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GEOLOGY AND SOILS REPORT

Yarbrough Minor Subdivision
0 Rockbrook Road
El Paso County, CO

PREPARED FOR:

Richard Yarbrough
18385 White Fawn Dr
Monument, CO 80132

JOB NO. 163771

June 20, 2018

Respectfully Submitted,

RMG – Rocky Mountain Group

Kelli Zigler
Project Geologist

Reviewed by,

RMG – Rocky Mountain Group

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45046
PROFESSIONAL ENGINEER

TABLE OF CONTENTS

FIGURES

1.0 GENERAL SITE AND PROJECT DESCRIPTION

1.1 Project Location

The project lies in the northeast portion of Section 9, Township 11 South, Range 66 West of the 6th Principal Meridian in El Paso County, Colorado. The approximate location of the site is shown on the Site Vicinity Map, Figure 1.

1.2 Existing Land Use

The Yarbrough minor subdivision currently consists of one 1.72 acre parcel. The parcel included in this investigation is undeveloped and unplatted land. An existing driveway follows the western boundary of the property, providing access to an existing residence south of the lot. Rockbrook Road is an existing gravel public road, which terminates in a non-standard cul-de-sac at the north end of the Yarbrough property.

1.3 Project Description

The parcel is to contain one new single-family residence with water provided by Forest View Acres Water District and wastewater treatment provided by Palmer Lake Sanitation District. A Topographic Survey provided by Rampart Surveys, Inc. dated April 1, 2010 is presented in Figure 2.

2.0 QUALIFICATIONS OF PREPARERS

This Geology and Soils report was prepared by a professional geologist as defined by Colorado Revised Statures section 34-1-201(3) and by a qualified geotechnical engineer as defined by policy statement 15, "Engineering in Designated Natural Hazards Areas" of the Colorado State Board of Registration for Professional Engineers and Professional Land Surveyors. (Ord. 96-74; Ord. 01-42)

The principle investigators for this study are Kelli Zigler, P.G. and Geoff G. Webster, P.E. Ms. Zigler is a Professional Geologist as defined by State Statute (C.R.S 34-1-201) with over 17 years of experience in the geological and geotechnical engineering field. Ms. Kelli Zigler holds a B.S. in Geology from the University of Tulsa. Ms. Zigler has supervised and performed numerous geological and geotechnical field investigations in Colorado.

Geoff Webster, P.E. is a licensed Professional Engineer with over 33 years of experience in the structural and geotechnical engineering fields. Mr. Webster is a professional engineer and holds a Master's degree from the University of Central Florida. Mr. Webster has supervised and performed numerous geological and geotechnical field investigation programs in Colorado and other states.

3.0 STUDY OVERVIEW

The purpose of this investigation is to characterize the general geotechnical and geologic site conditions, and present our opinions of the potential effect of these conditions on the proposed development of single-family residences within the referenced site. As such, our services exclude evaluation of the environmental and/or human, health-related work products or recommendations previously prepared, by others, for this project.

Revisions to the conclusions presented in this report may be issued based upon submission of the development plan. This study has been prepared in accordance with the requirements outlined in the El Paso County Land Development Code (LDC) specifically Chapter 8 last updated 01/06/2015 applicable sections include 8.4.9. and the Engineering Criteria Manual (ECM), specifically Appendix C last updated July 29, 2015.

This report presents the findings of the study performed by RMG relating to the geotechnical and geologic conditions of the above-referenced site. Revisions and modifications to the conclusions and recommendations presented in this report may be issued subsequently by RMG based upon additional observations made during grading and construction which may indicate conditions that require re-evaluation of some of the criteria presented in this report.

3.1 Scope and Objective

This report presents the findings of our Geology and Soils Investigation for the Yarbrough minor subdivsion located in northern El Paso County, Colorado.

The purpose of our report is to adhere to the guidelines outlined in Appendix C of the ECM and Chapter 8.4.9 of the LDC. The occurrences of potential geologic hazards were evaluated and our opinions of the observed conditions on the proposed development with the respect to the intended usage are outlined in this report.

This report presents the findings of the study performed by RMG-Rocky Mountain Group (RMG) relating to the geology and soil conditions of the above-referenced site.

3.2 Site Evaluation Techniques

The information included in this report has been compiled from:

- Field reconnaissance
- Geologic and topographic maps
- Review of selected publicly available, pertinent reports
- Available aerial photographs
- Exploratory borings
- Laboratory testing of representative site soil and rock samples
- Geologic research and analysis
- Site development plans prepared by others

Geophysical investigations were not considered necessary for characterization of the site geology. Monitoring programs, which typically include instrumentation and/or observations for changes in groundwater, surface water flows, slope stability, subsidence, and similar conditions, are not known to exist and were not considered applicable for the scope of this report.

3.3 Previous Studies and Field Investigation

Reports of previous geotechnical engineering/geologic investigations for this site were available for our review along with additional studies performed for the site are listed below.

1. *Soils Report, S-1/2, SE 1/4, Section 9. TS 11 S, Range 67 West of the 6th PM, Tock Brook Road, El Paso County, Colorado*, Front Range Geotechnical, Inc, Job #14792 dated March 2, 2006.
2. *United States Department of the Interior, Fish and Wildlife Service, Ecological Services, with regard to the Preble's meadow jumping mouse*, dated December 1, 2009.
3. *Drainage Letter Report for Yarbrough Subdivision*, JPS Engineering, May 5, 2010.
4. *Colorado Wildfire Risk Assessment Summary Report, Yarbrough Minor Subdivision*, report generated December 20, 2017.

4.0 SITE CONDITIONS

4.1 Proposed Land Use and Zoning

The site is generally located south and west of the intersection of Highway 105 and Rockbrook Road, Monument, El Paso County, Colorado. The site includes one parcel and has a total acreage of approximately 1.72 acres, on which there has been no development. Figure 1 presents the general boundaries of our investigation.

Based upon our review of the Public Record Real Estate Property Search provided by El Paso County Assessors web-site, the parcel of land is zoned "RR-0.5 – Residential Rural – 0.5 acre minimum lots". The surrounding properties are also county zoned as "RR-0.5 – Residential Rural – 0.5 acre minimum lots". The proposed minor subdivision will create a single residential building lot.

4.2 Topography

In general, the site is higher in elevation on the eastern portion of the site and gradually steps down to the west towards Monument Creek. The overall slope of the site is generally down to the west with approximately 40 feet of elevation difference from the east to the west property lines.

4.3 Vegetation

The majority of the site consists of native deciduous trees and low lying vegetation consisting of native grasses, weeds and yuccas.

5.0 FIELD INVESTIGATION

5.1 Drilling

The subsurface conditions within the property were explored by drilling two exploratory borings on May 3, 2018 extending to depths of approximately 20 feet below the existing ground surface. The test borings were performed to explore the subsurface soils underlying the proposed site. The Topographic Survey with Test Boring Locations is presented in Figure 3.

The test borings were drilled with a power-driven, continuous-flight auger drill rig. Samples were obtained during drilling of the test borings in general accordance with ASTM D-1586 utilizing a 2-inch O.D. Split Barrel sampler. Results of the penetration tests are shown on the drilling logs. The Explanation of Test Boring Logs and Test Boring Logs are presented in Figures 4 and 5.

5.2 Laboratory Testing

Soil laboratory testing was performed as part of this investigation. The laboratory tests included moisture content, dry density, grain-size analyses and Atterberg Limits. Swell/Consolidation tests were not performed on the onsite non-expansive sandstone. A Summary of Laboratory Test Results is presented in Figure 6. Soils Classification Data is presented in Figure 7.

6.0 GEOLOGIC AND SUBSURFACE CONDITIONS

6.1 Geologic Conditions

Based upon review of the *Geologic Map of the Palmer Lake Quadrangle, El Paso County, Colorado,* Keller, Morgan, Thorson, Lindsay and Barkmann, 2006 the site reconnaissance and exploratory drilling, the site is underlain by the Dawson Formation.

The geology at the site and surrounding area generally consists of a silty to clayey sand overlying the Dawson Formation. The Palmer Lake Quadrangle is presented in Figure 9.

6.2 General Geology

Our field investigation included a site reconnaissance with consideration given to geologic features and significant surficial deposits.

In general, the geology at the site consists of alluvium soils overlying the Dawson formation. Two geologic units were mapped at the site as:

- Qg_2 - Gravel deposit two (early middle Pleistocene) – composed of reddish brown to brown, poorly sorted, bouldery cobble and gravel and sand above Monument Creek. This unit is derived from the Pikes Peak Granite.
- $Tkda_4$ - Dawson Formation, facies unit four (Paleocene) – lithofacies unit four of the Dawson Formation is dominated by very thick-bedded to massive cross-bedded,

pebbly arkose to Arkosic pebble conglomerate. The sandstones are poorly sorted and have high clay contents which are usually thinly bedded.

The General Geology and Engineering Geology Map is presented if Figure 8.

6.3 U.S. Soil Conservation Service

The U.S. Soil Conservation Service along with United States Department of Agriculture (USDA) has identified the soils on the property as:

- 41 – Kettle gravelly loamy sand, 8 to 40% slopes. Properties of the gravelly loamy sand include, somewhat excessively drained soils, depth of the water table is anticipated to be greater than 6.5 feet, run-off is anticipated to be medium, frequency of flooding and/or ponding is none, and landforms include hills.

  The USDA Soil Survey Map is presented in Figure 10.

6.4 Subsurface Materials

The subsurface materials encountered in the test borings were classified using the Unified Soils Classification System (USCS) and the materials were grouped into the general categories of poorly graded sand with various amounts of silt (SM-SP), overlying sandstone bedrock.

Additional descriptions and the interpreted distribution (approximate depths) of the subsurface materials are presented on the Test Boring Logs presented in Figure 5. The descriptions shown on the logs are based upon the engineer's visual classification of the samples at the depths indicated. Stratification lines shown on the logs represent the approximate boundaries between material types and the actual transitions may be gradual and vary with location.

6.5 Bedrock Conditions

Bedrock was encountered in both test borings for this investigation. The bedrock beneath the site is considered to be part of the Dawson Formation – facies unit four which consists of silty sandstone. The bedrock was encountered from the existing ground surface to the 20-foot termination depth of the test borings. The Dawson formation is thick-bedded to massive, generally light colored arkose, pebbly, and pebble conglomerate. The sandstones are poorly sorted with high clay contents. The sandstone is generally permeable, well drained, and has good foundation characteristics.

6.6 Structural Features

Structural features such as schistocity, folds, zones of contortion or crushing, joints, shear zones or faults were not observed on the site, surrounding the site, or in the soil samples collected for laboratory testing.

6.7 Surficial (Unconsolidated) Deposits

Various lake and pond sediments, swamp accumulations, sand dunes, marine and non-marine terrace deposits, talus accumulations, creep or slope wash were not observed on the site. Slump and slide debris were not observed on the site.

6.8 Drainage of Water and Groundwater

The overall topography of the site slopes down from the east to the west, towards Monument Creek. Groundwater was not encountered in the test borings at the time of drilling.

Monument Creek is currently a defined drainage way that is approximately the western property line of the site. It is not anticipated that the drainage of Monument Creek will adversely impact construction on the property due to the elevation change from the creek at 6970 feet to the proposed construction site at approximately 7008 feet.

6.9 Features of Special Significance

Features of special significance such as accelerated erosion, (advancing gully head, badlands or cliff reentrants) were not observed on the property. Features indicating settlement or subsidence such as fissures, scarplets and offset reference features were also not observed on the property.

Features indicating creep, slump or slide masses in bedrock and surficial deposits were also not observed on the property.

6.10 Engineering Geology

The Engineering Geology is presented below. Charles Robinson and Associates (1977) have mapped two environmental engineering units on the site as:

- 3B – Expansive and potentially expansive soil and bedrock on moderate to steep slopes (0 to 12%).
- 7A – Phyisographic floodplain where erosion and deposition presently occur and is generally subject to recurrent flooding. Includes 100-year floodplain along major streams where floodplain studies have been conducted.

Although, the engineering unit 3B was mapped in the vicinity of the site, expansive soils and bedrock were not encountered in the test borings performed for this investigation.

The Engineering Geology is presented in the General Geology and Engineering Geology Map in Figure 9.

6.11 Mineral Resources

Under the provision of House Bill 1529, it was made a policy by the State of Colorado to preserve for extraction commercial mineral resources located in a populous county. Review of the *Master Plan for Mineral Extraction*, *Map 1* indicates the site is not identified as an aggregate resource.

Extraction of the sand and sandstone resources are not considered to be economical compared to materials available elsewhere within the county.

6.12 Permeability

The permeability of a soil measures how well air and water can flow within the soil. Soil permeability varies according to the type of soil and other factors.

The infiltration rate of a soil refers to how much water a type of soil can absorb over a specific time period. Infiltration rates are determined by soil permeability and surface conditions, and usually are measured in inches per hour.

The soils encountered in the test borings, at the time of drilling were silty to clayey sand and sandstone. The permeability of the sands is anticipated to be moderate to high. The permeability of the sandstone is anticipated to be low.

7.0 POTENTIAL GEOLOGIC CONDITIONS

The El Paso County Engineering Criteria Manual recognizes and delineates the difference between hazards and constraints. A geologic hazard is one of several types of adverse geologic conditions capable of causing significant damage or loss of property and life. Geologic hazards are defined in Section C.2.2 Sub-section E.1 of the ECM. A geologic constraint is one of several types of adverse geologic conditions capable of limiting or restricting construction on a particular site. Geologic constraints are defined in Section C.2.2 Sub-section E.2 of the ECM. The following sections discuss potential geologic conditions that commonly exist within El Paso County, Colorado.

7.1 Landslides

Landslides are a form of mass wasting slope failure that consists of relatively rapid downward sliding, falling, or flowing of a mass of soil, rock, or a mixture of the two. Landslides typically have one or more distinct failure surfaces. They typically occur on slope sides where the shear strength of a material is exceeded by the driving mass or weight of the material and may be induced by the presence of groundwater, heavy precipitation, and seismic events.

The entire area appears to lie outside the mapped areas of previous landslide and/or unstable slopes according to the electronic (online) version of the Colorado Landside Inventory map prepared by the Colorado Geological Survey (CGS) located at:

https://cologeosurvey.maps.arcgis.com/apps/webappviewer/index.html?id=5e7484a637c4432e84f4f16d0af306d3

Neither unstable slopes nor apparent signs of ongoing slope movement were observed on the property.

7.2 Rockfall

Rockfall is the falling of a newly detached mass of rock from a cliff or down a very steep slope, and is considered to be a type of landslide with a very rapid rate of down-slope movement. It usually occurs on mountainsides or other steep slopes during periods of abundant moisture and frequent freeze-thaw cycles, and is caused by the loss of support from underneath or detachment from a larger rock mass. Ice wedging, root growth, or ground shaking, erosion or chemical weathering may start the fall. The rocks may freefall, bounce, tumble, roll, or slide down slope and can vary considerably in size.

The subject site does not have steep slopes with large boulders above or around it to generate rockfall. The subject property is not considered to be prone to rockfall.

7.3 Debris Flow and Debris Fans

Debris flows consist of water with a high sediment load of sand, cobbles and boulders flowing down a stream, ravine, canyon, arroyo or gully, and are typically activated by heavy or long-term rains or snowmelts which cause rapid erosion and transport of surficial materials down slope of drainages. Debris fans are created when debris flows reach a valley with a much lower gradient. As the energy level drops, the sediment load is deposited creating the fan shape.

The potential for the development of significant debris flows was not observed on the surface of the property.

7.4 Faults and Seismicity

Information presented by the CGS indicates that several recent earthquakes have occurred in the vicinity of the Ute Pass Fault near Colorado Springs and Woodland Park. The earthquakes, with magnitudes in the range of 3.0 to 3.9, occurred approximately from 1962 to 2007. According to the CGS, these faults are not considered to be recently active. However, they have been active during geologic times and could affect the site if they did rupture.

Earthquakes felt at this site will most likely result from minor shifting of the granite mass within the Pikes Peak Batholith which includes pull from minor movements along faults found in the Denver basin. Ground motions resulting from small earthquakes are more likely to affect structures at this site and will likely only affect slopes stability to a minimal degree.

In accordance with the International Building Code, 2012/2015, seismic design parameters have been determined for this site. The Seismic Site Class has been interpreted from the results of the soil test boring drilled within the project site. The USGS seismic design tool has been used to determine the seismic response acceleration parameters. USGS output is presented in Appendix B. The soil on this site is not considered susceptible to liquefaction. The following recommended Seismic Design Parameters are based upon Seismic Site Class B, and a 2 percent probability of exceedance in 50 years. The Seismic Design Category is “B”.

Period (sec)	Mapped MCE Spectral Response Acceleration (g)		Site Coefficients		Adjusted MCE Spectral Response Acceleration (g)		Design Spectral Response Acceleration (g)	
0.2	S_s	0.189	F_a	1.6	S_{ms}	0.302	S_{ds}	0.202
1.0	S_1	0.061	F_v	2.4	S_{m1}	0.146	S_{d1}	0.098

Notes: MCE = Maximum Considered Earthquake
g = acceleration due to gravity

The USGS Seismic Output is presented in Appendix B.

7.5 Steeply Dipping Bedrock

Steeply dipping bedrock is a geological hazard common along the Rocky Mountain Front Range piedmont where uplifted sedimentary formations containing thin layers of moderately to highly expansive shale are encountered near the ground surface e.g., Noe and Dodson 1995; Noe 1997. Problematic formations in the region, most notably the Pierre Shale, are characterized by relatively thin vertically oriented beds that can exhibit dissimilar swelling characteristics from one particular bed to the next.

The site is lies outside of the mapped zone of areas susceptible to differential heave in expansive steeply dipping bedrock. Bedrock was encountered in both the test borings drilled for this investigation. Indications of dipping bedrock were not observed in the soil samples collected. The site is generally not considered to be prone to steeply dipping bedrock.

7.6 Unstable or Potentially Unstable Slopes

Slope stability is the potential of soil covered slopes to withstand and undergo movement. The stability of a slope is determined by the balance of shear stress and shear strength. Previously stable slopes may initially be affected by preparatory factors, making the slope conditionally unstable. Factors that may trigger a slope failure may be climatic events that can make a slope actively unstable, leading to mass movements. Mass movements can be caused by an increase in shear stress, such as loading, lateral pressure, and transient forces. Alternatively, shear strength may be decreased by weathering, changes in pore water pressure, and organic material.

According to the LDC, Chapter 8.4.2 Section B.3 Unsuitable Building Areas, areas that are identified as having certain characteristics "… *shall be deemed unsuitable for building and shall be identified as no build areas on the plat."* One such characteristic is *"Areas where slopes are greater than 30%."* These areas have typically been designated as "No Build" areas in the recent past. Figure 8 presents the areas with slopes greater than 30 percent and the recommended No Build Zone.

Slopes greater than 30 percent were observed on the western portion of the site down to Monument Creek. Unstable slopes or apparent signs of ongoing slope movement were not

observed around or on the property. The subject site is also not in an area identified as containing unstable slopes in the Colorado Landslide Inventory map referenced in section 7.1 of this report.

Mitigation
Long term fill slopes should be limited to areas supported by foundation walls or other engineered components, unless adequately benched into the bedrock. Long term cut slopes in the upper soil should be limited to no steeper than 3:1 (horizontal:vertical).

We believe the surficial soils will classify as Type C materials as defined by OSHA in 29CFR Part 1926, date January 2, 1990. OSHA requires temporary slopes made in Type C materials be laid back at ratios no steeper than 1.5:1 (horizontal to vertical) unless the excavation is shored or braced. Flatter slopes will likely be necessary should groundwater conditions occur.

7.7 Ground Subsidence

Subsidence is the motion of the ground surface as it shifts downward relative to a datum such as sea-level.

Common causes of land subsidence from human activity are pumping water, oil, and gas from underground reservoirs; dissolution of limestone aquifers (sinkholes); collapse of underground mines; drainage of organic soils; and initial wetting of dry soils (hydrocompaction).

The presence of sinkholes and collapse were not observed on the site. The site lies outside of the Colorado Springs Subsidence Investigation report (Dames and Moore, 1985). Evidence of underground mining or the presence of coal was not encountered in the test boring samples. The site is generally not considered to be prone to ground subsidence.

7.8 Hydrocompactive and Potentially Expansive Soils (Moisture Sensitive Soils)

The subsurface materials at the site generally consist of silty to clayey Dawson sandstone. Based on the test borings performed on site, the silty to clayey sandstone generally possess low swell potential. Expansive soils and bedrock were not identified on this site. However, the Dawson formation is known to have interbedded claystone seams. The claystone generally possess low to moderate swell potential. It is anticipated that if these materials are encountered can readily be mitigated with typical construction practices common to this region of El Paso County, Colorado.

Mitigation
A shallow foundation is anticipated for the single family residence. Foundation design and construction are typically adjusted for expansive soils. Mitigation of expansive soils and bedrock are typically accomplished by overexcavation and replacement with structural fill, subexcavation and replacement with on-site moisture-conditioned soils, and/or the installation of deep foundation systems. If loose sands are encountered, mitigation of hydrocompactive soils can be accomplished by overexcavation and replacement with structural fill, subexcavation and replacement with on-site moisture-conditioned soils, and/or the use of a geogrid reinforced fill.

7.9 Radon

***"Radon Act 51** passed by Congress set the natural outdoor level of radon gas (0.4 pCi/L) as the target radon level for indoor radon levels.*

Palmer Lake, CO and the 80133 zip code located in El Paso County, has an EPA assigned Radon Zone of 1. A radon zone of 1 predicts an average indoor radon screening level greater than 4 pCi/L, which is above the recommended levels assigned by the EPA. Palmer Lake is located in a high risk area of the country. *The EPA recommends you take corrective measures to reduce your exposure to radon gas.*

Most of Colorado is generally considered to have the potential of high levels of radon gas, based on the information provided at: http://county-radon.info/CO/El_Paso.html. There is not believed to be unusually hazardous levels of radon from naturally occurring sources at this site.

Mitigation
Radon hazards are best mitigated at the building design and construction phases. Providing increased ventilation of basements, crawlspaces, creating slightly positive pressures within structures, and sealing of joints and cracks in the foundations and below-grade walls can help mitigate radon hazards.

7.10 Flooding and Surface Drainage

Based on our review of the Federal Emergency Management Agency (FEMA) Community Panel No. 08041C0260F and the online ArcGIS El Paso County Risk Map, the western boundary of the is impacted by the delineated FEMA 100-year floodplain limits. According to the Drainage report (referenced above) the proposed shared driveway improvements will not include any fill within the floodplain, to ensure zero-rise in the floodplain. A floodplain development permit will be required through the Pikes Peak Regional Building Department for the proposed shared driveway improvement within the floodplain. The FEMA Map is presented in Figure 11.

7.11 Springs and High Groundwater

Based on the site observations, review of the Palmer Lake Quadrangle and Google Earth images dating back to September 1999, springs do not appear to originate on the subject site. Groundwater was not encountered at the time of drilling for this investigation.

Fluctuations in groundwater and subsurface moisture conditions may occur due to variations in rainfall and other factors not readily apparent at this time. Development of the property and adjacent properties may also affect groundwater levels.

Mitigation:
Shallow groundwater conditions are not anticipated. However, if shallow groundwater conditions are encountered during the Open Excavation Observations, mitigations can include a combination of surface and subsurface drainage systems, vertical drainboard, etc.

In general, if groundwater was encountered within 4 to 6 feet of the proposed basement slab elevation, an underslab drain should be anticipated in conjunction with the perimeter drain. A Perimeter drain is anticipated for the single family residence to prevent the infiltration of water and to help control wetting of potentially expansive and hydrocompactive soils in the immediate vicinity of foundation elements. It must be understood that the drain is designed to intercept some types of subsurface moisture and not others. Therefore, the drain could operate properly and not mitigate all moisture problems relating to foundation performance or moisture intrusion into the basement area.

7.12 Erosion and Corrosion

The Dawson sandstone at this site typically has low resistivity values (less than 2,000 ohm-cm) and is likely to be potentially corrosive to buried, ferrous metal piping and other structures.

Mitigation:
Due to the nature of the soils on the site it is anticipated that the majority of the surficial soils (silty to clayey sand) is subject to erosion by wind or water. During construction disturbance of the site most likely will occur around the building site and may require regrading and revegetation. Further recommendations for Erosion Control are discussed in section 7.15

To help mitigate potential corrosion, buried ferrous metal piping, conduit, and similar construction materials should be coated, wrapped or otherwise protected to avoid or reduce contact with the on-site soils. For environments corrosive to concrete, sulfate-resistant cement and additives should be used.

7.13 Surface Grading and Drainage

The ground surface should be sloped from the buildings with a minimum gradient of 10 percent for the first 10 feet. This is equivalent to 12 inches of fall across this 10-foot zone. If a 10-foot zone is not possible on the upslope side of the structure, then a well-defined swale should be created a minimum 5 feet from the foundation and sloped parallel with the wall with a minimum slope of 2 percent to intercept the surface water and transport it around and away from the structure. Roof drains should extend across backfill zones and landscaped areas to a region that is graded to direct flow away from the structure. Homeowners should maintain the surface grading and drainage recommended in this report to help prevent water from being directed toward and/or ponding near the foundations.

Landscaping should be selected to reduce irrigation requirements. Plants used close to foundation walls should be limited to those with low moisture requirements and irrigated grass should not be located within 5 feet of the foundation. To help control weed growth, geotextiles should be used below landscaped areas adjacent to foundations. Impervious plastic membranes are not recommended.

Irrigation devices should not be placed within 5 feet of the foundation. Irrigation should be limited to the amount sufficient to maintain vegetation. Application of more water will increase the likelihood of slab and foundation movements.

The recommendations listed in this report are intended to address normal surface drainage conditions, assuming the presence of groundcover (established vegetation, paved surfaces, and/or structures) throughout the regions upslope from this structure. However, groundcover may not be present due to a variety of factors (ongoing construction/development, wildfires, etc.). During periods when groundcover is not present in the "upslope" regions, higher than normal surface drainage conditions may occur, resulting in perched water tables, excess runoff, flash floods, etc. In these cases, the surface drainage recommendations presented herein (even if properly maintained) may not mitigate all groundwater problems or moisture intrusion into the structure. We recommend that the site plan be prepared with consideration of increased runoff during periods when groundcover is not present on the upslope areas.

7.14 Fill Soils

Fill soils were not encountered at the time of drilling and are not anticipated. However, if unsuitable soils are encountered during the Open Excavation Observation, they may require removal (overexcavation) and replacement with compacted structural fill.

Mitigation

If any man-placed fill is encountered, it is considered unsuitable for support of foundations. If unsuitable fill soils are encountered during construction, they should be removed (overexcavated) and replaced with compacted structural fill. The zone of overexcavation shall extend to the bottom of the unsuitable fill zone and shall extend at least that same distance beyond the building perimeter (or lateral extent of any fill, if encountered first). Provided that this recommendation is implemented, the presence of this fill is not considered to pose a risk to the proposed new single family residence.

7.15 Proposed Grading, Erosion Control, Cuts and Masses of Fill

Preliminary grading plans were not provided and reviewed at the time the report was issued. It is assumed based on the test borings for this investigation that the excavations will encounter silty to clayey sandstone near the surface. The on-site sandstone soils can be used as site grading fill.

The on-site soils are mildly susceptible to wind and water erosion. Minor wind erosion and dust may be an issue for a short time during and immediately after construction. Should the problem be considered severe during construction, watering of the cut areas may be required. Once construction is complete, vegetation should be re-established.

Prior to placement of overlot fill or removal and recompaction of the existing materials, topsoil, low-density native soil, fill and organic matter should be removed from the fill area. The subgrade should be scarified, moisture conditioned to within 2% of the optimum moisture content, and recompacted to the same degree as the overlying fill to be placed. The placement and compaction of fill should be periodically observed and tested by a representative of RMG during construction.

7.16 Onsite Wastewater Treatment Systems

It is our understanding that an On-site Wastewater Treatment System (OWTS) is not proposed. Based on information provided by the client, water for the lot is to be provided by Forest View

Acres Water District and wastewater treatment is to be provided by Palmer Lake Sanitation District.

8.0 BEARING OF GEOLOGIC CONDITIONS UPON PROPOSED DEVELOPMENT

Geologic hazards (as described in section 7.0 of this report) and geologic constraints (also as described in section 7.0 of this report) other than Seismicity and Radioactivity/Radon Gas were not found to be present at this site. These hazards can be satisfactorily mitigated through proper engineering and design contraction practices and avoidance when deemed necessary.

The proposed development is to consist of the construction of one new single family residence and associated site improvements. Shallow foundations are anticipated for the structure on site. It is our opinion that the existing geologic and engineering conditions will not be constraints on the proposed development.

9.0 BURIED UTILITIES

Based upon the conditions encountered in the test borings, we anticipate that the soils encountered in the individual utility trench excavations will consist of native silty to clayey sand overlying sandstone. It is anticipated that the sands will be encountered at medium dense to dense relative densities and the sandstone at medium hard to hard relative densities.

We believe the sand will classify as Type C materials as defined by OSHA in 29 CFR Part 1926. OSHA requires that temporary excavations made in Type B and C materials be laid back at ratios no steeper than 1:1 (horizontal to vertical) and 1½:1 (horizontal to vertical), respectively, unless the excavation is shored and braced. Excavations deeper than 20 feet, or when water is present, should always be braced or the slope designed by a professional engineer.

10.0 ANTICIPATED FOUNDATION SYSTEMS

Based on the information presented previously, conventional shallow foundation systems consisting of standard spread footings/stemwalls are anticipated to be suitable for the proposed residential structure. It is anticipated that the deepest basement excavation cuts will be approximately 6 to 8 feet below the final ground surface not including overexcavation or subexcavation which may be required.

Expansive clay and claystone were not encountered in the test borings. If expansive soils are encountered near foundation or floor slab bearing levels, overexcavation and replacement with nonexpansive structural fill will be required. Overexcavation depths of 3 feet should be anticipated if expansive soil is encountered at the time of the Open Excavation Observation.

If loose sands are encountered, they may require additional compaction to achieve the allowable bearing pressure indicated in this report. In some cases, removal and recompaction up to 2 feet may be required for loose soils. Similarly, if shallow groundwater conditions are encountered and

result in unstable soils unsuitable for bearing of residential foundations, these soils may require stabilization prior to construction of foundation components.

The foundation system should be designed and constructed based upon recommendations in the site specific Subsurface Soil Investigation. The recommendations presented in the Subsurface Soil Investigation should be verified following the Open Excavation Observation.

10.1 Subexcavation and Moisture-Conditioned Fill

Based upon the field exploration and laboratory testing, subexcavation and replacement is not anticipated. However, prior to performing excavation and/or filling operations, vegetation, organic and deleterious material shall be cleared and disposed of in accordance with applicable requirements. The excavation should extend to a minimum depth below and laterally beyond the bottom of foundations as determined based on final grading plans.

10.2 Foundation Stabilization

Groundwater and loose soils were not encountered at the time of drilling, however if moisture conditions encountered at the time of the foundation excavation result in water flow into the excavation and/or destabilization of the foundation bearing soils, stabilization techniques should be implemented. Various stabilization methods can be employed, and can be discussed at the time of construction. However, a method that affords potentially a reduced amount of overexcavation (versus other methods) and provides increased performance under moderately to severely unstable conditions is the use of a layered geogrid and structural fill system.

Additionally, dependent upon the rate of groundwater flow into the excavation, a geosynthetic vertical drain and an overexcavation perimeter drain may be required around the lower portions of the excavation to allow for installation of the layered geogrid and structural fill system.

10.3 Foundations Drains

A subsurface perimeter drain is recommended around portions of the structure which will have habitable or storage space located below the finished ground surface. This includes crawlspace areas but not the walkout trench, if applicable.

Shallow groundwater conditions were not encountered in the test borings at the time of field exploration. Depending on the conditions encountered during the Open Excavation Observation, additional subsurface drainage systems may be recommended.

One such system is an underslab drainage layer to help intercept groundwater before it enters the slab area should the groundwater levels rise. In general, if groundwater was encountered within 4 to 6 feet of the proposed basement slab elevation, an underslab drain should be anticipated. Another such system would consist of a subsurface drain and/or vertical drain board placed around the perimeter of the overexcavation to help intercept groundwater and allow for proper placement and compaction of the replacement structural fill. Careful attention should be paid to grade and discharge of the drain pipes of these systems.

It must be understood that the drain systems are designed to intercept some types of subsurface moisture and not others. Therefore, the drains could operate properly and not mitigate all moisture problems relating to foundation performance or moisture intrusion into the basement area.

10.4 Structural Fill

Areas to receive structural fill should have topsoil, organic material, or debris removed. The upper 6 inches of the exposed surface soils should be scarified and moisture conditioned to facilitate compaction (usually within 2 percent of the optimum moisture content) and compacted to a minimum of 95 percent of the maximum dry density as determined by the Standard Proctor test (ASTM D-698) or to a minimum of 92 percent of the maximum dry density as determined by the Modified Proctor test (ASTM D-1557) prior to placing structural fill.

Structural fill placed on slopes should be benched into the slope. Maximum bench heights should not exceed 4 feet, and bench widths should be wide enough to accommodate compaction equipment.

Structural fill shall consist of granular, non-expansive material. It should be placed in loose lifts not exceeding 8 to 12 inches, moisture conditioned to facilitate compaction (usually within 2 percent of the optimum moisture content) and compacted to a minimum of 92 percent of the maximum dry density as determined by the Modified Proctor test, ASTM D-1557. The materials should be compacted by mechanical means.

Materials used for structural fill should be approved by RMG prior to use. Structural fill should not be placed on frozen subgrade or allowed to freeze during moisture conditioning and placement.

10.5 Design Parameters

The allowable bearing pressure of the sands and sandstone should be determined by a detailed site specific Subsurface Soil Investigation. Bearing directly on expansive soils (if encountered) is not recommended.

11.0 ADDITIONAL STUDIES

The findings, conclusions and recommendations presented in this report were provided to evaluate the suitability of the site for future development. Unless indicated otherwise, the test borings, laboratory test results, conclusions and recommendations presented in this report are not intended for use for design and construction. ***A site specific Subsurface Soil Investigation will be required for all proposed structures including (but not limited to) residences and retaining walls, etc.***

To develop recommendations for construction of the proposed roadways, a pavement design investigation should be performed. This investigation should consist of additional test borings, soil laboratory testing and specific recommendations for the design and construction of roadway pavement sections.

12.0 CONCLUSIONS

Based upon our evaluation of the geologic conditions, it is our opinion that the proposed development is feasible. Mitigation of geologic hazards is most effectively accomplished by avoidance. However, where avoidance is not a practical or acceptable alternative, geologic hazards should be mitigated by implementing appropriate planning, engineering, and local construction practices.

Revisions and modifications to the conclusions and recommendations presented in this report may be issued subsequently by RMG based upon additional observations made during grading and construction which may indicate conditions that require re-evaluation of some of the criteria presented in this report.

13.0 CLOSING

This report is for the exclusive purpose of providing geologic hazards information and preliminary geotechnical engineering recommendations. The scope of services did not include, either specifically or by implication, evaluation of wild fire hazards, environmental assessment of the site, or identification of contaminated or hazardous materials or conditions. Development of recommendations for the mitigation of environmentally related conditions, including but not limited to, biological or toxicological issues, are beyond the scope of this report. If the owner is concerned about the potential for such contamination or conditions, other studies should be undertaken.

This report has been prepared for **Richard Yarbrough** in accordance with generally accepted geotechnical engineering and engineering geology practices. The conclusions and recommendations in this report are based in part upon data obtained from review of available topographic and geologic maps, review of available reports of previous studies conducted in the site vicinity, a site reconnaissance, and research of available published information, soil test borings, soil laboratory testing, and engineering analyses. The nature and extent of variations may not become evident until construction activities begin. If variations then become evident, RMG should be retained to re-evaluate the recommendations of this report, if necessary.

Our professional services were performed using that degree of care and skill ordinarily exercised, under similar circumstances, by geotechnical engineers and engineering geologists practicing in this or similar localities. RMG does not warrant the work of regulatory agencies or other third parties supplying information which may have been used during the preparation of this report. No warranty, express or implied, is made by the preparation of this report. Third parties reviewing this report should draw their own conclusions regarding site conditions and specific construction techniques to be used on this project.

If we can be of further assistance in discussing the contents of this report or analysis of the proposed development, from a geotechnical engineering and/or geologic hazards point-of-view, please feel free to contact us.

14.0 REFERENCES

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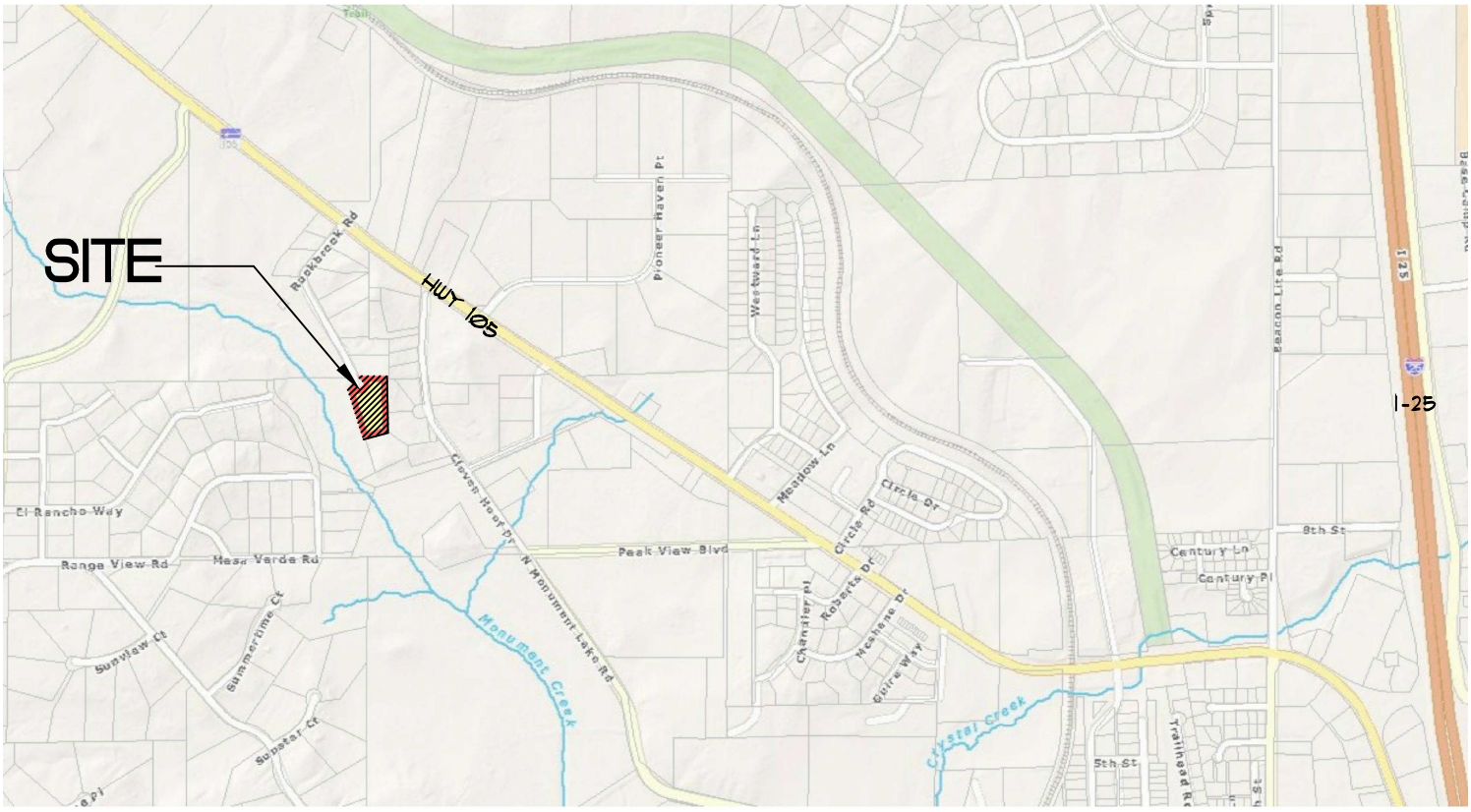
FIGURES



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SITE VICINITY MAP

YARBROUGH MINOR SUBDIVISION
0 ROCKBROOK ROAD
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RICHARD YARBROUGH

JOB No. 163771

FIG No. 1

DATE 6-20-18

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BASE MAP PROVIDED BY: RAMPART SURVEYS, INC.

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TOPOGRAPHIC SURVEY

YARBROUGH MINOR SUBDIVISION
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EL PASO COUNTY, CO
RICHARD YARBROUGH

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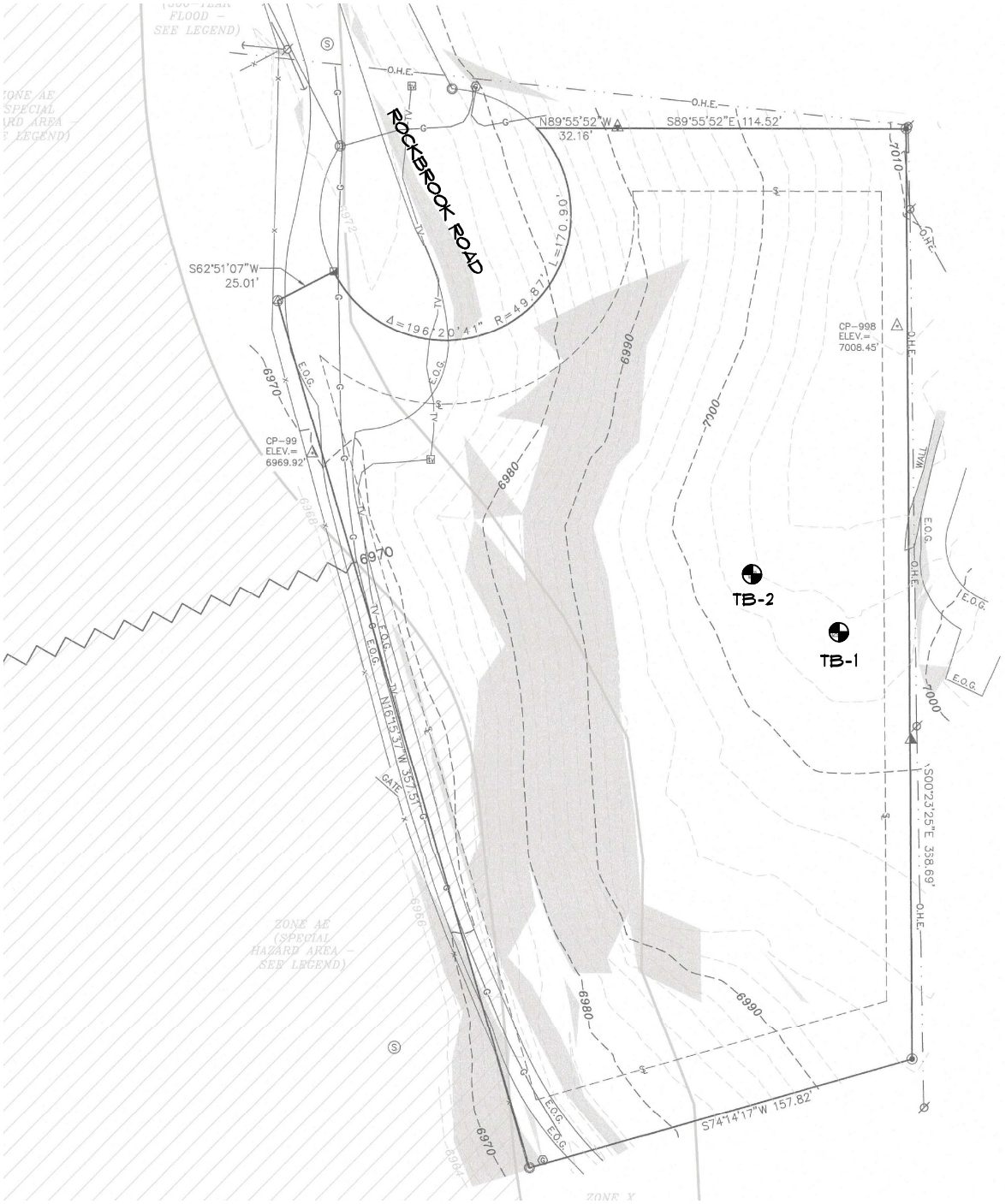
FIG No. 2

DATE 6-20-18



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DENOTES APPROXIMATE LOCATION OF TEST BORINGS

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TOPOGRAPHIC SURVEY WITH TEST BORING LOCATIONS

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RICHARD YARBROUGH

JOB No. 163771

FIG No. 3

DATE 6-20-18

SOILS DESCRIPTION

SANDSTONE

SYMBOLS AND NOTES

XX — STANDARD PENETRATION TEST - MADE BY DRIVING A SPLIT-BARREL SAMPLER INTO THE SOIL BY DROPPING A 140 LB. HAMMER 30", IN GENERAL ACCORDANCE WITH ASTM D-1586. NUMBER INDICATES NUMBER OF HAMMER BLOWS PER FOOT (UNLESS OTHERWISE INDICATED).

FREE WATER TABLE

BULK — DISTURBED BULK SAMPLE

XX — UNDISTURBED CALIFORNIA SAMPLE - MADE BY DRIVING A RING-LINED SAMPLER INTO THE SOIL BY DROPPING A 140 LB. HAMMER 30", IN GENERAL ACCORDANCE WITH ASTM D-3550. NUMBER INDICATES NUMBER OF HAMMER BLOWS PER FOOT (UNLESS OTHERWISE INDICATED).

1 — RMG SOIL TYPE - SEE REPORT TEXT FOR DESCRIPTION

4.5 — WATER CONTENT (%)

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EXPLANATION OF TEST BORING LOGS

JOB No. 163771

FIGURE No. 4

DATE 6/18/18

TEST BORING: **1**
DATE DRILLED:
5/3/18
REMARKS:
NO GROUNDWATER ON
5/3/18

DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %	SOIL TYPE
					SANDSTONE, SILTY, tan to gray, hard to very hard, moist
5		■	50/9"	9.0	
10		■	50/11"	13.0	
15		■	50/5"	4.8	
20		■	50/2"	9.9	

TEST BORING: **2**
DATE DRILLED:
8/5/01
REMARKS:
NO GROUNDWATER ON
5/3/18

DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %	SOIL TYPE
					SANDSTONE, SILTY, tan to gray, medium hard to very hard, moist
5		■	34	2.0	
10		■	29	4.6	
15		■	48	8.9	
20		■	10/0"	8.4	

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TEST BORING LOGS

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FIGURE No. 5

DATE 6/18/18

Test Boring No.	Depth	Water Content (%)	Dry Density (pcf)	Liquid Limit	Plasticity Index	% Retained No.4 Sieve	% Passing No. 200 Sieve	FHA Expansion Pressure (psf)	% Swell @ 1000 psf	USCS Classification
1	4.0	9.0								
1	9.0	13.0		30	13	4.0	0.9			SP
1	14.0	4.8								
1	19.0	9.9								
2	4.0	2.0		NP	NP	2.0	16.9			SM
2	9.0	4.6								
2	14.0	8.9								
2	19.0	8.4								

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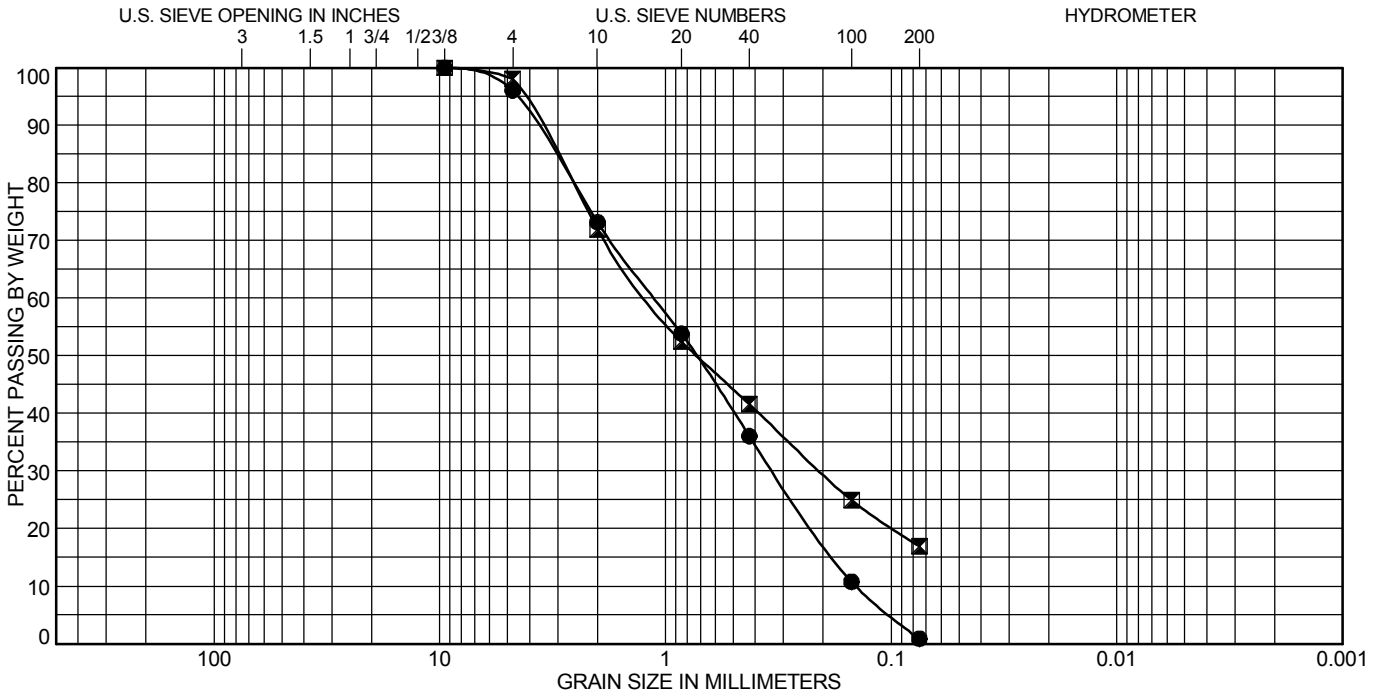
SUMMARY OF LABORATORY TEST RESULTS

JOB No. 163771
FIGURE No. 6
PAGE 1 OF 1
DATE 6/18/18



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Test Boring	Depth (ft)	Classification	LL	PL	PI	Cc	Cu
●	1	9.0	**POORLY GRADED SAND(SP)**	**30**	**17**	**13**	**0.7**	**7.9**
⧗	2	4.0	**SILTY SAND(SM)**	**NP**	**NP**	**NP**		

	Test Boring	Depth (ft)	%Gravel	%Sand	%Silt	%Clay
●	1	9.0	**4.0**	**95.2**	**0.9**	
⧗	2	4.0	**2.0**	**81.1**	**16.9**	

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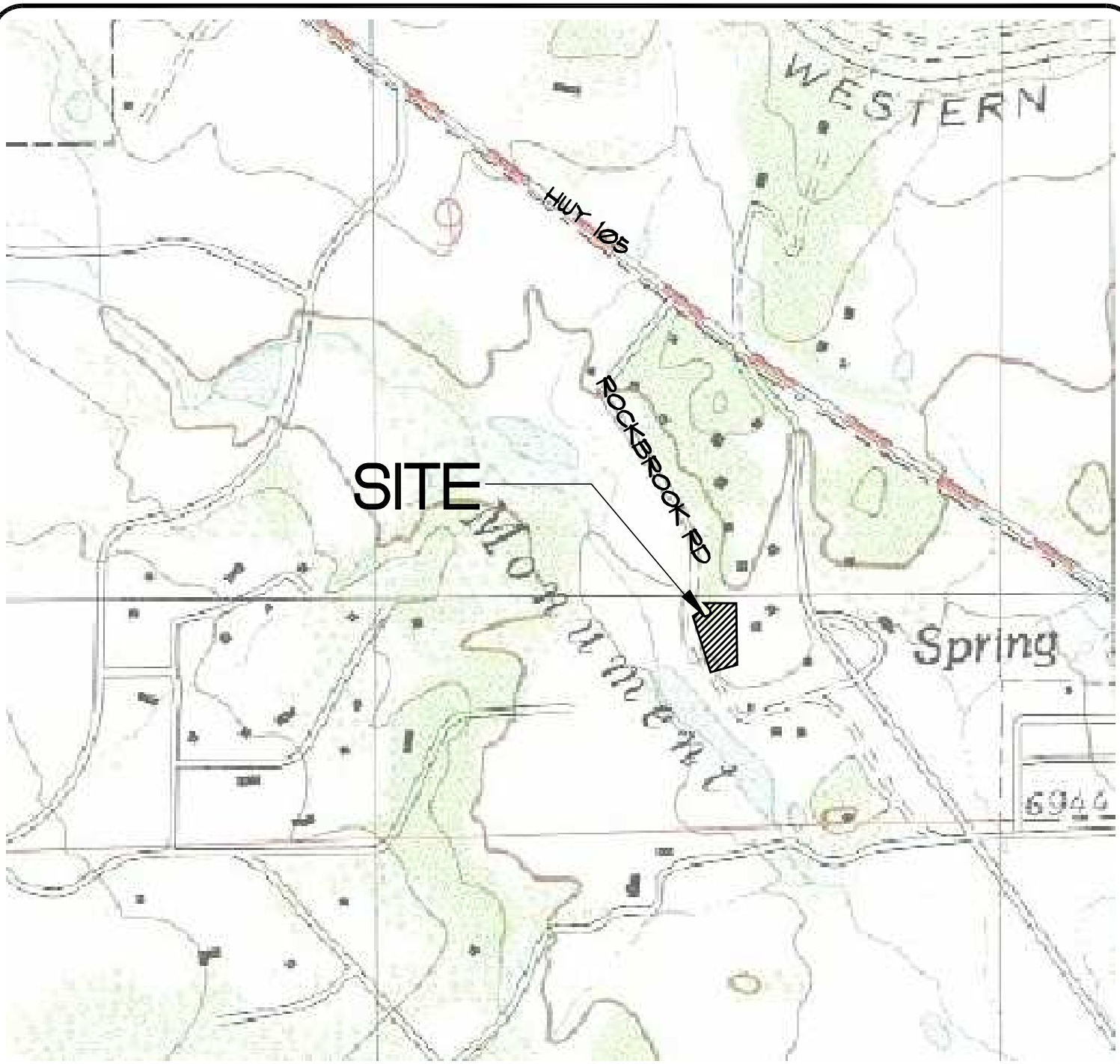
SOIL CLASSIFICATION DATA

JOB No. 163771

FIGURE No. 7

DATE 6/18/18



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PALMER LAKE QUADRANGLE

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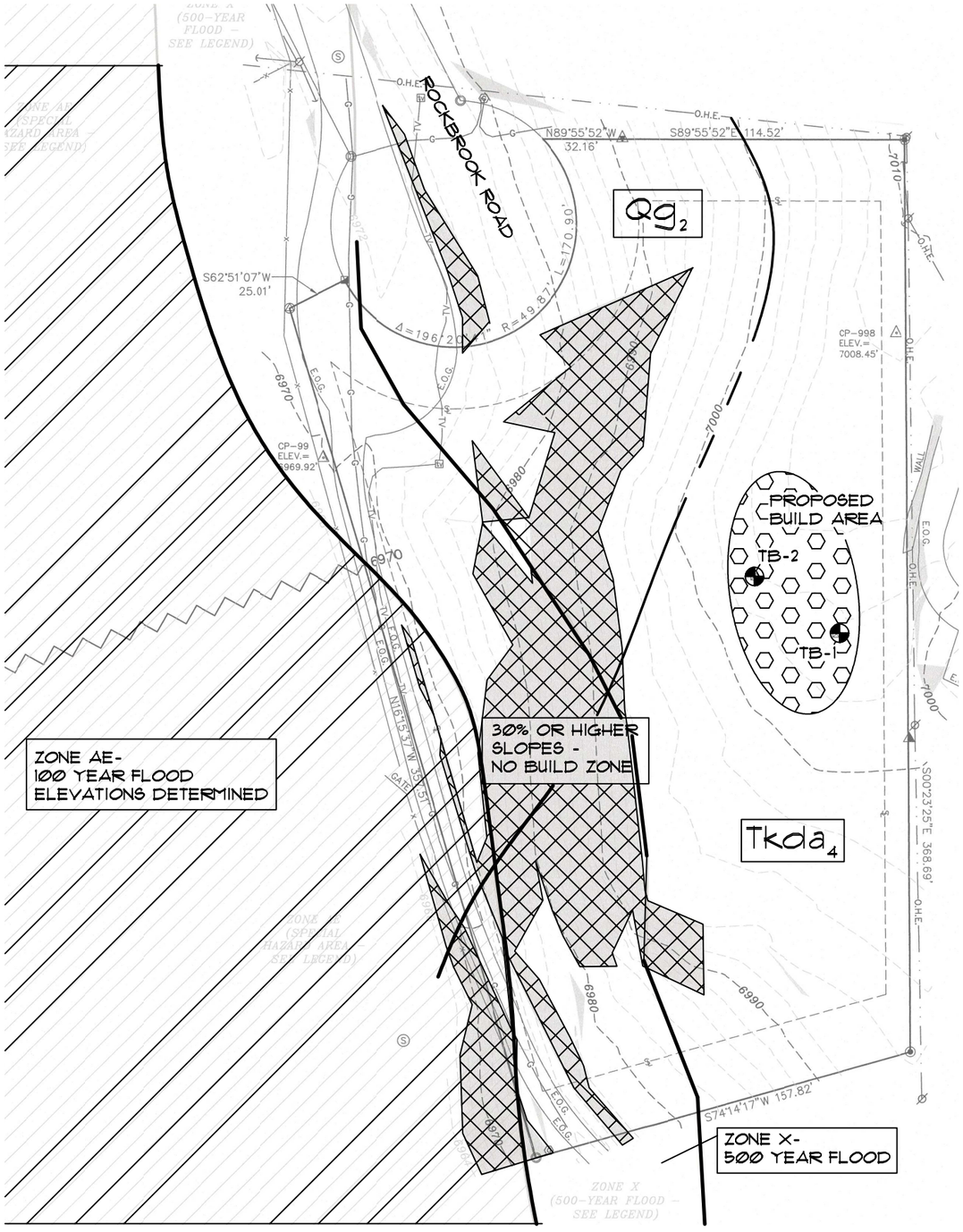
FIG No. 8

DATE 6-20-18



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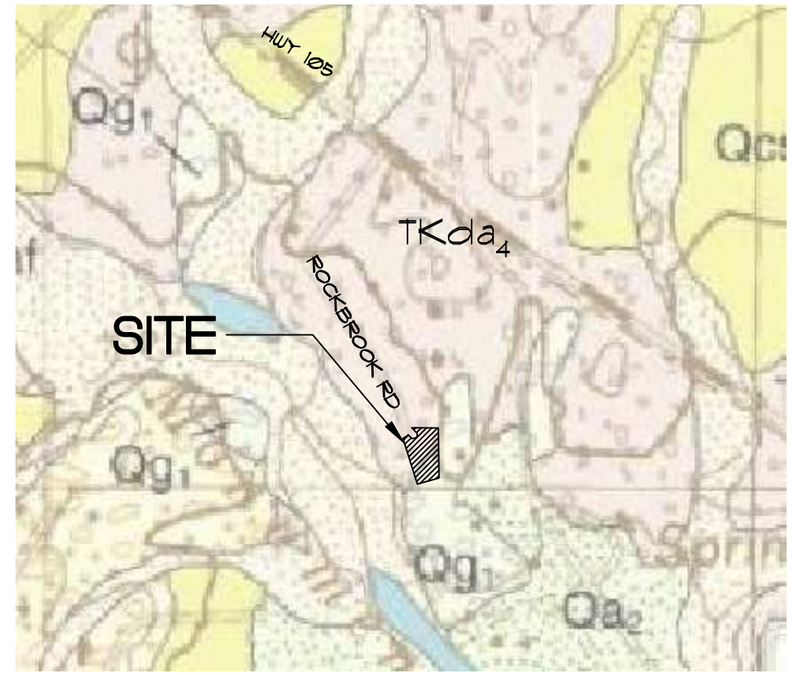

Geologic

Qg_2- Gravel Pediment

$TKda_4$- Dawson Formation

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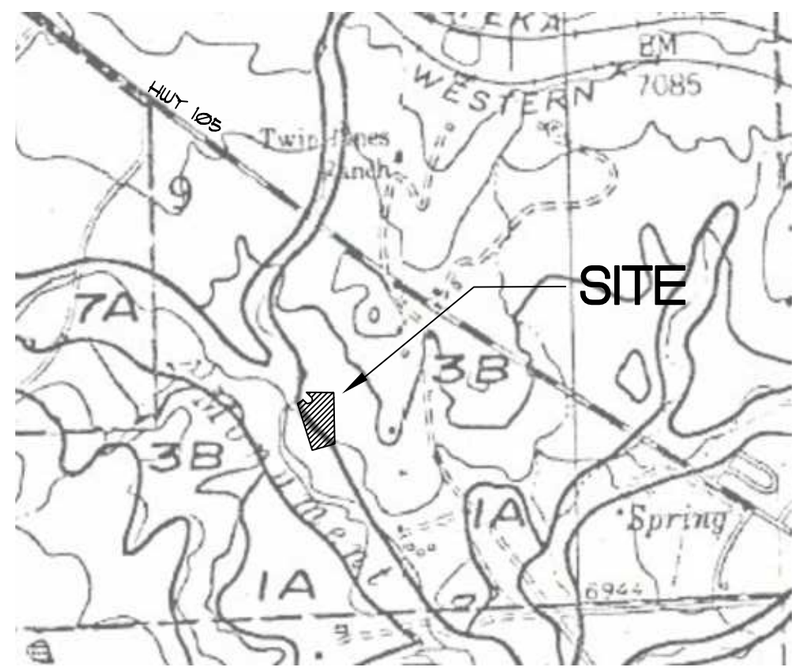

Engineering

3B - Expansive and potentially expansive soil and bedrock on moderate to steep slopes (0 to 12%)

7A - Physiographic floodplain where erosion and deposition presently occur and is generally subject to recurrent flooding. Includes 100-year floodplain along major streams where floodplain studies have been conducted

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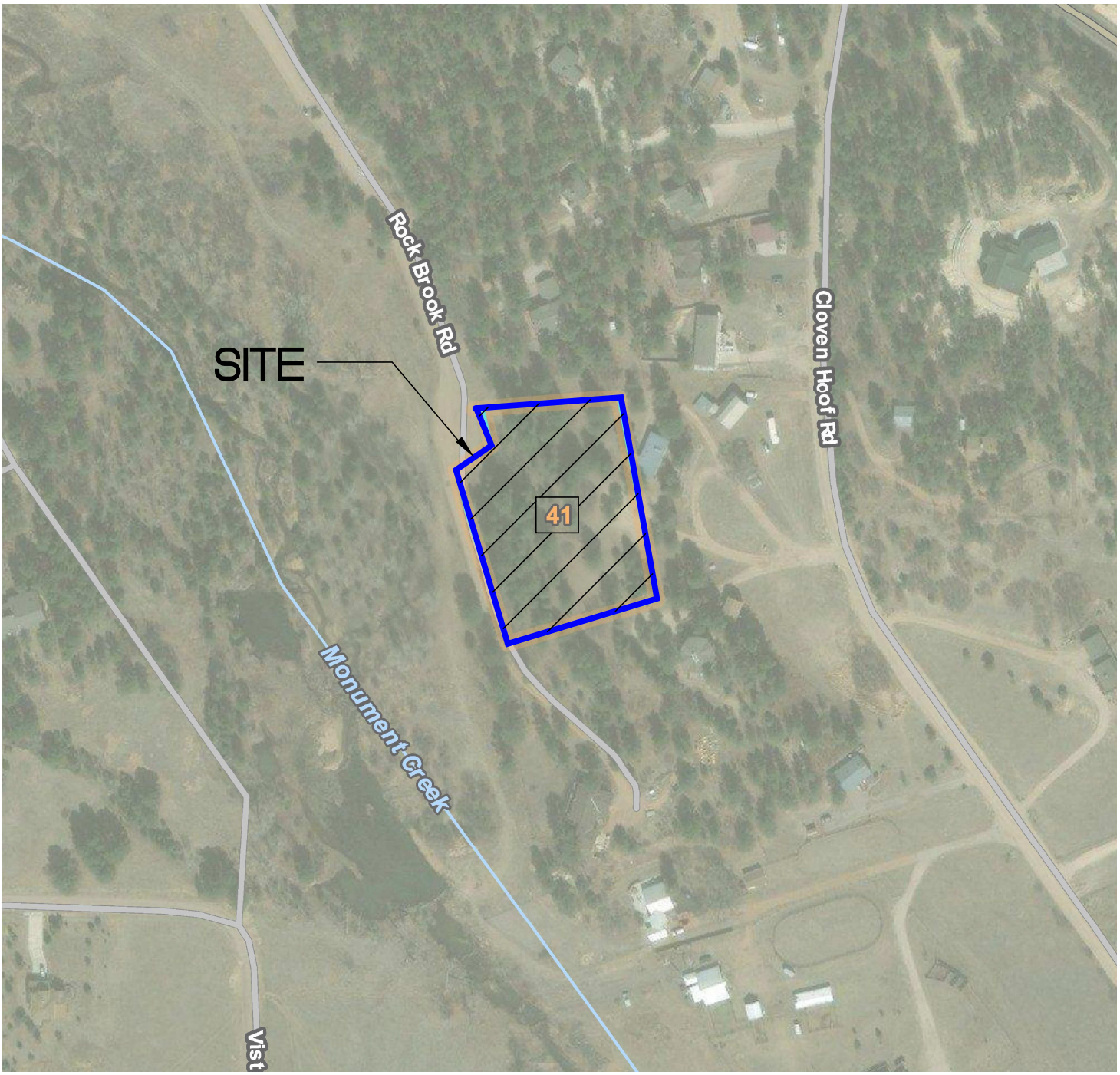
ROCKBROOK ROAD

EL PASO COUNTY, CO
RICHARD YARBROUGH

ENGINEER:	GGW
DRAWN BY:	KMZ
CHECKED BY:	KMZ
ISSUED:	6-18-2018
REVISION:	DATE: JOB #:

GENERAL GEOLOGY AND ENGINEERING GEOLOGY MAP

SHEET No.
FIG-9



Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
41	Kettle gravelly loamy sand, 8 to 40 percent slopes	1.5	100.0%

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USDA SOILS SURVEY MAP

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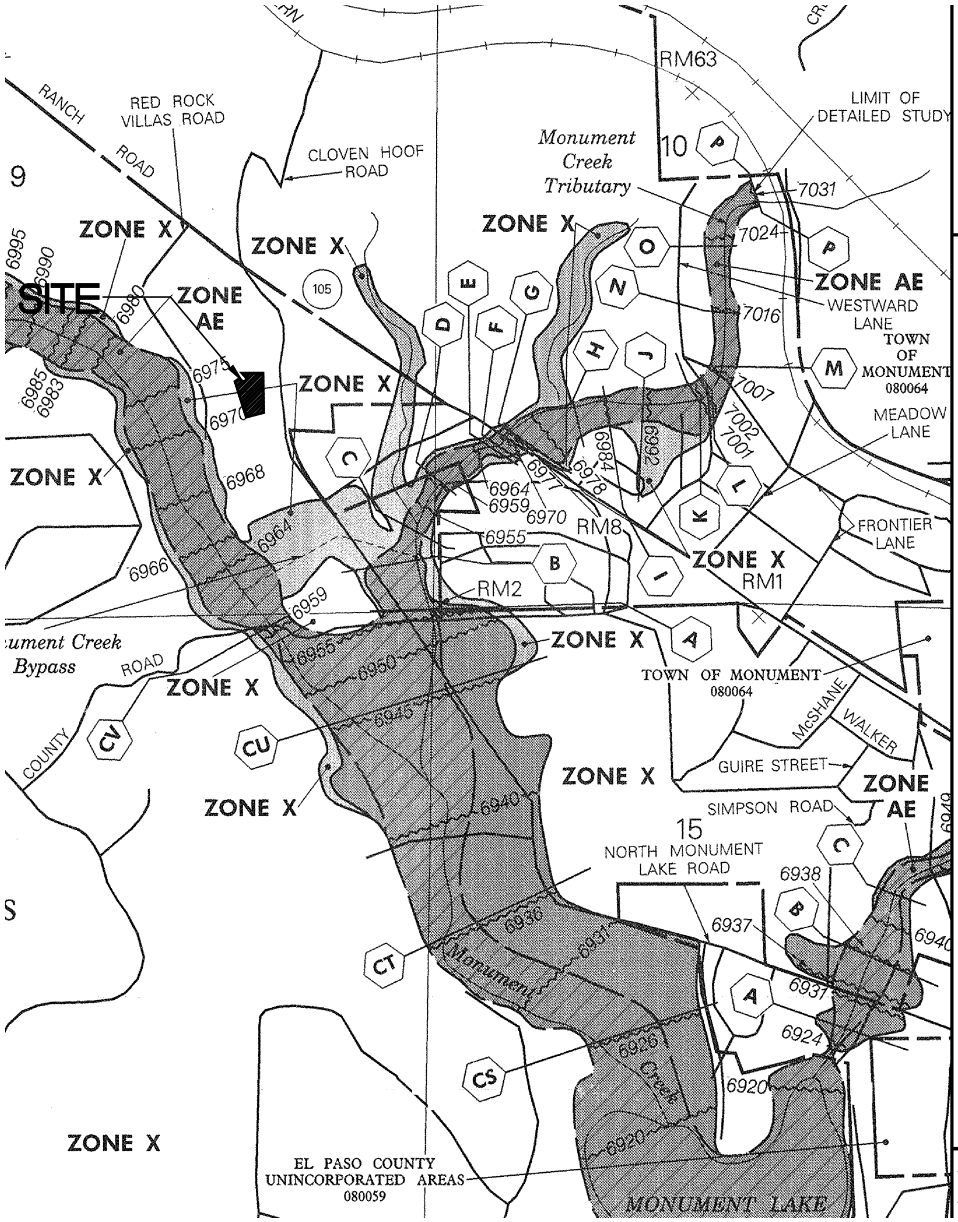
FIG No. 10

DATE 6-20-18



APPROXIMATE SCALE IN FEET

1000 0 1000

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

EL PASO COUNTY, COLORADO AND INCORPORATED AREAS

PANEL 260 OF 1300

(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS: COMMUNITY	NUMBER	PANEL	SUFFIX
EL PASO COUNTY, UNINCORPORATED AREAS	080059	0260	F
MONUMENT, TOWN OF	080064	0260	F
PALMER LAKE, TOWN OF	080065	0260	F

MAP NUMBER 08041C0260 F

EFFECTIVE DATE: MARCH 17, 1997

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance

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FEMA MAP

YARBROUGH MINOR SUBDIVISION
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JOB No. 163771

FIG No. 11

DATE 6-20-18

APPENDIX A

Guideline Site Grading Specifications

Guideline Site Grading Specifications

Description: Unless specified otherwise by local or state regulatory agencies, these guideline specifications are for the excavation, placement and compaction of material from locations indicated on the plans, or staked by the Engineer, as necessary to achieve the required elevations. These specifications shall also apply to compaction of materials that may be placed outside of the project.

General: The Geotechnical Engineer shall approve fill materials, method of placement, moisture contents and percent compactions, and shall give written approval of the compacted fill.

Clearing Site: The Contractor shall remove trees, brush, rubbish, vegetation, topsoil and existing structures before excavation or fill placement is commenced. The Contractor shall dispose of the cleared material to provide the Owner with a clean job site. Cleared material shall not be placed in areas to receive fill or where the material will support structures. Clearing shall also include removal of existing fills that do not meet the requirements of this specification and existing structures.

Preparation of Slopes or Drainage Areas to Receive Fill: Natural slopes or slopes of drainage gullies where grades are 20 percent (5:1, horizontal to vertical) or steeper shall be benched prior to fill placement. Benches shall be at least 10 feet wide. Benches may require additional width to accommodate excavation or compaction equipment. At least one bench shall be provided for each 5 feet or less of vertical elevation difference. The bench surface shall be essentially horizontal perpendicular to the slope or at a slight incline into the slope.

Scarifying: Topsoil and vegetation shall be removed from the ground surface in areas to receive fill. The surface shall be plowed or scarified a minimum of 12 inches until the surface is free from ruts, hummocks or other uneven features which would prevent uniform compaction by the equipment to be used.

Compacting Area to Receive Fill: After the area to receive fill has been cleared and scarified, it shall be disked or bladed until it is free from large clods, moisture conditioned to a proper moisture content and compacted to the maximum density as specified for the overlying fill. Areas to receive fill shall be worked, stabilized, or removed and replaced, if necessary, in accordance with the Geotechnical Engineer's recommendations in preparation for fill.

Fill Materials: Fill material shall be free from organic material or other deleterious substances, and shall not contain rocks or lumps having a diameter greater than six inches. Fill materials shall be obtained from cut areas shown on the plans or staked in the field by the Engineer or imported to the site and shall be approved by the Geotechnical Engineer prior to placement. It is recommended that the fill materials have nil to low expansion potential, i.e., consist of silty to slightly clayey sand.

- The moisture-conditioned materials should be placed in maximum 6" compacted lifts. These materials should be compacted to a minimum of 92 percent of the maximum Modified Proctor dry density or 95 percent of the maximum Standard Proctor dry density. Material not meeting the above requirements shall be reprocessed.

Materials used for moisture-conditioned structural fill should be approved by RMG prior to use. Moisture-conditioned structural fill should not be placed on frozen subgrade or allowed to freeze during moisture conditioning and placement.

Moisture Content: Fill materials shall be moisture conditioned to within limits of optimum moisture content specified. Sufficient laboratory compaction tests shall be made to determine the optimum moisture content for the various soils encountered in borrow areas or imported to the site.

The contractor may be required to add moisture to the excavation materials in the borrow area if, in the opinion of the Geotechnical Engineer, it is not possible to obtain uniform moisture content by adding water to the fill material during placement. The Contractor may be required to rake or disk the fill soils to provide uniform moisture content through the soils.

The application of water to embankment materials shall be made with watering equipment, approved by the Geotechnical Engineer, which will give the desired results. Water jets from the spreader shall not be directed at the embankment with such force that fill materials are eroded.

Should too much water be added to the fill, such that the material is too wet to permit the desired compaction to be obtained, compacting and work on that section of the fill shall be delayed until the material has been allowed to dry to the required moisture content. The Contractor will be permitted to rework the wet material in an approved manner to hasten its drying.

Compaction of Fill Areas: Selected fill material shall be placed and mixed in evenly spread layers. After each fill layer has been placed, it shall be uniformly compacted to not less than the specified percentage of maximum density. Fill materials shall be placed such that the thickness of loose material does not exceed 10 inches and the compacted lift thickness does not exceed 6 inches.

Compaction, as specified above, shall be obtained by the use of sheepsfoot rollers, multiple-wheel pneumatic-tired rollers, or other equipment approved by the Geotechnical Engineer. Granular fill shall be compacted using vibratory equipment or other equipment approved by the Geotechnical Engineer. Compaction shall be accomplished while the fill material is at the specified moisture content. Compaction of each layer shall be continuous over the entire area.

Moisture Content and Density Criteria:

A. Fill placed in roadways and utility trenches should be moisture conditioned and compacted in accordance with El Paso County Specifications.
B. Fill placed outside of roadways and utility trenches should be compacted to at least 92% of the maximum Modified Proctor density (ASTM D-1557) or at least 95% of the maximum Standard Proctor density (ASTM D-698) at a moisture content within 2% of optimum.

Compaction of Slopes: Fill slopes shall be compacted by means of sheepsfoot rollers or other suitable equipment. Compaction operations shall be continued until slopes are stable, but not too dense for planting, and such that there is no appreciable amount of loose soil on the slopes.

Compaction of slopes may be done progressively in increments of three to five feet in height or after the fill is brought to its total height. Permanent fill slopes shall not exceed 3:1 (horizontal to vertical).

Density Testing: Field density testing shall be performed by the Geotechnical Engineer at locations and depths of his choosing. Where sheepsfoot rollers are used, the soil may be disturbed to a depth of several inches. Density tests shall be taken in compacted material below the disturbed surface. When density tests indicate the density or moisture content of any layer of fill or portion thereof is below that required, the particular layer or portion shall be reworked until the required density or moisture content has been achieved.

Observation and Testing of Fill: Observation by the Geotechnical Engineer shall be sufficient during the placement of fill and compaction operations so that he can declare the fill was placed in general conformance with Specifications. All observations necessary to test the placement of fill and observe compaction operations will be at the expense of the Owner.

Seasonal Limits: No fill material shall be placed, spread or rolled while it is frozen, thawing, or during unfavorable weather conditions. When work is interrupted by heavy precipitation, fill operations shall not be resumed until the Geotechnical Engineer indicates the moisture content and density of previously placed materials are as specified.

Reporting of Field Density Tests: Density tests made by the Geotechnical Engineer shall be submitted progressively to the Owner. Dry density, moisture content, percent compaction, and approximate location shall be reported for each test taken.

APPENDIX B

USGS Seismic Output

USGS Design Maps Summary Report

User–Specified Input

Report Title	Rockbrook Road Tue June 19, 2018 19:51:11 UTC
Building Code Reference Document	2012/2015 International Building Code (which utilizes USGS hazard data available in 2008)
Site Coordinates	39.10444°N, 104.89215°W
Site Soil Classification	Site Class D – "Stiff Soil"
Risk Category	I/II/III

USGS–Provided Output

S_S =	0.189 g	S_{MS} =	0.302 g	S_{DS} =	0.202 g
S_1 =	0.061 g	S_{M1} =	0.146 g	S_{D1} =	0.098 g

For information on how the SS and S1 values above have been calculated from probabilistic (risk-targeted) and deterministic ground motions in the direction of maximum horizontal response, please return to the application and select the "2009 NEHRP" building code reference document.