor and classification tests should be conducted to determine if the fill meets required specifications. Fill material should be well graded meeting the specifications in Table 17.2.

TABLE 17.2. Import Fill Specifications

Soil Parameter	Specification
Maximum particle size	3 inch
Percent finer than No. 200 sieve	10% to 20%
Liquid limit	30% maximum
Plasticity index	15% maximum

Due to the quantity of the gravel in the onsite material, placement may be controlled via a method specification (i.e., through observation). Material shall be placed in loose lifts not exceeding 12 inches thick. Each lift shall be compacted using vibratory methods. The vibratory equipment must be capable of exerting a minimum of 15,000 pounds of centrifugal force. The gravel particles shall be in a surface saturated condition. Each lift shall be rolled with a minimum of four passes or until no visible compaction of the layer is observed, whichever is greater.

18. SUBSURFACE DRAINAGE

Groundwater was encountered within the native soil. The structures will be excavated below the groundwater contact. The 2018 IBC requires that basement and/or crawlspace areas be provided with an exterior perimeter subsurface drainage system. The system shall be sloped to drain to a suitable gravity outlet. The drainage system shall consist of a minimum of 8 inches of free draining gravel and Miradrain (or equivalent) attached to the exterior of the wall to within 12 inches of the surface extending to a filter media surrounding a perforated, machine slotted, or equivalent rigid plastic pipe. Pipes with a smooth interior are recommended. Pipes that are corrugated on the interior can become obstructed more easily than pipes with smooth interiors and may be more difficult to clean. A recommended drain schematic is shown in Figure 3.

At least 4 inches of properly graded sand and gravel should also be placed below the basement floor level and connected to the perimeter drain system to reduce moisture transfer through the floor slabs and to assist in the collection of groundwater.

19. SURFACE DRAINAGE

Good drainage and surface water management is important. Performance of site improvements, such as foundations, floors, hardscape, and pavement are often adversely affected by failing to establish and/or maintain good site drainage. Grades must be adjusted to provide positive drainage away from the structure, pavement, and other site improvements during construction and maintained throughout the life of the proposed facility. The following drainage precautions are recommended:

a) Ground surface around the perimeter foundation walls should be sloped to drain away from the structure in all directions. Current building codes require a minimum slope of 6 inches in the first 10 feet (5%) of the structure. At the completion of construction, CMT recommends a continuous slope away from foundations of 12 inches in the first 10 feet (10%), where site constraints permit. CMT recommends that concrete and pavement adjacent to structures slope at a rate of at least 2% away from the structure or as otherwise required by ADA criteria. Maximum grades practical should be used for paving and flatwork to prevent areas where water can pond.
b) Joints that occur at locations where paving or flatwork abuts the structure should be properly sealed with flexible sealants and maintained.
c) Ground surface should be sloped so water will not pond between or adjacent to structures and other site improvements. Curbs, sidewalks, paths, plants, or other improvements should not block, impede, or otherwise disrupt surface runoff. Use of chases and weep holes to promote drainage is encouraged. Landscape edging should be perforated or otherwise constructed in a manner to prevent ponding of surface water, especially in the vicinity of the backfill soil.
d) Drainage swales should be located as far away from the foundation as practicable.

e) If site constraints do not allow for the recommended slopes, the project civil engineer shall provide a method for drainage that is equivalent to the recommendations herein. Water should not be allowed to pond adjacent to or near foundations, flatwork, or other improvements.
f) Roof downspouts and other water collection systems should discharge onto pavements or extend away from the structure well beyond the limits of the backfill zone using downspout extensions, appropriately sized splash blocks, or other means. Buried downspout extensions are discouraged as they can be difficult to monitor and maintain.
g) Irrigation directly adjacent to the structure is discouraged and should be minimized. Sprinkler lines, zone control boxes, and sprinkler drains shall be located outside the limits of the foundation backfill. Sprinkler systems should be placed so that the spray from the heads, under full pressure, does not fall within 5 feet of the foundation walls.
h) Plants, vegetation, and trees that require moderate to high water usage are discouraged and should not be located within 5 feet of foundation walls.
i) Plantings within 10 feet of the foundation should be placed in watertight planters/containers.
j) The project civil engineer shall perform measurements to document that positive drainage, as described in this section or as otherwise designed by the project civil engineer, is achieved. Maintenance of surface drainage is imperative subsequent to construction and is the responsibility of the owner and/or tenant.

20. SOIL CHEMICAL TESTING

20.1 SULFATE EXPOSURE

Water soluble sulfate contents of 0.00% were measured on a sample from B-3 at 0 to 10 feet. Results are summarized in Appendix B. The PCA publication, *Design and Control of Concrete Mixtures* 2002 and the ACI publication, *Building Code Requirements for Structural Concrete and Commentary* consider this range negligible for water soluble sulfate exposure.

21. GEOTECHNICAL RISK

The concept of risk is an important aspect of any geotechnical study. The primary reason for this is that the analytical methods used by geotechnical engineers are generally empirical and must be tempered by engineering judgment and experience, therefore, the solutions or recommendations presented in any geotechnical study should not be considered risk free, and more importantly, are not a guarantee that the interaction between the soil and the proposed construction will perform as predicted, desired, or intended. The engineering recommendations presented in the preceding sections constitute CMT's best estimate of those measures that are necessary to help the structure/pavement perform in a satisfactory manner based on the information generated during this study, training, and experience in working with these conditions.

22. LIMITATIONS

This document has been prepared as an instrument of service for the exclusive use of 1 Gothic, LLC for the specific application to the project as discussed herein and has been prepared in accordance with geotechnical engineering practices generally accepted in the state of Colorado at the date of its preparation. No warranties, either expressed or implied, are intended or made. This document should not be assumed to contain information for other parties or other purposes.

The findings of this study are valid as of the date of its preparation. Changes in the conditions of a property can occur with the passage of time, whether due to natural processes or the works of people on this or adjacent properties. Standards of practice evolve in engineering and changes in applicable or appropriate standards may occur, whether a result from legislation or the broadening of knowledge. Accordingly, the findings of this study may be invalidated wholly or partially by changes outside of CMT's control, therefore, this study is subject to review and should not be relied upon without such review after a period of 3 years.

In the event that changes, including but not limited to, the nature, type, design, size, elevation, or location of the project or project elements as outlined in this report are made, the conclusions and recommendations contained in this report shall not be considered valid unless CMT reviews the changes and either confirms or modifies the conclusions of this report in writing.

CMT should be retained to review final plans and specifications that are developed for proposed construction to judge whether the recommendations presented in this report and any addenda have been appropriately interpreted and incorporated in the project plans and specifications as intended.

The exploration locations for this study were selected to obtain a reasonably accurate depiction of underground conditions for design purposes and these locations are often modified based on accessibility and the presence of underground or overhead utility conflicts. Variations from the soil conditions encountered are possible. These variations may necessitate modifications to CMT's design recommendations, therefore, CMT should be retained to observe subsurface conditions, once exposed, to evaluate whether they are consistent with the conditions encountered during CMT's exploration and that the recommendations of this study remain valid. If parties other than CMT perform these observations and judgements, they must accept responsibility to judge whether the recommendations in this report remain appropriate.

CMT's scope of services for this report did not include either specifically, or by implication, any environmental assessment of the site or identification of contaminated or hazardous material or conditions. Additionally, none of the services performed in connection with this 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 enough to prevent mold from growing in or on the structures involved.

At a minimum, CMT should be retained during construction to observe and/or test:

- completed excavations.
- placement and compaction of fill.
- retained earth wall construction operations.
- proposed import or onsite fill material.

CMT offers many other construction observations, materials engineering, and testing services and can be contacted to discuss further.

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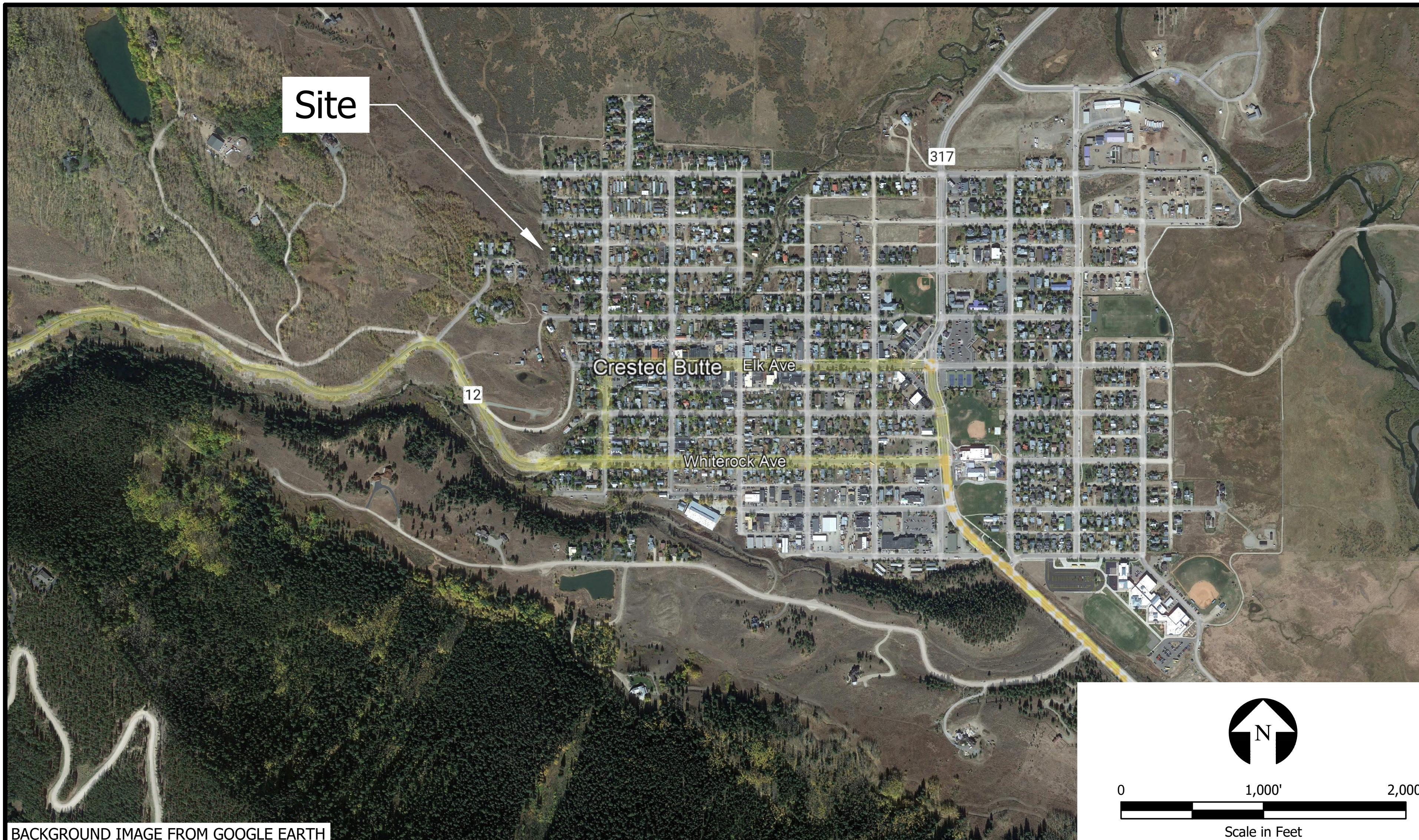

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PROJECT NAME:	Lots 17 and 18 Block 7		
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FIGURE 1
Vicinity Map

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FIGURE 2
Exploration Plan

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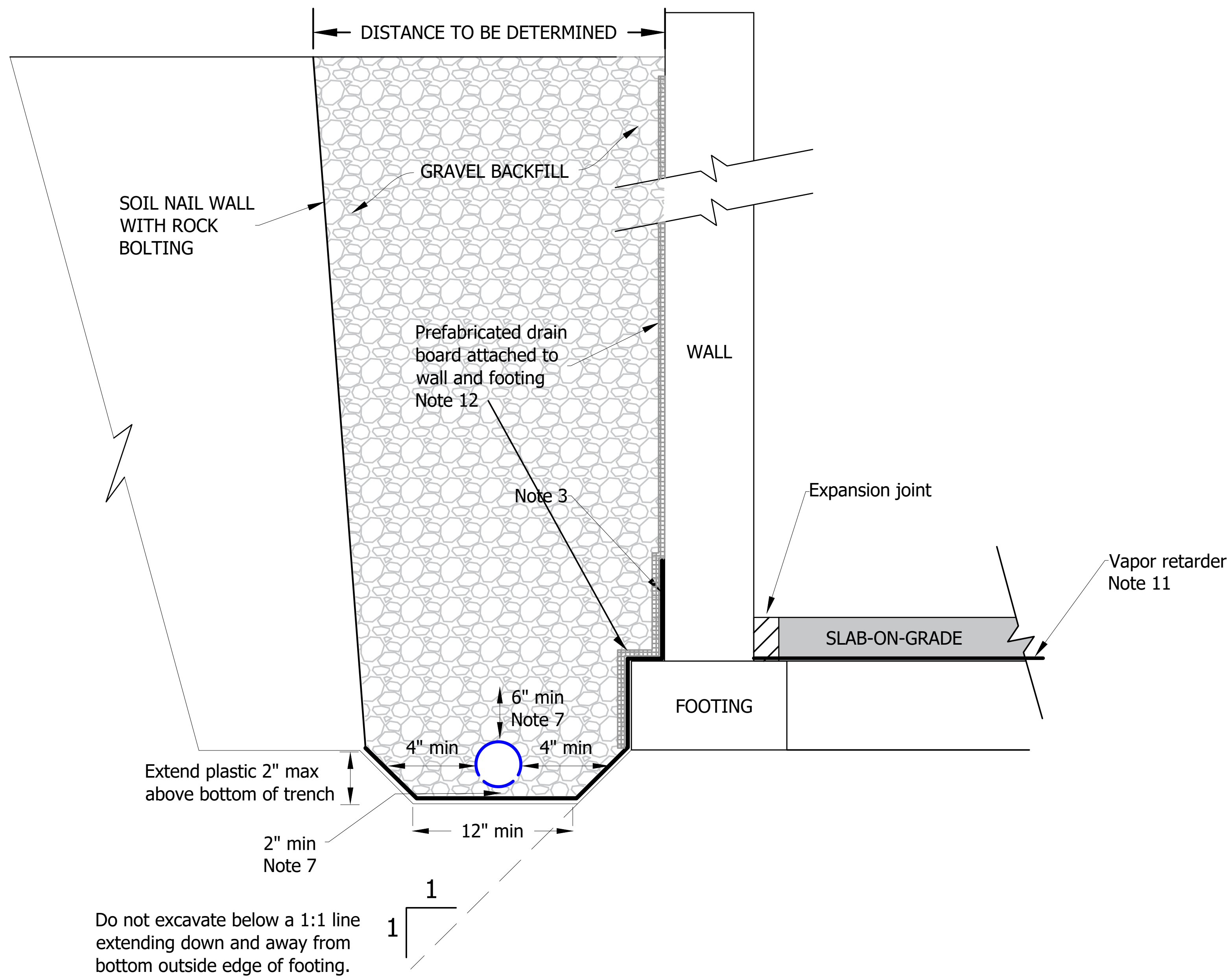

TYPICAL EXTERIOR PERIMETER DRAIN FOOTINGS/SLAB-ON-GRADE FLOOR

NOTES:

1. At the high point of the drain system the bottom of the pipe shall be a minimum of 2 inches below the bottom of the footing.
2. Bottom of trench and drainpipe must slope a minimum of 1/8 inch per foot (i.e., 1%) to a positive gravity outlet (i.e. daylight) and/or to a sump where water can be removed by pumping.
3. Plastic sheeting shall have a minimum thickness of 10 mils, extend beneath the drain media across the bottom of the trench excavation and extend a maximum of 2 inches above the trench bottom. The plastic sheeting shall be continuous, attached to the foundation wall, and shall extend up the foundation wall above the top of the footing a minimum of 12 inches. Where plastic sheeting must be lapped, upstream sections should be placed over downstream sections.
4. Drainpipe shall consist of perforated, machine slotted, or equivalent rigid plastic pipe (minimum Schedule 20), with a minimum inside diameter of 4 inches.
5. Perforated pipe should have a fabric sock around the pipe or alternatively, the pipe perforations or drainage media sized so that at least 85% of the drainage media is larger than the perforations in the pipe.
6. Perforated pipe shall be positioned so that perforations are facing down in about the 4 and 8 o'clock positions.
7. Drainpipe shall be surrounded by an envelope of drainage media. Drainage media shall be at least 2 inches thick under the pipe, 4 inches thick on both sides of the pipe, and shall extend at least 6 inches above the top of the pipe and at least 4 inches above the bottom of the footing.
8. Drainage media shall consist of durable, washed, free draining, crushed natural stone aggregate. Recycled concrete or recycled asphalt materials are not acceptable.
9. Drainage media shall have a maximum particle size of 3/4 inches, 30% to 100% passing the 3/8 inch sieve, and a maximum of 35% passing the #4 sieve size. Alternatively, drainage media meeting CDOT 703.09 Class B Filter requirements may be used.
10. The drainage media shall be covered with a nonwoven geotextile filter fabric consisting of Mirafi 140N or 180N or equivalent. The fabric shall extend beyond the drainage media so that it is lapped against the foundation and the side or bottom of the trench at least 8 inches. Alternatively, the drainage media should be completely wrapped by nonwoven geotextile filter fabric with a minimum overlap of at least 8 inches on top of the drainage media.
11. A vapor retarder should be placed per the recommendation of the geotechnical report. Overlap joints at least 3 feet and seal.
12. The top edge of prefabricated drain board shall be at least 1 foot below final surface grade and shall extend to at least the bottom of the footing. The drain board shall consist of Mirafi 6000 XL (one sided drainage) or equivalent and shall be attached to the foundation wall in accordance with the manufacturer's recommendations.

LEGEND

Free draining granular material (i.e., Drainage media)

Perforated drainpipe

Plastic sheeting

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FIGURE 3
Typical Exterior Perimeter Drain
Footings/Slab On Grade Floor

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APPENDIX A

Field Exploration

FIELD EXPLORATION

At this site, samples of the subsoil were obtained using a split spoon sampler which was driven into the soil by dropping a 140 pound hammer through a free fall of 30 inches. The split spoon sampler is a 2 inch outside diameter by 1-3/8 inch inside diameter device. The procedure to drive the split spoon sampler into the soil and to record the number of blows required to drive the sampler into the soil is known as a penetration test. The number of blows required for the sampler to penetrate 12 inches gives an indication of the of the relative stiffness of cohesive soil, relative density of non-cohesive soil, and relative hardness for sedimentary bedrock material that were encountered.

Bedrock was sampled using NX core lengths of 5 feet.

Bulk samples were collected from cuttings generated during drilling and excavations. Locations of sampling and penetration test results are presented on the boring logs contained in this appendix.

B-1

PROJECT NAME	Lots 17 and 18 Block 7 CB	PROJECT NUMBER	23.6023
BORING LOCATION	See Figure 2	BORING ELEVATION	8921ft.
DRILLING COMPANY/RIG	Dakota Drilling/Track-mounted D-50	CMTTS REP.	D. Fuorry
DRILLING METHOD	5in. Diameter ODEX	DATE STARTED	3/15/2023
HAMMER SYSTEM	140 lb hammer rope and cathead	DATE COMPLETED	3/15/2023

DEPTH (ft)	NATURAL MOISTURE CONTENT (%)	FINES (%)	LL-PL-PI	UNCONFINED COMPRESSIVE STRENGTH (psf)	Recovery/RQD (%/%)	BLOW COUNT	SAMPLE: DRIVE	SAMPLE: BULK	ELEVATION (ft)	MATERIAL DESCRIPTION	DEPTH (ft)	Water Level and Depth of Cave (ft)
0										SAND, silty, with gravel, cobbles and boulders up to 21" in dimension, very dense, low plasticity, slightly moist, light brown to strong brown (SM; A-1-b).		
						20/12	X					
						72/11	X					53
8										Boulder		
9						50/5	X		8912	SAND, clayey, with gravel, cobbles and boulders up to 21" in dimension, very dense, low plasticity, moist to very moist, dark brown to brown with iron oxide staining, weathered shale present at bottom of layer (SC-SM; A-1-b).	9	
11										Boulder		
13	6.2	16	22-17-5					X		Boulder		
16								X				
19.5						93/10	X		8901.5	CLAY, gravelly, with sand, medium plasticity, very moist to wet, gray to brown, weathered shale present (CL; A-6).		19.5
21.5								X	8899.5	WEATHERED BEDROCK, shale and sandstone, medium plasticity (shale), fine to medium grained (sandstone), brown to dark gray.	21.5	
24							Rock core		8897	SHALE, with infrequent sandstone seams, slightly to moderatley weathered, thinly laminated, gray to dark gray.	24	
26				1,134,000	97/53		Rock core		8895	SANDSTONE with interbedded SHALE layers, gray to dark gray. Sandstone: slightly weathered, very strong to extremely strong, close to wide fracture spacing, laminated cross bedding, iron oxide staining. Shale: slightly to moderatley weathered, weak to medium strong, very close to close fracture spacing, laminated bedding.	26	
29					100/80		Rock core					
34					100/89		Rock core					
39									8882		39	

Boring terminated at 39 feet

LEGEND

- ▼ WATER LEVEL AT TIME OF DRILLING
- ∇# WATER LEVEL # DAYS AFTER DRILLING
- →# DEPTH OF CAVE # DAYS AFTER DRILLING
- ↑ DEPTH OF REFUSAL
- BULK SAMPLE
- STANDARD PENETRATION TEST
- ROCK CORE

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PROJECT NAME	Lots 17 and 18 Block 7 CB	PROJECT NUMBER	23.6023
BORING LOCATION	See Figure 2	BORING ELEVATION	8921ft.
DRILLING COMPANY/RIG	Dakota Drilling/Track-mounted D-50	CMTTS REP.	D. Fuorry
DRILLING METHOD	5in. Diameter ODEX	DATE STARTED	3/16/2023
HAMMER SYSTEM	140 lb hammer rope and cathead	DATE COMPLETED	3/16/2023

B-2

DEPTH (ft)	NATURAL DRY DENSITY (pcf)	UNCONFINED COMPRESSIVE STRENGTH (psf)	Recovery/RQD (%/%)	BLOW COUNT	SAMPLE	ELEVATION (ft)	MATERIAL DESCRIPTION	DEPTH (ft)	Water Level and Depth of Cave (ft)
0–3				22/12 (~2–3.5)	Drive (SPT)	8918	SAND, silty, clayey, with gravel and cobbles up to 12" in dimension, dense, low plasticity, slightly moist, strong to dark brown (SC-SM; A-1-b).	3	352
3–7				34/12 (~4–5.5)	Drive (SPT)	8914	SAND, clayey, with gravel and cobbles up to to 12" in dimension, very dense, medium plasticity, moist, strong brown with iron oxide staining (SC; A-2-6).	7	
7–13				68/12 (~9–10.5)	Drive (SPT)	8908	GRAVEL, clayey, with sand, cobbles and boulders, very dense, very moist to wet, dark brown, increasing gravel content with depth (GW-GC; A-1-a).	13	Water level at time of drilling (~10)
13–15					Bulk	8906	WEATHERED BEDROCK, shale and sandstone, medium plasticity (shale), fine to medium grained (sandstone), brown to dark gray.	15	
15–28			100/77 (19–24); 97/42 (24–29)		Bulk (17–19); Rock core (19–)	8893	SANDSTONE with interbedded SHALE layers, gray to dark gray. Sandstone: unweathered to slightly weathered, very strong to extremely strong, close to wide fracture spacing, laminated cross bedding, iron oxide staining. Shale: slightly to moderatley weathered, very weak to weak, extremely close to close fracture spacing, laminated bedding.	28	
28–39	153.3	2,233,000	97/63 (29–34); 98/48 (34–39)		Rock core	8882	SANDSTONE with interbedded SHALE seams and layers, poor to fair quality, gray to dark gray. Sandstone: unweathered to slightly weathered, strong to very strong, very close to moderate fracture spacing, laminated, FeOX staining. Shale: slightly to moderatley weathered, very weak to weak, extremely close to close fracture spacing, laminated bedding. 9 inch thick calcite vein at about 36.5 feet	39	

Boring terminated at 39 feet

LEGEND

- WATER LEVEL AT TIME OF DRILLING
- WATER LEVEL # DAYS AFTER DRILLING
- DEPTH OF CAVE # DAYS AFTER DRILLING
- DEPTH OF REFUSAL
- BULK SAMPLE
- STANDARD PENETRATION TEST
- ROCK CORE

CMT TECHNICAL SERVICES

PROJECT NAME	Lots 17 and 18 Block 7 CB	PROJECT NUMBER	23.6023	**B-3**
BORING LOCATION	See Figure 2	BORING ELEVATION	8920ft.	
DRILLING COMPANY/RIG	Dakota Drilling/Track-mounted D-50	CMTTS REP.	D. Fuorry	
DRILLING METHOD	5in. Diameter ODEX	DATE STARTED	3/16/2023	
HAMMER SYSTEM	140 lb hammer rope and cathead	DATE COMPLETED	3/16/2023	

DEPTH (ft)	NATURAL MOISTURE CONTENT (%)	FINES (%)	LL-PL-PI	Recovery/RQD (%/%)	BLOW COUNT	SAMPLE	ELEVATION (ft)	MATERIAL DESCRIPTION	DEPTH (ft)	Water Level and Depth of Cave (ft)
0–3					70/11	Drive (SPT); Bulk	8917	SAND, silty, with gravel, cobbles and boulders up to 18" in dimension, very dense, low plasticity, slightly moist, light to strong brown (SM; A-1-b),	3	
3–6	6.1	19	NV-NP-NP		43/12	Drive (SPT); Bulk	8914	SAND, with silt and gravel, cobbles and boulders up to 18" in dimension, very dense, poorly sorted, slightly moist, gravel content increases with depth, brown (SP-SM; A-1-b).	6	▽52
6–10						Drive (SPT); Bulk	8910	GRAVEL, clayey, with sand, cobbles and boulders, very dense, fine to coarse grained, medium plasticity, strong brown to gray (GW-GC; A-1-a).	10	▼10
10–11							8909	WEATHERED BEDROCK, shale and sandstone, medium plasticity (shale), fine to medium grained (sandstone), brown to dark gray	11	
11–23				97/34; 98/66		Rock Core	8897	SANDSTONE with interbedded SHALE layers, poor to fair quality, gray to dark gray. Sandstone: slightly to moderatley weathered, medium strong to extremely strong, extremely close to moderate fracture spacing, laminated bedding, iron oxide staining. Shale: slightly to moderatley weathered, weak to medium strong, extremely close to very close fracture spacing, laminated bedding.	23	
23–36.5				95/85; 97/76; 100/87.5		Rock Core	8883.5	SANDSTONE with interbedded SHALE seams and layers, fair to good quality, gray to dark gray. Sandstone: unweathered to slightly weathered, very strong to extremely strong, close to wide fracture spacing, laminated bedding. Shale: slightly to moderatley weathered, weak to medium strong, extremely close to close fracture spacing, laminated bedding.	36.5	
36.5–40				100/75		Rock Core	8880	SHALE with interbedded SANDSTONE seams and layers, slightly to moderately weathered, weak to medium strong, extremely close to moderate fracture spacing, laminated bedding, gray to dark gray.	40	

Boring terminated at 40 feet

LEGEND

- ▼ WATER LEVEL AT TIME OF DRILLING
- ▽# WATER LEVEL # DAYS AFTER DRILLING
- →# DEPTH OF CAVE # DAYS AFTER DRILLING
- ↑ DEPTH OF REFUSAL
- BULK SAMPLE
- STANDARD PENETRATION TEST
- ROCK CORE

CMT TECHNICAL SERVICES

PROJECT NAME	Lots 17 and 18 Block 7 CB	EXPLORATORY PIT ID	EP-1
PROJECT NUMBER	23.6023	PIT ELEVATION	8912ft.
CMTTS REP.	D. Fuorry	PIT LOCATION	See Figure 2
DATE STARTED	3/17/2023	EXCAVATOR COMPANY	Lacy
DATE COMPLETED	3/17/2023	TYPE OF EXCAVATOR	CAT 308
CO STATE PLANE			

WATER LEVEL & CAVE DEPTH (ft)	GRAPHIC LOG	ELEVATION (ft)	MATERIAL DESCRIPTION	DEPTH (ft)	DEPTH (ft)	SAMPLE	NATURAL MOISTURE CONTENT (%)	NATURAL DRY DENSITY (pcf)	LL-PL-PI	FINES (%)	SWELL-CONSOL VOL CHANGE/SURCHARGE PRESSURE (psf)
		8911.5	TOPSOIL, organic rich, angular to subrounded, dark brown, wet	0.5	0.0						
▼		8910	CLAY, gravelly with sand, cobbles and boulders up to 20" in dimension, wet, gray to light brown (CL; A-6).	2							
		8906	GRAVEL, with silt and sand, cobbles and boulders up to 24" in dimension, non-plastic, angular to rounded clasts, wet, brown to strong brown (GW-GM; A-1-a).	6	2.5 5.0	Bulk	8		23-20-3	10	
↑			Pit excavated to 6 feet								

LEGEND

▼ WATER LEVEL AT TIME OF EXCAVATION

BULK SAMPLE

↑ DEPTH OF REFUSAL

CMT TECHNICAL SERVICES

APPENDIX B

Laboratory Testing

LABORATORY TESTING

Unconfined compressive strength testing was performed to evaluate undrained shear strength of the soil. Testing was performed on core samples using ASTM D2166. For shale, the unconfined compressive strength was estimated using point load testing (ASTM D5731).

SUMMARY OF LABORATORY TEST RESULTS
Lots 17 and 18 Block 7
Project No. 23.6023

Sample Location		Natural Dry Density (pcf)	Natural Moisture Content (%)	Water Soluble Sulfates (%)	Unconfined Compressive Strength (ksf)	Gradation			Atterberg Limits		Material Type
Boring / Pit	Depth (feet)					Gravel (%)	Sand (%)	Silt/ Clay (%)	Liquid Limit (%)	Plasticity Index (%)	
EP-1	2 to 6		8.0			49	41	10	23	3	GRAVEL, sandy, with silt, dark brown (GW-GM), A-1-a
B-1	13 to 14		6.2			41	43	16	22	5	SAND, silty, clayey, with gravel, dark brown (SC-SM), A-1-b
B-1	24				1,134*						SANDSTONE, thinly laminated, dark gray
B-2	29	153.3	0.5		2233						SANDSTONE, massive, gray
B-3	0 to 10		6.1	0.00		33	48	19	NV	NP	SAND, silty, with gravel, brown (SM), A-1-b

* estimate using point load test (ASTM D5731)
NP = non plastic
NV = no value

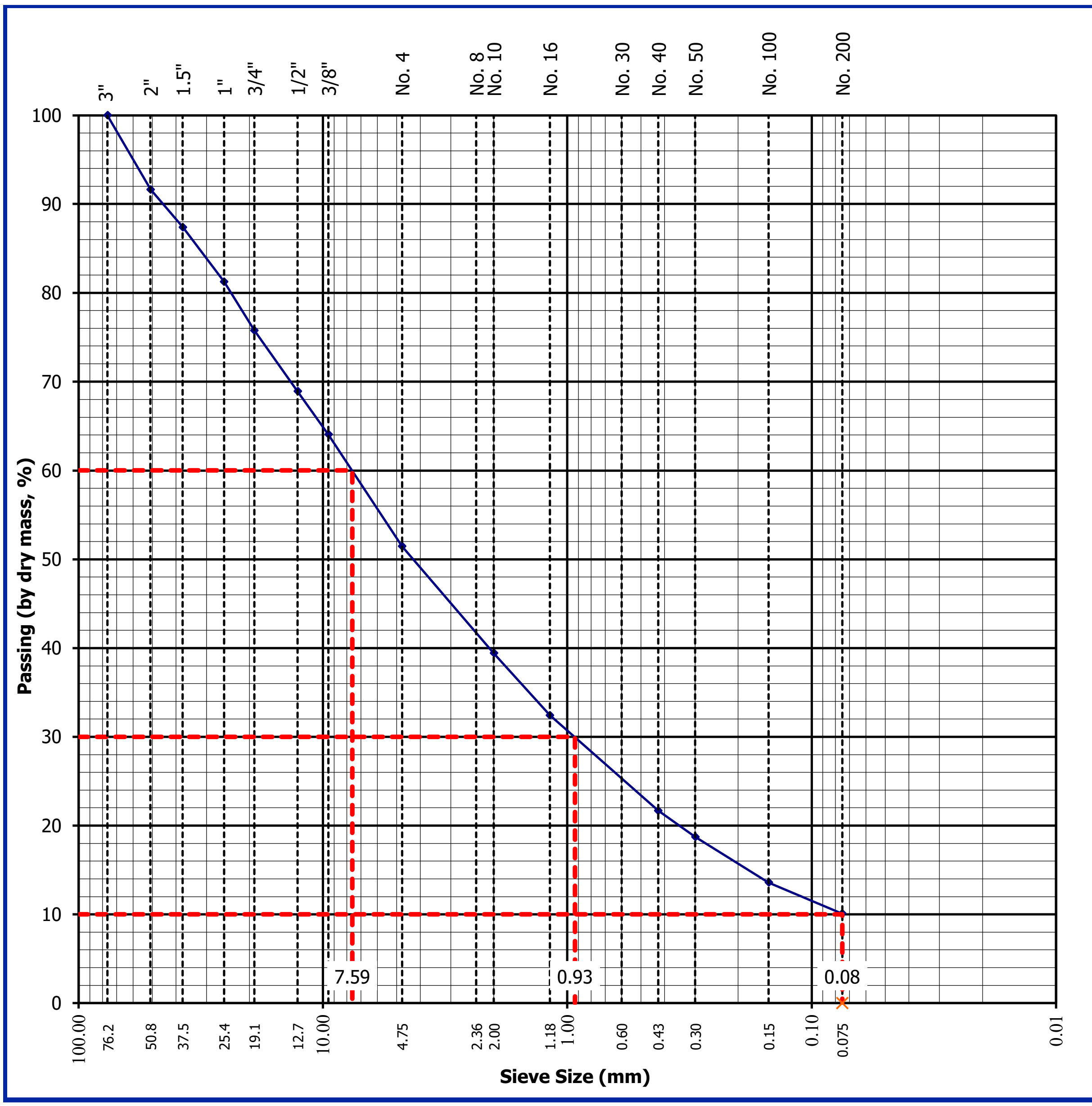
CMT TECHNICAL SERVICES

AASHTO ACCREDITED

GRADATION PLOT - SOIL AND AGGREGATE

Project number	23.6023	Date	March 28, 2023
Project name	Lots 17 and 18 Block 7	Technician	D. Fuorry
Lab ID number	SW232035	Reviewer	G. Hoyos
Sample location	EP-1 at 2 to 6 feet		
Visual description	GRAVEL, sandy, with silt, dark brown		

AASHTO M145 Classification				Soaking Method	
				Procedure	**Method**
Classification	**A-1-a**	**Group Index**	**(0)**	AASHTO T11	
Unified Soil Classification System (ASTM D2487)				ASTM D1140	**B**
(GW-GM)	**Well graded gravel with silt and sand**			Specimen soaking time (min)	**1,170**



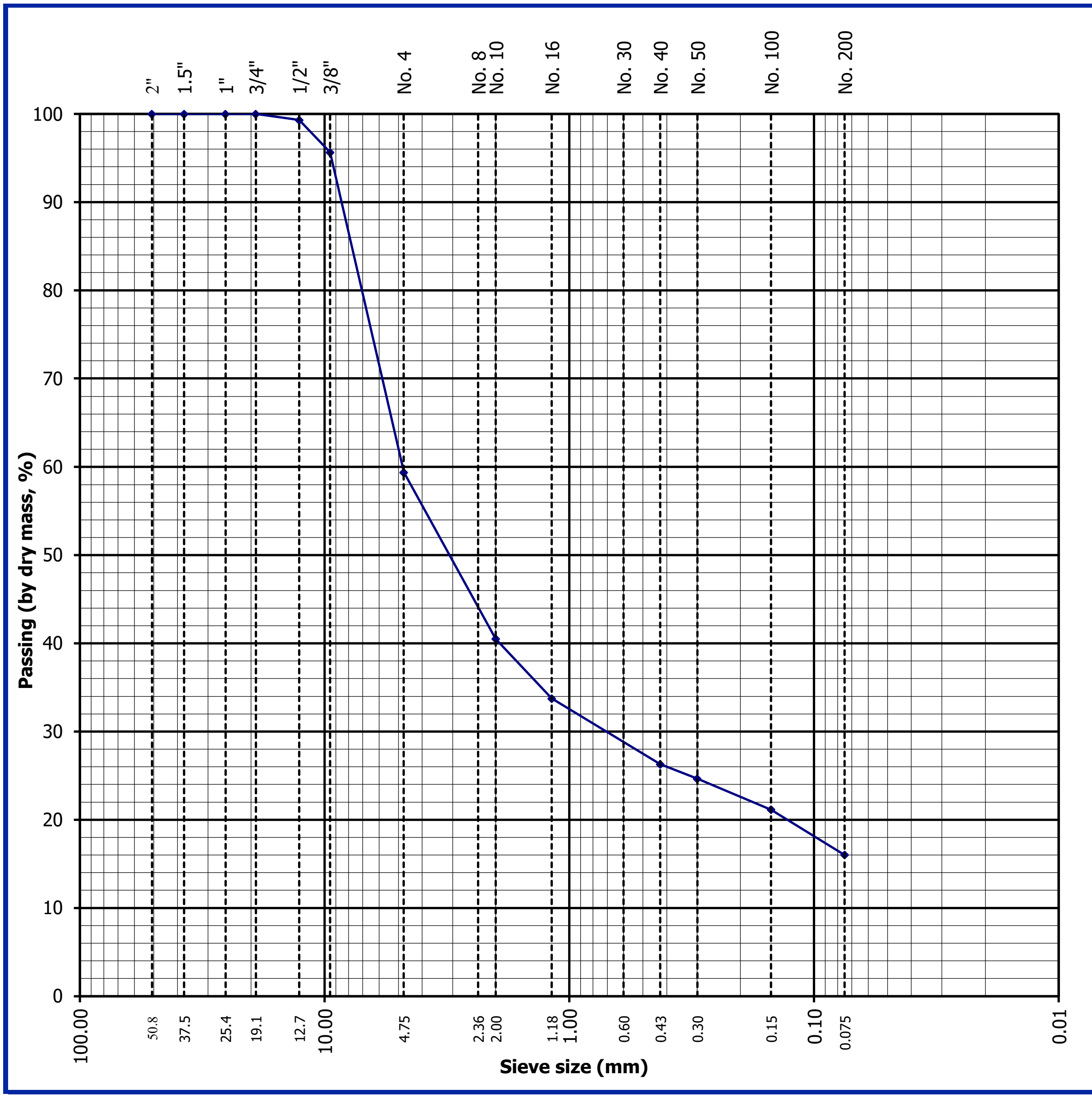
Sieve Size	**Passing (%)**
3"	
2"	92
1.5"	87
1"	81
3/4"	76
1/2"	69
3/8"	64
#4	51
#8	
#10	39
#16	32
#30	
#40	22
#50	19
#100	14
#200	10.1

Moisture (M) and Density (D)	
M (%)	8.0
D (pcf)	
LL	23
PL	20
PI	3
D_{60}	7.59
D_{30}	0.93
D_{10}	0.08
Cu	**101.20**
Cc	**1.52**

GRADATION PLOT - SOIL AND AGGREGATE

Project number	23.6023	Date	March 29, 2023
Project name	Lots 17 and 18 Block 7	Technician	D. Fuorry
Lab ID number	SW232036	Reviewer	G. Hoyos
Sample location	B-1 at 14 feet		
Visual description	SAND, silty, clayey, with gravel, dark brown		

AASHTO M145 Classification				Soaking Method	
				Procedure	**Method**
Classification	**A-1-b**	**Group Index**	**(0)**	AASHTO T11	
Unified Soil Classification System (ASTM D2487)				ASTM D1140	**B**
(SC-SM)	**Silty, clayey sand with gravel**			Specimen soaking time (min)	**>2,880**



Sieve Size	Passing (%)
2"	
1.5"	
1"	
3/4"	100
1/2"	99
3/8"	96
#4	59
#8	
#10	41
#16	34
#30	
#40	26
#50	25
#100	21
#200	16.0

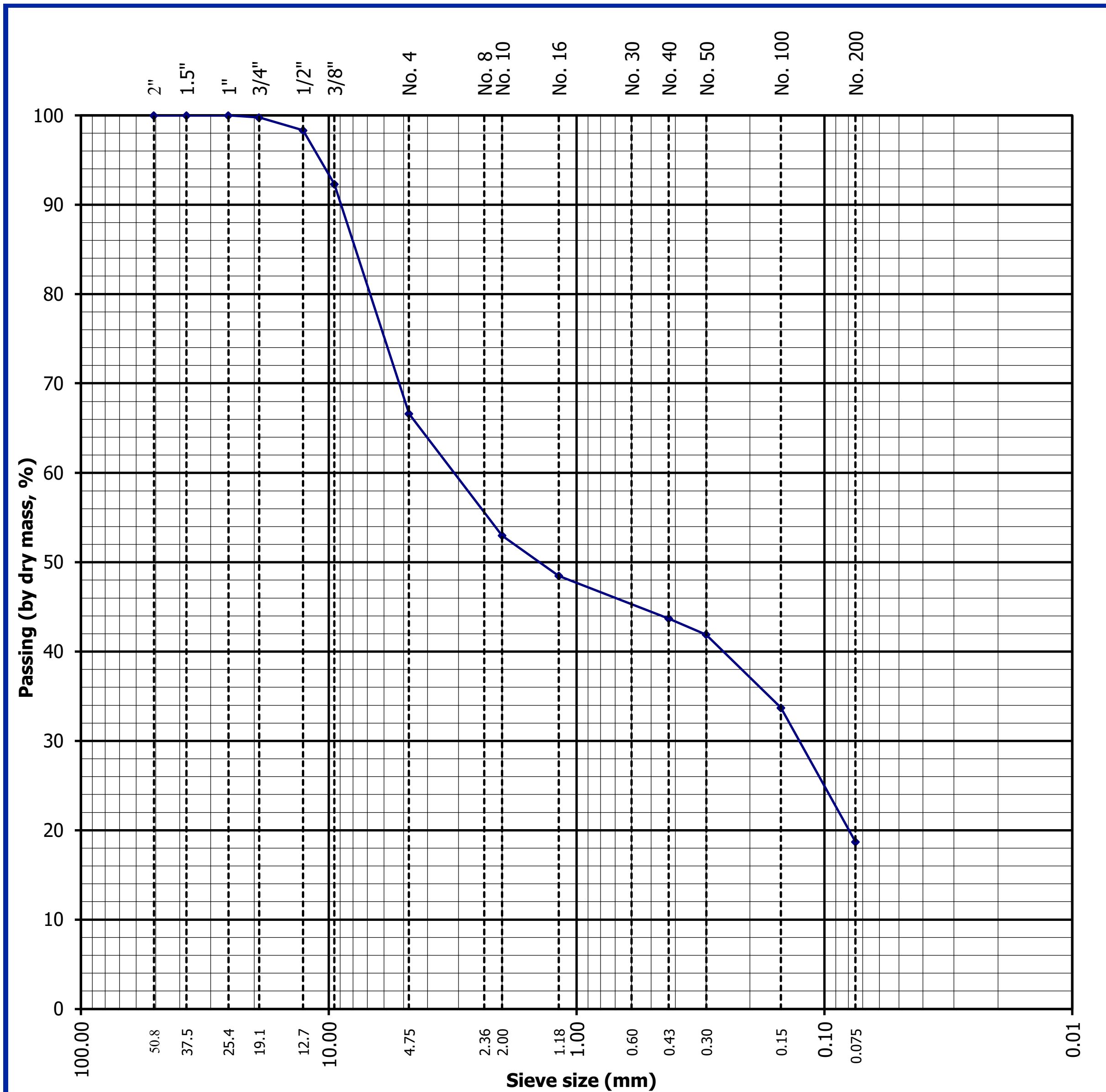
Moisture (M) and Density (D)	
M (%)	6.2
D (pcf)	
LL	22
PL	17
PI	5
D_{60}	
D_{30}	
D_{10}	
Cu	
Cc	

CMT TECHNICAL SERVICES

GRADATION PLOT - SOIL AND AGGREGATE

Project number	23.6023	Date	March 29, 2023
Project name	Lots 17 and 18 Block 7	Technician	D. Fuorry
Lab ID number	SW232037	Reviewer	G. Hoyos
Sample location	B-3 at 0 to 10 feet		
Visual description	SAND, silty, with gravel, brown		

AASHTO M145 Classification				Soaking Method	
				Procedure	**Method**
Classification	**A-1-b**	**Group Index**	**0**	AASHTO T11	
Unified Soil Classification System (ASTM D2487)				ASTM D1140	**A**
(SM)	**Silty sand with gravel**			Specimen soaking time (min)	**NR**



Sieve Size	Passing (%)
2"	
1.5"	
1"	100
3/4"	100
1/2"	98
3/8"	92
#4	67
#8	
#10	53
#16	48
#30	
#40	44
#50	42
#100	34
#200	18.7
Moisture (M) and Density (D)	
M (%)	6.1
D (pcf)	
LL	NV
PL	NP
PI	NP
D_{60}	
D_{30}	
D_{10}	
Cu	
Cc	

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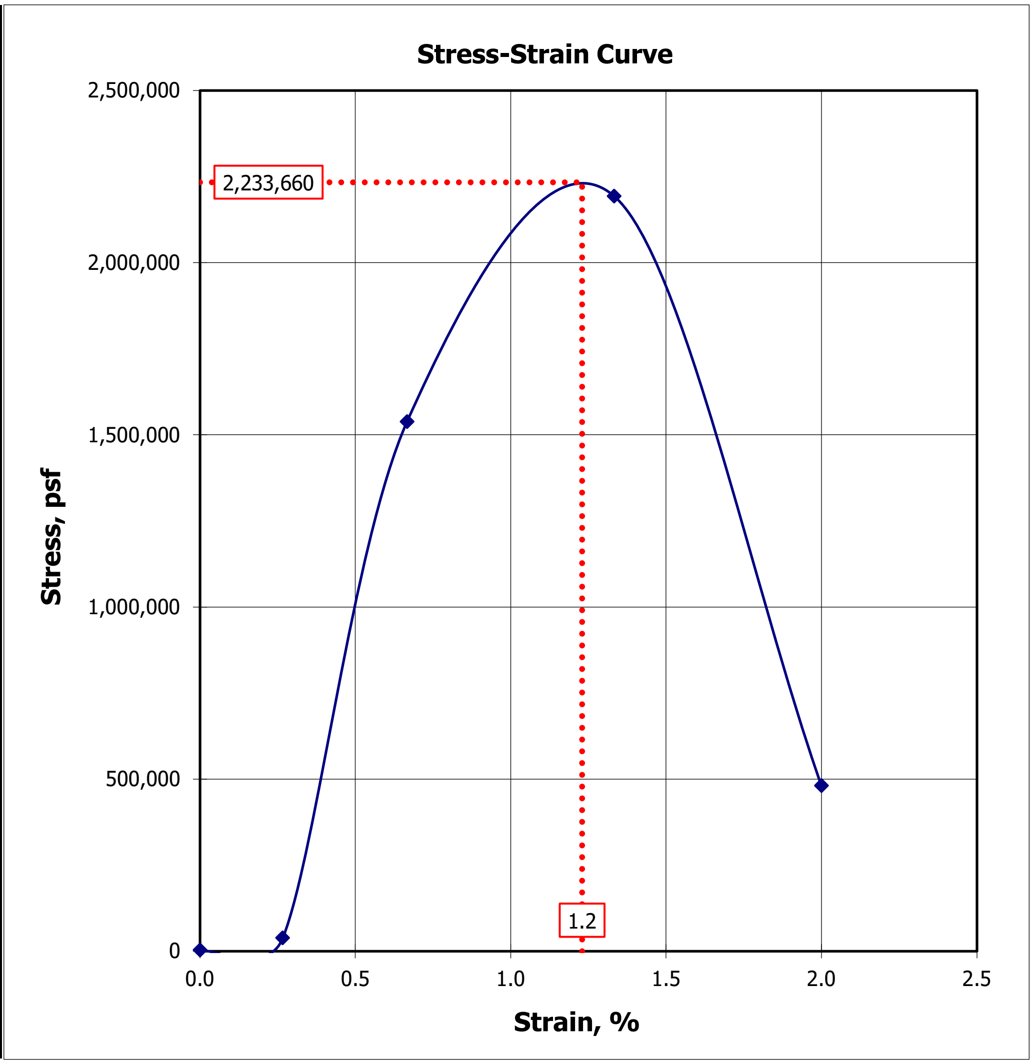
UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOIL (ASTM D2166)

Project No.:	23.6023			Hole:	B-2
Project Name:	Lots 17 and 18 Block 7			Depth:	29.25 to 30 feet
Date:	25-Apr-23	Lab Tech:	J. Holiman	Visual Description of Sample:	
Lab ID:	232277	Checked By:	G. Hoyos	SANDSTONE, gray	

Unconfined Compressive Strength (q_u):	**2,233,660**	**psf**	**Density (pcf):**	153.3
Shear Strength (S_u):	**1,116,830**	**psf**	**Moisture:**	0.5

Axial Strain (%)	Axial Stress (psf)
0.0	2,647.0
0.3	38,542.8
0.7	1,538,157.3
1.3	2,192,768.4
2.0	480415.4



APPENDIX C

Vapor Barriers

VAPOR BARRIERS

If it is determined that a vapor retarder/barrier is warranted, CMT recommends that the vapor barrier comply with ASTM E1745, and if moisture sensitive flooring will be utilized, have a permeance below 0.01 perms before and after mandatory conditioning testing. The vapor retarder/barrier should be installed per ASTM E1643 and the design professional should consider project specific requirements in specification verbiage. See the ACI Committee 302, "Guide for Concrete Floor and Slab Construction (ACI 302.R-96)" for additional discussion and guidance regarding the use of vapor retarders/barriers beneath floor slabs.

Section 1805 of the 2018 IBC addresses dampproofing and waterproofing as follows:

Section 1805.1 General.

> *"Walls or portions thereof that retain earth and enclose interior spaces and floors below grade shall be waterproofed and dampproofed in accordance with this section, with the exception of those spaces containing groups other than residential and institutional where such omission is not detrimental to the building or occupancy.*

Section 1805.2 Dampproofing.

> *"Where hydrostatic pressure will not occur, as determined by Section 1803.5.4, floors and walls for other than wood foundation systems shall be dampproofed in accordance with this section."*

Section 1805.2.1 Floors.

> "*Dampproofing materials for floors shall be installed between the floor and the base course required by Section 1805.4.1, except where a separate floor is provided above a concrete slab. Where installed beneath the slab, dampproofing shall consist of not less than 6-mil (0.006 inch; 0.152 mm) polyethylene with joints lapped not less than 6 inches (152 mm), or other approved methods or materials. Where permitted to be installed on top of the slab, damp proofing shall consist of mopped-on bitumen, not less than 4-mil; (0.004 inch; 0.102 mm) polyethylene, or other approved methods or materials. Joints in the membrane shall be lapped and sealed in accordance with the manufacturer's installation instructions*".

Section 1805.4.1 Floor Base Course.

> *"Floors of basements, except as provided for in Section 1805.1.1 shall be placed over a floor base course not less than 4 inches (102 mm) in thickness that consists of gravel or crushed stone containing no more than 10 percent of material that passes through a No. 4 (4.75mm) sieve."*

CMT recommends the architect be consulted regarding the need for a vapor retarder or vapor barrier. Decision to include a vapor retarder/barrier beneath the slab is dependent on the sensitivity of floor coverings and building use to moisture.