Architecture
Structural
Geotechnical

Materials Testing
Forensic
Civil/Planning

ROCKY MOUNTAIN GROUP
EMPLOYEE OWNED

SOIL, GEOLOGY AND GEOTECHNICAL REPORT

5080 Tamlin Road
EPC Schedule No. 5321002001
El Paso County, Colorado

PREPARED FOR:

C&M Properties
12748 Barossa Valley Road
Colorado Springs, CO 80921

JOB NO. 174679
PCD File No. PPR1945

March 2, 2020
Amended August 14, 2020

Respectfully Submitted,
RMG – Rocky Mountain Group

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Reviewed by,
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1.0 GENERAL SITE AND PROJECT DESCRIPTION

1.1 Project Location

The project lies in a portion of the southwest quarter of the northwest quarter in Section 21, Township 13 South, Range 65 West of the 6th Principal Meridian in El Paso County, Colorado. The site is located approximately 1/4 mile to the north and east of the intersection of Marksheffel Road and Tamlin Road. The approximate location of the site is shown on the Site Vicinity Map, Figure 1.

1.2 Project Description

The proposed site development is to consist of an RV and boat storage with a total of 289 parking spaces ranging from small to large spaces. A trash enclosure is to be located near the entrance of the property, which is to be accessed from Tamlin Road. The development includes a full spectrum detention pond to be located near the center of the eastern property line. The site currently does not propose to utilize sewer and water services, furthermore, individual wells and on-site wastewater treatment systems are not proposed.

The interior parking areas are to be privately owned and maintained by the owner.

2.0 QUALIFICATIONS OF PREPARERS

This Geology and Soils Study 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 Webster, P.E. Ms. Zigler is a Professional Geologist as defined by State Statute (C.R.S 34-1-201) with over 19 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 throughout 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 August 27, 2019 applicable sections include 8.4.8 and 8.4.9. the Engineering Criteria Manual (ECM), specifically Appendix C last updated July 9, 2019.

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

The scope of this study is to include a physical reconnaissance of the site and a review of pertinent, publically available documents including (but not limited to) previous geologic and geotechnical reports, overhead and remote sensing imagery, published geology and/or hazard maps, design documents, etc. Our services exclude the evaluation of the environmental and/or human, health-related work products or recommendations previously prepared, by others, for this project.

The objectives of our study are to:

- Identify geologic conditions that are present on this site,
- Analyze the potential negative impacts of these conditions on the proposed site development,
- Analyze the potential negative impacts to the surrounding properties and/or public services resulting from the proposed site development as it relates to existing geologic hazards,
- Provide our opinion of suitable techniques that may be utilized to mitigate the potential negative impacts identified herein.

This report presents the findings of the study performed by RMG relating to the geologic conditions of the above-referenced site. Revisions and modifications to 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,
- Review of pertinent documents (development plans, plat maps, drainage reports/plans, etc.) not available at the time of this study,
- Comments received from the governing jurisdiction and/or their consultants subsequent to submission of this document.

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 engineering reports
- Available aerial photographs
- Exploratory soil test borings by RMG

- Laboratory testing of representative site soil and rock samples by RMG
- 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 and/or nearby sites were not available for our review.

3.4 Additional Documents

Additional documents reviewed during the performance of this study are included in Appendix A.

4.0 SITE CONDITIONS

4.1 Proposed Land Use and Zoning

The Phase 1 development consists of one parcel with a total acreage of 11.9 acres. The included parcel has a Schedule No. of 5321002001 and is currently zoned *RR-5 CS – Residential Rural Commercial Service.* The zoning is to remain the same.

The proposed site development is to consist of an RV and boat storage with a total of 289 parking spaces ranging from small to large spaces. A trash enclosure is to be located near the entrance of the property, which is to be accessed from Tamlin Road. The development includes a full spectrum detention pond to be located near the center of the eastern property line. The site currently does not propose to utilize sewer and water services, furthermore, individual wells and on-site wastewater treatment systems are not proposed. The Site Layout with Test Boring Locations is presented in Figure 2.

4.2 Topography

Based on our observations, the site topography is gently sloping and does not contain slopes greater than 10 percent. The approximate elevation difference across the site is approximately 14 to 26 feet.

4.3 Vegetation

The majority of the site consists of low lying native grasses and weeds.

5.0 FIELD INVESTIGATION AND LABORATORY TESTING

The subsurface conditions within the property were explored by drilling four borings to 5 to 10 feet for pavement recommendations and two borings to 20 feet for the full spectrum detention pond. This is in compliance with the minimum of one test boring per 10 acres of development up to 100 acres, required by the ECM.

The test borings were drilled with a power-driven, continuous-flight auger drill rig. Samples were obtained during drilling of the test boring in general accordance with ASTM D-1586 and D-3550, utilizing a 2-inch O.D. Split Barrel Sampler and a 2½-inch O.D. California sampler, respectively. Results of the penetration tests are shown on the drilling logs. The Site Layout with Test Boring Location plan is presented in Figure 2. An Explanation of Test Boring Logs is shown in Figure 3, and the Test Boring Log is shown in Figure 4.

Soil laboratory testing was performed as part of this investigation. The laboratory tests included moisture content, dry density, grain-size analyses and Atterberg Limits testing. A Summary of Laboratory Test Results is presented in Figure 7. Soils Classification Data is presented in Figures 8 and 9. Swell/Consolidation Test Results are presented in Figure 10.

5.1 Groundwater

Groundwater was not encountered in the test borings at the time of drilling. 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.

6.0 SOIL, GEOLOGY, AND ENGINEERING GEOLOGY

6.1 Subsurface Soil Conditions

The subsurface materials encountered in the test borings performed for this study were classified within the laboratory using the Unified Soil Classification System (USCS). The materials were identified and classified as silty sand (SM), clayey sand (SC) and low plasticity sandy clay (CL).

Additional descriptions and the interpreted distribution (approximate depths) of the subsurface materials are presented on the Test Boring Log. The classifications shown on the logs are based upon the engineer's 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.

6.2 Bedrock Conditions

In general, the bedrock (as mapped by Colorado Geologic Survey - CGS) beneath the site is considered to be part of the Dawson Formation. Bedrock was not encountered in the test borings performed for this investigation.

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:

- 97 – Truckton sandy loam, 3 to 9 percent slopes. The Truckton sandy loam was mapped by the USDA to encompass the entire site. Properties of the Truckton sandy loam include, well-drained

soil, depth of the water table is anticipated to be greater than 6.5 feet, runoff is anticipated to be very low, frequency of flooding/ponding is none, and landforms are interfluves and hillslopes.

The USDA Soil Survey Map is presented in Figure 11.

6.4 General Geologic Conditions

Based on our field observations and the Geologic Map of the Falcon NW Quadrangle, an interpreted geologic map of significant surficial deposits and features was mapped for the site. The identified geologic conditions affecting the development are presented in the Engineering and Geology Map, Figure 14.

The site generally consists of sand with various amounts of silt and sandy clay (alluvium). Three geologic units were mapped at the site as:

- *Af – Artificial fill (latest Holocene)* – end dump piles placed sometime after October 2018.
- psw – potentially seasonally wet areas
- *Tkda$_2$– Dawson Formation facies unit two* – middle part of the Dawson Formation, generally dominated by fine grained arkosic sandstone with interbedded thin layers of olive-green claystone.

6.5 Structural Features

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

6.6 Surficial (Unconsolidated) Deposits

Lake and pond sediments, swamp accumulations, sand dunes, marine terrace deposits, talus accumulations, creep, or slope wash were not observed on the site. Slump and slide debris were also not observed on the site. The alluvial deposits are non-marine terrace deposits that have been reworked from either conglomerates in the Dawson Formation up-valley along Sand Creek and its tributaries or reworked from gravel-capped mesas from the Pleistocene.

6.7 Engineering Geology

Charles Robinson and Associates (1977) have mapped one environmental engineering unit at the site as:

- 2A – Stable alluvium, colluvium and bedrock on flat to gentle to moderate slopes (5 to 12%).

The Engineering Geology is presented in the Engineering and Geology Map, Figure 14.

6.8 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 not observed on the property or surrounding areas.

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

6.9 Drainage of Water and Groundwater

The overall topography of the site slopes down from the north to the south. A defined pond is located to the east of the property. Based on historical aerial photos dating back to 1947 it the surface water tends to flow from Tamlin Road across the site to the offsite pond.

Groundwater or indications of groundwater were not observed in the test borings performed for this investigation at the time of the field observation.

7.0 ECONOMIC 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 *El Paso Aggregate Resource Evaluation Map, Master Plan for Mineral Extraction*, *Map 2* indicates the site is identified as valley fill comprised of sand and gravel with silt and clay deposited by water in one or a series of stream valley. Extraction of the sand and gravel resources are not considered to be economical compared to materials available elsewhere within the county.

According to the *Evaluation of Mineral and Mineral Fuel Potential of El Paso County State Mineral Lands*, the site is mapped within the Denver Basin Coal Region. However, the area of the site has been mapped "Poor" for coal resources, no active or inactive mines have been mapped in the area of the site. No metallic mineral resources have been mapped on the site.

8.0 IDENTIFICATION AND MITIGATION OF 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 (1.15 Definitions of Specific Terms and Phrases). The following geologic constraints were considered in the preparation of this report, and are not are not anticipated to pose a significant risk to the proposed development:

- Expansive Soils and Bedrock
- Avalanches
- Debris Flow-Fans/Mudslides
- Floodplains
- Ground Subsidence
- Landslides
- Rockfall
- Ponding water
- Steeply Dipping Bedrock
- Unstable or Potentially Unstable Slopes
- Scour, Erosion, accelerated erosion along creek banks and drainageways
- Springs and High Groundwater
- Corrosive Minerals

The following sections present geologic constraints that have been identified on the property:

8.2 Hydrocompactive Soils (Moisture Sensitive Soils)

Based on the test borings performed by RMG for this investigation, the silty to clayey sand generally possesses low to moderate hydrocompactive potential and the sandy clay generally possesses low hydrocompactive potential. It is anticipated that if these materials are encountered they can readily be mitigated with typical construction practices common to this region of El Paso County, Colorado.

Mitigation
Foundation construction is not anticipated at time, if future construction is proposed within this development foundation mitigation may consist of overexcavation and replacement with structural fill, subexcavation and replacement with on-site moisture-conditioned soils, the installation of deep foundation systems, and/or the use of a geogrid reinforced fill, all of which are considered common construction practices for this area. The final determination of mitigation alternatives and foundation design criteria are to be determined in site-specific subsurface soil investigations for each lot.

Provided that appropriate mitigations and/or foundation design adjustments are implemented, the presence of hydrocompactive soils is not considered to pose a risk to any future proposed structures.

8.3 Seasonally Wet Areas

Shallow groundwater was not encountered in the test borings at the time of drilling. Areas that have historically appeared seasonally wet are identified on the Engineering Geology Map, Figure 14. These are anticipated to periodically have high surface moisture conditions. Construction in these areas should follow these precautions.

Mitigation
Foundations are not proposed in these areas. However, parking lot construction should penetrate to a sufficient depth as to discourage the formation of ice lenses beneath the asphalt. Any grading in these areas should be done in a manner that directs surface flow around construction to avoid areas of ponded water. Areas of organic material will require removal before any filling is done.

8.4 Faults and Seismicity

Based on review of the Earthquake and Late Cenozoic Fault and Fold Map Server provided by CGS located at http://dnrwebmapgdev.state.co.us/CGSOnline/ and the recorded information dating back to November of 1900, Colorado Springs has not experienced a recorded earthquake with a magnitude greater than 1.6 during that time period. The nearest recorded earthquakes over 1.6 occurred in December of 1995 in Manitou Springs, which experienced magnitudes ranging between 2.8 to 3.5. Additional earthquakes over 1.6 occurred between 1926 and 2001 in Woodland Park, which experienced magnitudes ranging from 2.7 to 3.3. Both of these locations are in the vicinity of the Ute Pass Fault, which is greater than 10 miles from the subject site.

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. It is our opinion that ground motions resulting from minor earthquakes may affect structures (and the surrounding area) at this site if minor shifting were to occur.

Mitigation

Proposed construction is to consist of an asphalt parking lot, trash enclosure and full spectrum detention facility. If future construction is proposed it is recommended the structures be designed in accordance The Pikes Peak Regional Building Code, 2017 Edition, which indicates maximum considered earthquake spectral response accelerations of 0.185g for a short period (S_s) and 0.059g for a 1-second period (S_1). Based on the results of our experience with similar subsurface conditions, we recommend the site be classified as Site Class B, with average shear wave velocities ranging from 2,500 to 5,000 feet per second for the materials in the upper 100 feet.

8.5 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.*

Southern El Paso County and the 80923 zip code located in the Black Forest area, 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. Black Forest 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 unusual hazardous levels of radon from naturally occurring sources at this site.

Mitigation

Mitigation is not anticipated for the proposed construction. However, if future construction were to include structures, radon is 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.

8.7 Fill Soils

Fill soils were not encountered in the test borings at the time of drilling. However, fill soils exist in the form of end dump piles that are present near the center of the site. Fill soils may be considered unsuitable for a variety of reasons. These include (but are not limited to) non-engineered fills, fill soils containing trash or debris, fill soils that appear to have been improperly placed and/or compacted, etc. If unsuitable soils are encountered during the site-specific Subsurface Soil Investigation and/or the Open Excavation Observation, they may require removal (overexcavation) and replacement with compacted structural fill.

Mitigation
It is uncertain if the end dump piles are to be "spread out" to raise the elevation of the site or if the piles are to be removed prior to construction. If the piles are to be laid out across the site and used as overlot grading fill it is recommended all fill placed below pavements should be similar to the onsite soils and be compacted to at least 95 percent of the maximum modified Proctor density (ASTM D1557) at a moisture content within 2 percent of optimum. Prior to placement of the pavement section, the final subgrade should be scarified to a depth of 12 inches, adjusted to within 2 percent of the optimum moisture content and recompacted to at least 95 percent of the maximum modified Proctor density. The subgrade should then be proofrolled with a heavy, pneumatic tired vehicle. Areas which deform under wheel loads should be removed and replaced. Base course should be compacted to at least 95 percent of the maximum modified Proctor density.

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

An Overlot Grading Plan was not reviewed in the preparation of this report. Limited cuts and fills are anticipated. Based on the test borings for this investigation, the subgrade materials are anticipated to encounter silty to clayey sand and sandy clay. The native on-site soils can be used as site grading fill.

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.

Mitigation:
We believe the surficial soils will classify as Type C materials as defined by OSHA in 29CFR Part 1926, dated 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. Long term cut slopes in the upper soil should be limited to no steeper than 3:1 (horizontal to vertical). Flatter slopes will likely be necessary should groundwater conditions occur. It is recommended that long term fill slopes be no steeper than 3:1 (horizontal to vertical).

9.0 BEARING OF GEOLOGIC CONDITIONS UPON PROPOSED DEVELOPMENT

Geologic hazards (as described in Section 8.0 of this report) were not found to be present at this site. Geologic constraints (also as described in section 8.0 of this report) such as: expansive and hydrocompactive soils, faults, seismicity, radon, erosion and fill soils were found on the site. It is our

opinion that the existing geologic and engineering conditions can be satisfactorily mitigated through proper engineering and design contraction practices and avoidance when deemed necessary.

10.0 BURIED UTILITIES

It is uncertain if the site will have utilities, but based upon the conditions encountered in the test borings, we anticipate that the soils encountered in individual utility trench excavations will consist of native silty to clayey sand and sandy clay. It is anticipated the sands will be encountered at loose to medium dense relative densities, the sandy clay at stiff to very stiff densities at medium hard to hard relative densities. Bedrock conditions are not anticipated within the utility trenches.

We believe the sand will classify as Type C materials and the clay as Type B 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

11.0 PAVEMENT RECOMMENDATIONS

The discussion presented below is based on the subsurface conditions encountered in the test borings, laboratory test results and the project characteristics previously described. If the subsurface conditions are different from those described in this report or the project characteristics change, RMG should be retained to review our recommendations and modify them, if necessary. The conclusions and recommendations presented in this report should be verified by RMG during construction.

Pavement Design

Parking lot pavement is typically designed using the Colorado Asphalt Pavement Association's *A Guideline for the Design and Construction of Asphalt Parking Lots in Colorado*. The following recommendations are for preliminary planning purposes only. We suggest evaluating the soil conditions after site grading and pavement layout to assess our recommendations.

Subgrade Preparation

On-site soils encountered in the test borings are suitable as subgrade material. All subgrade material placed below pavements should be moisture conditioned and compacted in accordance with the **Structural Fill – General** section of this report. Prior to placement of the pavement section, the final subgrade should be scarified to a depth of 12 inches, adjusted to within 2 percent of the optimum moisture content and recompacted. The subgrade should then be proof-rolled with a heavy, pneumatic tired vehicle. Areas that deform under wheel loads should be removed and replaced. Base course should be compacted to at least 95 percent of the maximum Modified Proctor density (ASTM D1557).

Pavement Thickness

Recommended pavement sections for the normally loaded paved areas and for heavy vehicle loading areas are presented below.

Estimated Hot-Mix Asphalt Pavement Section	
Traffic Level	**HMA over ABC (inches)**
Moderate Traffic / Some Trucks	4.0 / 6.0
Heavy Vehicles with Turning Motions	6.0 / 6.0

As an alternative to the HMA section above, Rigid Concrete Pavements are recommended in areas where heavy vehicle loading is expected. These areas include drop-off/pick-up areas, loading docks, trash pick-up areas, and other locations where heavy trucks will be making frequent turning and braking movements. Rigid pavements may be constructed directly on proof-rolled non-expansive granular subgrade, the top one foot of which has been compacted to a minimum of 95% of maximum dry density as determined by ASTM D1557.

Minimum Rigid Concrete Pavement Section	
Traffic Level	**Portland Cement Concrete (in.)**
Heavy Vehicles with Turning Motions	5.0 in.

Pavement Materials

Pavement materials should be selected, prepared, and placed in accordance with the above referenced document and the *Pikes Peak Region Asphalt Paving Specifications*. Tests should be performed in accordance with the applicable procedures presented in the specifications.

Surface Drainage

Surface drainage is important for the satisfactory performance of pavement. Wetting of the subgrade soils or base course will cause a loss of strength that can result in pavement distress. Surface drainage should provide for efficient removal of storm-water runoff. Water should not pond on the pavement or at the edges of the pavement.

12.0 DETENTION STORAGE CRITERIA

This section has been prepared in accordance with the requirements outlined in the El Paso County Land Development Code (LDC), the Engineering Criteria Manual (ECM) Section 2.2.6 and Appendix C.3.2.B, and the El Paso County (EPC) Drainage Criteria Manual, Volume 1 Section 11.3.3.

12.1 Soil Design Parameters

Test borings TB-1 and TB-2 were located in the general vicinity of the proposed detention pond. RMG has performed laboratory tests of soil from across the proposed development. Based upon field and laboratory testing, the following soil parameters are typical for the soils likely to be encountered, and are recommended for use in detention pond embankment design.

Soil Description	Unit Weight (lb/ft^3)	Friction Angle (degree)	Active Earth Pressure, Ka	Passive Earth Pressure, Kp	At Rest Earth Pressure, Ko
Clayey sand (SC)	105	28	0.361	2.77	0.531

12.2 Detention Pond Considerations

Based on a review of Sheet 5 of 10 of the *Grading and Erosion Control Plans (w/Pond Details)*, a proposed full spectrum detention pond located at the eastern property boundary. Embankments constructed as part of pond development should comply with recommendations contained in Volume 1 of the El Paso County Drainage Criteria Manual, Chapter 11.3.3, repeated herein for reference.

> 11.3.3. Embankment Structures
>
> The width of the top of the embankment structure shall be a minimum of 12 feet for embankments less than 25 feet in height. Also, side slopes on embankment structures will vary with materials types used and shall be designed to produce a stable and easily maintained structure. A slope stability analysis shall be required on all Class 1 structures.
>
> An allowance for settlement shall also be factored into the design for all embankment structures. Consideration shall also be given to limiting excessive seepage through the embankment and foundation that may lead to embankment erosion and structure instability for all Class 1 structures.
>
> A geotechnical analysis and report prepared by a Colorado Professional Engineer with recommendations for the foundation preparation and embankment construction shall be submitted to the City/County Engineer with the complete design analysis for all permanent detention facilities.

As a complement to the above, the following general construction recommendations are applicable. Embankments should be constructed in accordance with applicable sections of the El Paso County Engineering Criteria Manual, the El Paso County Drainage Criteria Manual, and the El Paso County Land Development Manual. The following recommendations are in accordance with the El Paso county DCM Volume 2, Extended Detention Basin (EDB), Design Procedure and Criteria, paragraph 8.

The ground area to receive embankments should be cleared and grubbed to a minimum depth of two-feet to remove grass, shrubs, trees, roots, stumps, and other organic material. The exposed soil should be 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 Modified Proctor test (ASTM D-1557). The prepared surface should present a firm and stable condition.

Embankment should be constructed as structural fill on a prepared stable base. On-site native soil when screened of all deleterious material and cobbles greater than 6-inches in any dimension is suitable for embankment construction. Structural fill should be placed in 10-inch loose lifts 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 Modified Proctor test (ASTM D-1557).

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 should not be placed on frozen subgrade or allowed to freeze during moisture conditioning and placement. To verify the condition of the compacted soils, density tests should be performed during placement. The first density tests should be conducted when 24 inches of fill have been placed.

13.0 ADDITIONAL STUDIES

The findings, conclusions and recommendations presented in this report were provided to evaluate the suitability of the site for the proposed RV and boat storage development. Unless indicated otherwise, the test borings, laboratory test results, conclusions and recommendations presented in this report are intended for use for design and construction. We recommend that a *site-specific* **Subsurface Soil Investigation** be performed for any future proposed structures. The extent of any fill soils encountered during the lot-specific investigation(s) should be evaluated for suitability to support the proposed structures prior to construction.

The lot-specific subsurface soil investigation should consider the proposed structure type, anticipated foundation loading conditions, location within the property, and local construction methods. Recommendations resulting from the investigations should be used for design and confirmed by on-site observation and testing during development and construction.

14.0 CONCLUSIONS

Based upon our evaluation of the geologic conditions, it is our opinion that the proposed development is feasible. The geologic conditions identified (expansive and hydrocompactive soils, seismicity, radon, erosion and fill soils) are not considered unusual for the Front Range region of Colorado. Mitigation of geologic conditions is most effectively accomplished by avoidance. However, where avoidance is not a practical or acceptable alternative, geologic conditions should be mitigated by implementing appropriate planning, engineering, and local construction practices.

If future foundation construction is proposed, selection and design should consider the potential for subsurface expansive soil-related movements. Mitigation techniques commonly used in the El Paso County area include overexcavation and replacement with structural fill, subexcavation and replacement with on-site moisture-conditioned soils, and/or the installation of deep foundation systems all of which are considered common construction practices for this area.

We believe the surficial sand soils will classify as Type C materials and the clay soils will classify as Type B 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) and slopes made in Type B materials be laid back at ratios no steeper than 1:1 (horizontal to vertical) unless the excavation is shored or braced. Flatter slopes will likely be necessary should groundwater conditions occur.

Long term cut slopes in the upper soil should be limited to no steeper than 3:1 (horizontal to vertical). Flatter slopes will likely be necessary should groundwater conditions occur. It is recommended that long term fill slopes be no steeper than 3:1 (horizontal to vertical).

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.

15.0 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 **C&M Properties** 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 point-of-view, please feel free to contact us.

FIGURES

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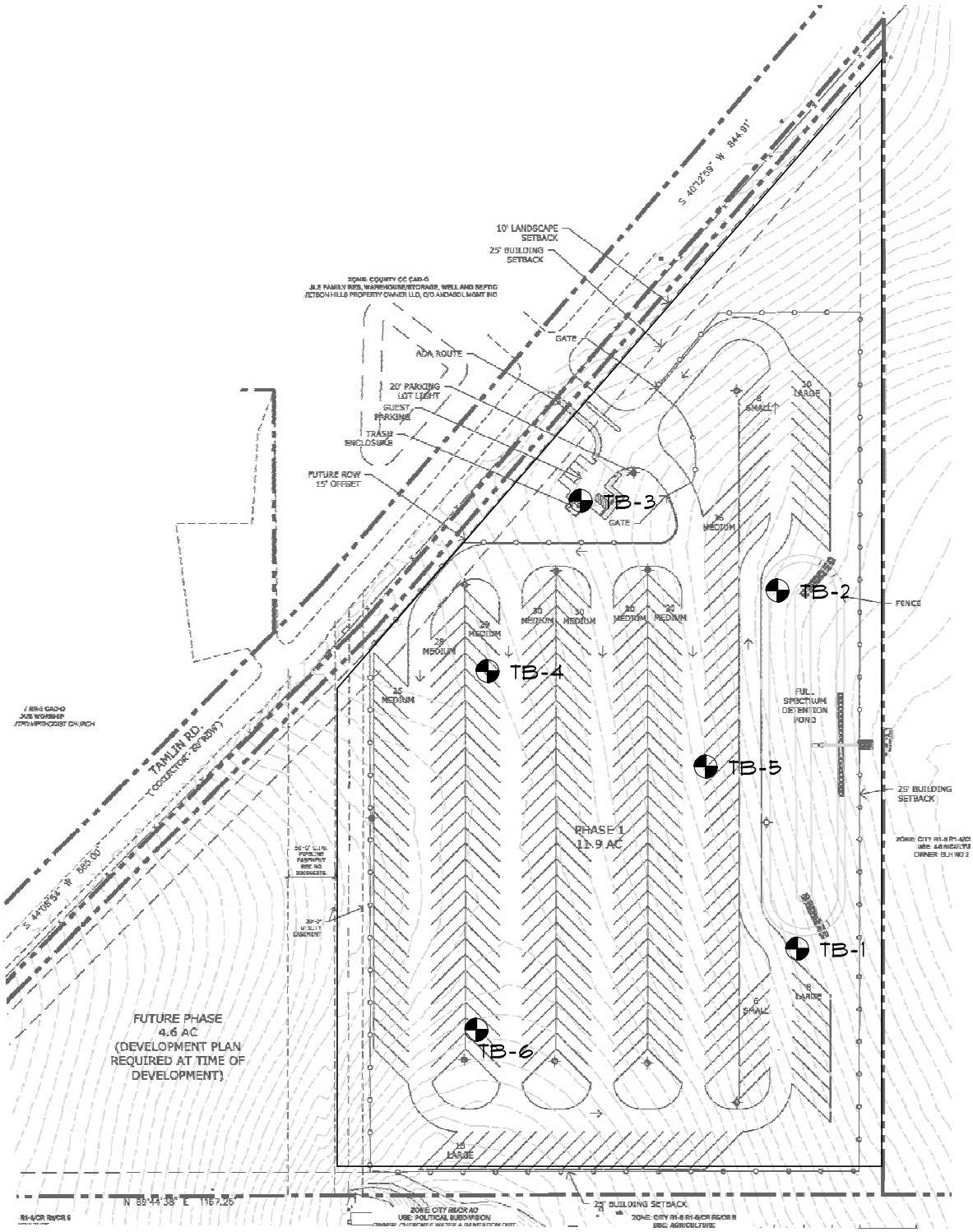
SITE VICINITY MAP

5080 TAMLIN ROAD
EL PASO COUNTY, COLORADO
C&M PROPERTIES

JOB No. 174679

FIG No. 1

DATE 3-2-2020



NOT TO SCALE

BASE MAP PROVIDED BY: N.E.S. INC.

DENOTES APPROXIMATE LOCATION OF TEST BORINGS

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PROPOSED SITE LAYOUT WITH TEST BORING LOCATIONS

5080 TAMLIN ROAD
EL PASO COUNTY, COLORADO
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FIG No. 2

DATE 3-2-2020

SOILS DESCRIPTION

 CLAYEY SAND

 SANDY CLAY

 SILTY TO CLAYEY SAND

UNLESS NOTED OTHERWISE, ALL LABORATORY
TESTS PRESENTED HEREIN WERE PERFORMED BY:
RMG - ROCKY MOUNTAIN GROUP
2910 AUSTIN BLUFFS PARKWAY
COLORADO SPRINGS, COLORADO

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).

 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).

 FREE WATER TABLE

 DEPTH AT WHICH BORING CAVED

 BULK DISTURBED BULK SAMPLE

 AUG AUGER "CUTTINGS"

4.5 WATER CONTENT (%)

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EXPLANATION OF TEST BORING LOGS

JOB No. 174679

FIGURE No. 3

DATE 3/2/20

TEST BORING: **1**
DATE DRILLED:
1/27/20
REMARKS:
NO GROUNDWATER ON
1/27/20

DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
	CLAY, SANDY, light brown, very stiff, moist			
5			21	14.0
	SAND, SILTY TO CLAYEY, light brown, medium dense, moist			
10			22	12.3
15			19	10.7
20			17	7.5

TEST BORING: **2**
DATE DRILLED:
1/27/20
REMARKS:
NO GROUNDWATER ON
1/27/20

DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
	CLAY, SANDY, light brown to brown, very stiff, moist			
5			21	13.8
	SAND, SILTY TO CLAYEY, light brown, medium dense, moist			
10			14	10.0
15			21	12.6
20			12	10.0

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TEST BORING LOGS

JOB No. 174679

FIGURE No. 4

DATE 3/2/20

TEST BORING: **3** DATE DRILLED: 1/27/20 REMARKS: NO GROUNDWATER ON 1/27/20	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
SAND, SILTY TO CLAYEY, brown, loose, moist	5			10	10.6
	10			11	11.3

TEST BORING: **4** DATE DRILLED: 1/27/20 REMARKS: NO GROUNDWATER ON 1/27/20	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
CLAY, SANDY, light brown, stiff to very stiff, moist				19	9.2
	5			16	9.8

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TEST BORING LOGS

JOB No. 174679

FIGURE No. 5

DATE 3/2/20

TEST BORING: **5** DATE DRILLED: 1/27/20 REMARKS: NO GROUNDWATER ON 1/27/20	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
CLAY, SANDY, brown to dark brown, medium stiff to stiff, moist					
				12	10.5
				9	15.5
	5				

TEST BORING: **6** DATE DRILLED: 1/27/20 REMARKS: NO GROUNDWATER ON 1/27/20	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
SAND, SILTY TO CLAYEY, light brown, medium dense, moist					
				24	8.5
				20	7.7
	5				

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TEST BORING LOGS

JOB No. 174679

FIGURE No. 6

DATE 3/2/20

Test Boring No.	Depth	Water Content (%)	Dry Density (pcf)	Liquid Limit	Plasticity Index	% Retained No.4 Sieve	% Passing No. 200 Sieve	Load (psf)	% Swell/ Collapse	USCS Classification
1	4.0	14.0	99.8	45	27	0.0	59.2		1.1	CL
1	9.0	12.3								
1	14.0	10.7								
1	19.0	7.5								
2	4.0	13.8								
2	9.0	10.0		30	14	0.0	45.7			SC
2	14.0	12.6								
2	19.0	10.0								
3	4.0	10.6		28	14	0.0	38.9			SC
3	9.0	11.3								
4	2.0	9.2		38	23	0.0	58.4			CL
4	4.0	9.8								
5	2.0	10.5		33	20	0.0	48.0			SC
5	4.0	15.5								
6	2.0	8.5		33	19	0.0	29.8			SC
6	4.0	7.7								

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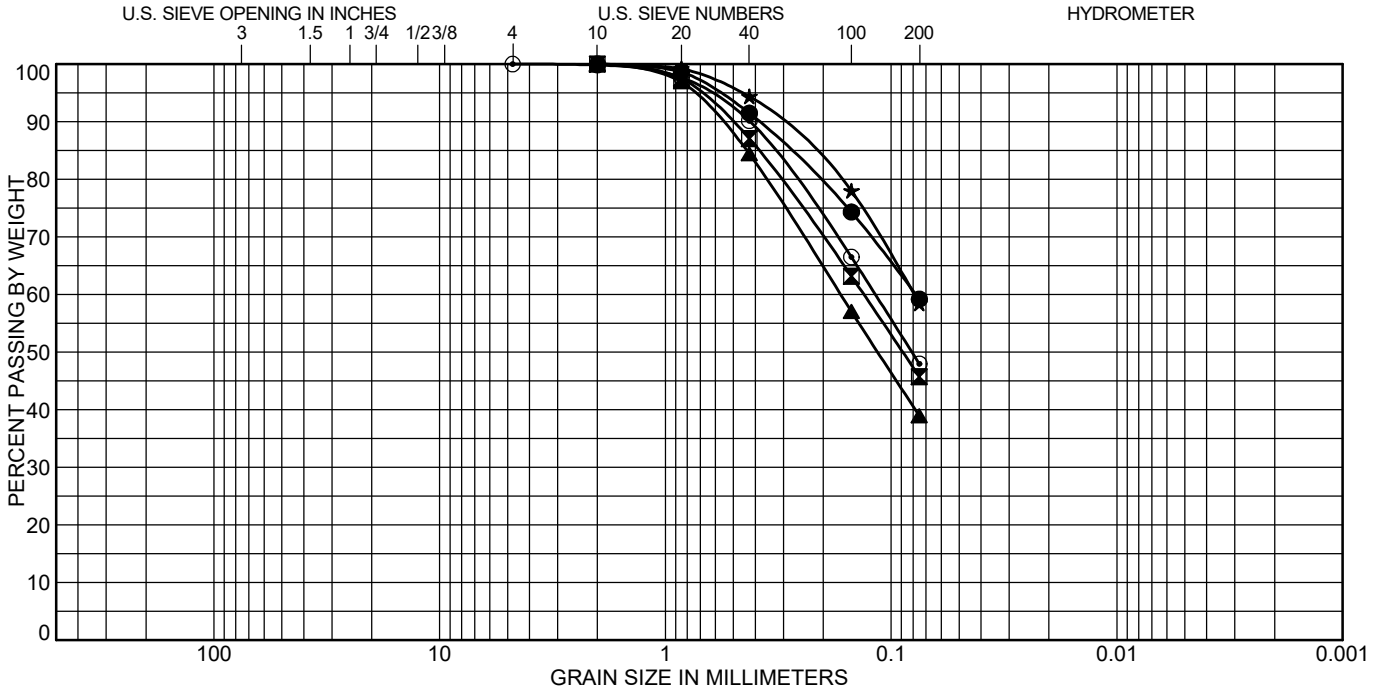
SUMMARY OF LABORATORY TEST RESULTS

JOB No. 174679
FIGURE No. 7
PAGE 1 OF 1
DATE 3/2/20



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Test Boring		Depth (ft)	Classification	LL	PL	PI
●	1	4.0	**SANDY LEAN CLAY(CL)**	45	18	27
⧓	2	9.0	**CLAYEY SAND(SC)**	30	16	14
▲	3	4.0	**CLAYEY SAND(SC)**	28	14	14
★	4	2.0	**SANDY LEAN CLAY(CL)**	38	15	23
⊙	5	2.0	**CLAYEY SAND(SC)**	33	13	20

Test Boring		Depth (ft)	%Gravel	%Sand	%Silt	%Clay
●	1	4.0	0.0	40.8	59.2	
⧓	2	9.0	0.0	54.3	45.7	
▲	3	4.0	0.0	61.1	38.9	
★	4	2.0	0.0	41.6	58.4	
⊙	5	2.0	0.0	52.0	48.0	

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SOIL CLASSIFICATION DATA

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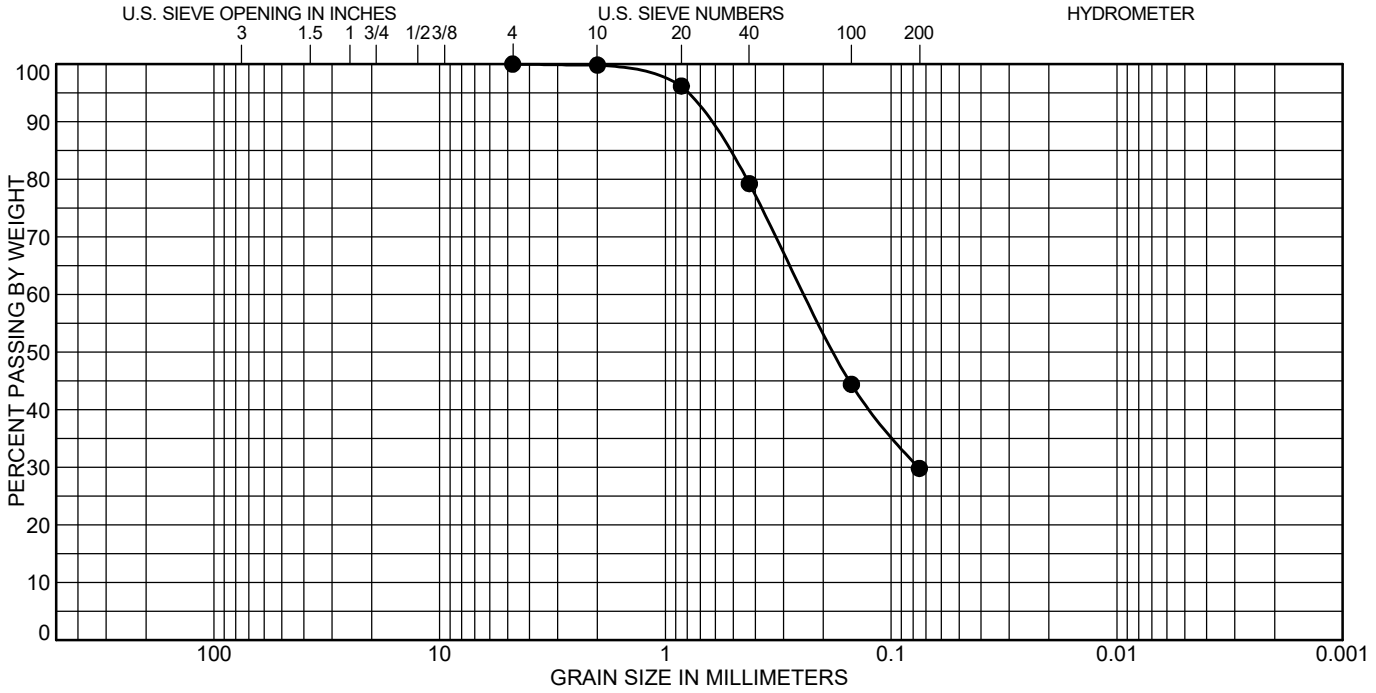
FIGURE No. 8

DATE 3/2/20



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Test Boring	Depth (ft)	Classification	LL	PL	PI
● 6	2.0	**CLAYEY SAND(SC)**	33	14	19

Test Boring	Depth (ft)	%Gravel	%Sand	%Silt	%Clay
● 6	2.0	0.0	70.2	29.8	

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SOIL CLASSIFICATION DATA

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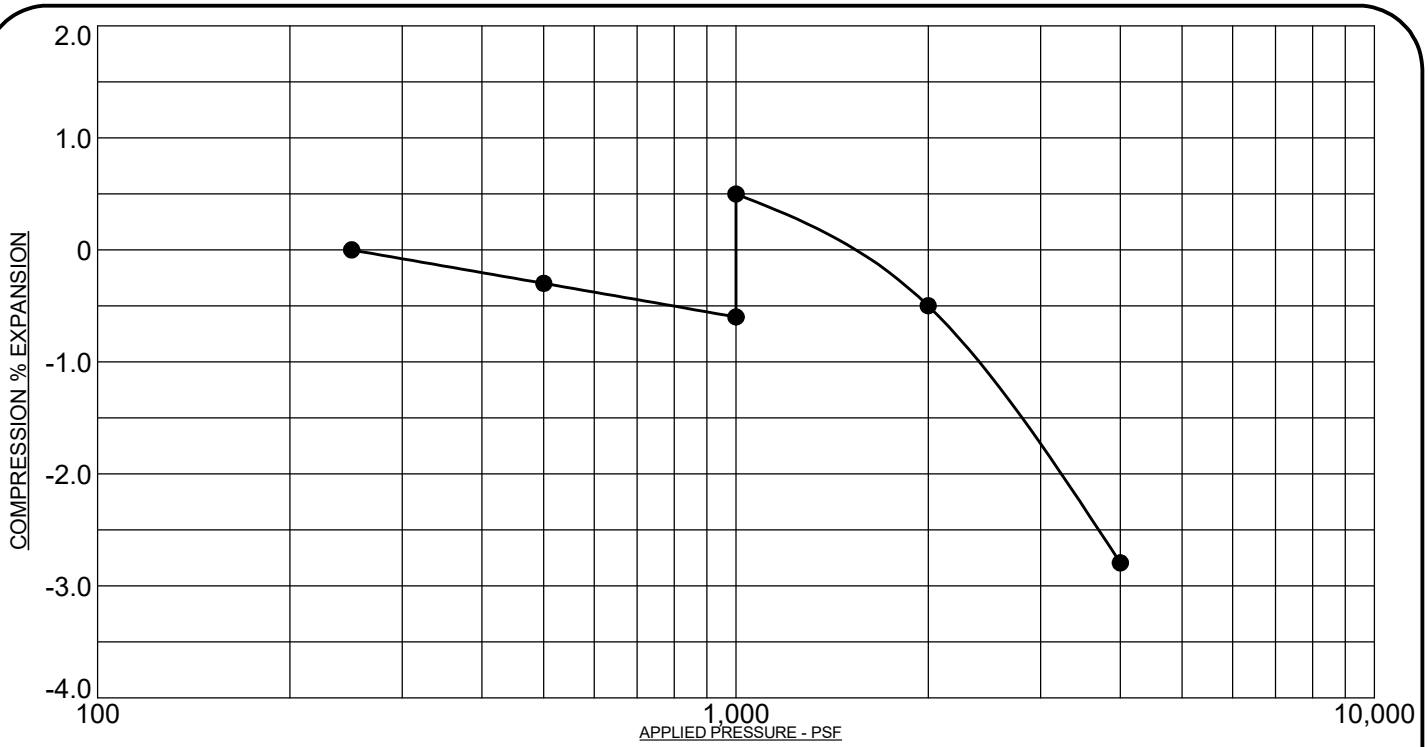
FIGURE No. 9

DATE 3/2/20



PROJECT: **5080 Tamlin Road, El Paso County, Colorado**
SAMPLE DESCRIPTION: **CLAY, SANDY**
NOTE: SAMPLE WAS INUNDATED WITH WATER AT 1,000 PSF

SAMPLE LOCATION: **1 @ 4 FT**
NATURAL DRY UNIT WEIGHT: **99.8 PCF**
NATURAL MOISTURE CONTENT: **14.0%**
PERCENT SWELL/COMPRESSION: **1.1**

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SWELL/CONSOLIDATION TEST RESULTS

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FIGURE No. 10

DATE 3/2/20

97 - Truckton sandy laon 3 to 9 percent slopes

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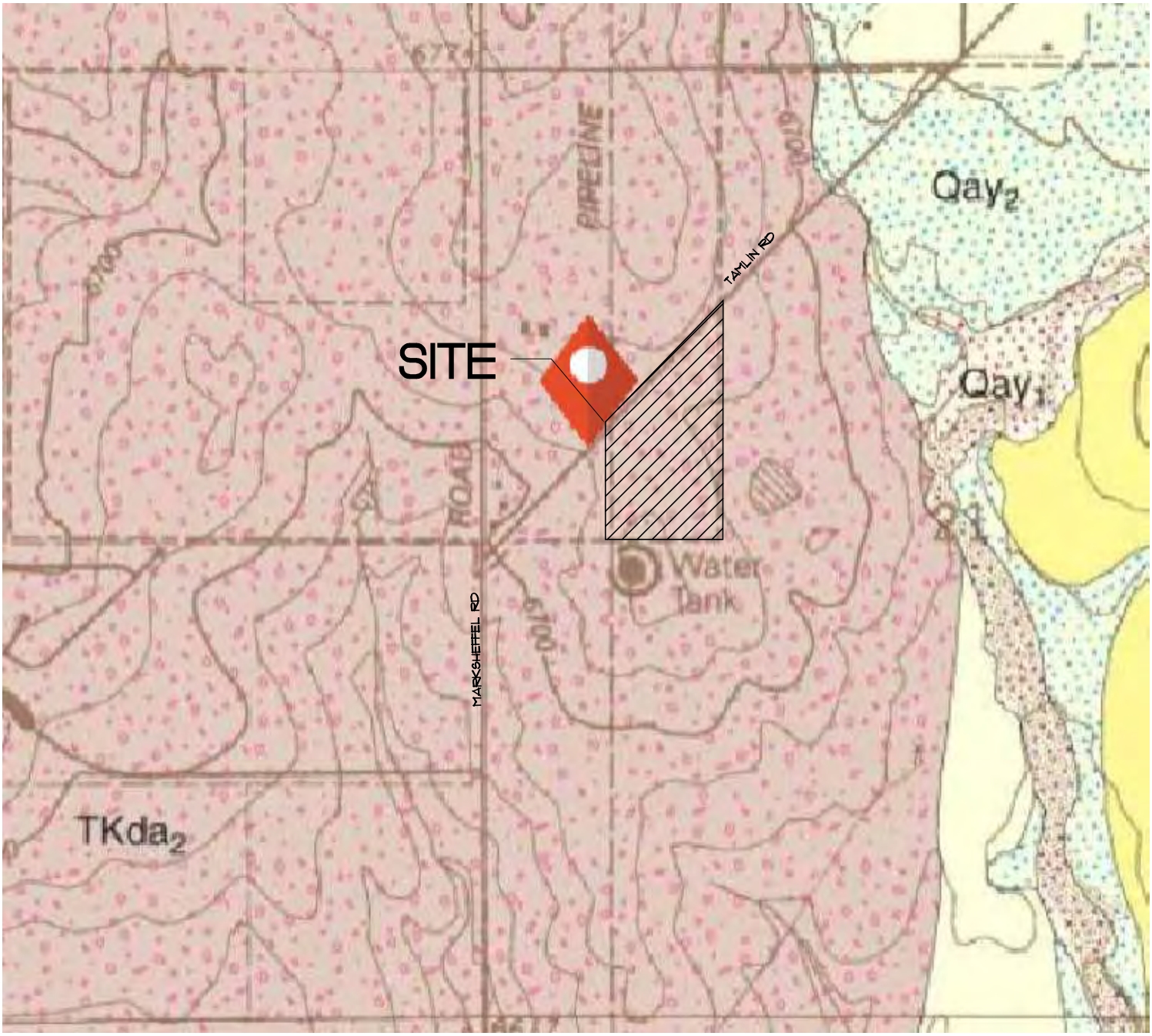
USDA SOILS SURVEY MAP

5080 TAMLIN ROAD
EL PASO COUNTY, COLORADO
C&M PROPERTIES

JOB No. 174679

FIG No. 11

DATE 3-2-2020



$Tkda_2$ - Dawson Formation

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FALCON NW QUADRANGLE

5080 TAMLIN ROAD
EL PASO COUNTY, COLORADO
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FIG No. 12

DATE 3-2-2020

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FEMA MAP

5080 TAMLIN ROAD
EL PASO COUNTY, COLORADO
C&M PROPERTIES

JOB No. 174679

FIG No. 13

DATE 3-2-2020

NOT TO SCALE

Geologic

Af - Artificial Fill

psw - potentially seasonally wet

$Tkda_2$ - Dawson Formation

Engineering

2A - Stable alluvium, colluvium and bedrock on flat to gentle slopes (5% to 12%)

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ENGINEERING GEOLOGY MAP

5080 TAMLIN ROAD
EL PASO COUNTY, COLORADO
C&M PROPERTIES

JOB No. 174679

FIG No. 14

DATE 3-2-2020

APPENDIX A
Additional Reference Documents

1. *Site Development Plan, Tamlin Road Storage, El Paso County, Colorado*, prepared by NES, Inc., last dated January 10, 2020.
2. *Grading and Erosion Control Plasn (w/ Pond Details),* Tamlin Road RV Storage, 5080 Tamlin Road, prepared by J.R. Engineering, Job No. 25134.00, last dated July 14, 2020
3. *Flood Insurance Rate Map, El Paso County, Colorado and Unincorporated Areas, Community Panel No. 08041C0543G,* Federal Emergency Management Agency (FEMA), effective December 7, 2018.
4. *Geologic Map of the Falcon NW 7.5 Quadrangle, El Paso County, Colorado*, Madole, R.F. Colorado Geological Survey Open-File Report OF03-08, 2003.
5. *Falcon NW Quadrangle, Environmental and Engineering Geologic Map for Land Use*, compiled by Dale M. Cochran, Charles S. Robinson & Associates, Inc., Golden, Colorado, 1977.
6. *Falcon NW Quadrangle, Map of Potential Geologic Hazards and Surficial Deposits*, compiled by Dale M. Cochran, Charles S. Robinson & Associates, Inc., Golden, Colorado, 1977.
7. *Pikes Peak Regional Building Department:* https://www.pprbd.org/.
8. https://property.spatialest.com/co/elpaso/#/property/5522105006 Schedule No.: 5321002001.
9. *Colorado Geological Survey, USGS Geologic Map Viewer*: http://coloradogeologicalsurvey.org/geologic-mapping/6347-2/.
10. *Historical Aerials:* https://www.historicaerials.com/viewer, Images dated 1947, 1960, 1969, 1999, 2005, 2009, 2011, 2013, and 2015.
11. *USGS Historical Topographic Map Explorer:* http://historicalmaps.arcgis.com/usgs/ Colorado Springs Quadrangles dated 1950, 1951, 1958, 1963, 1969, 1970, 1975, 1978, 1981, 1994, 2013 and 2016.
12. *Google Earth Pro*, Imagery dated 1999, 2003, 2004, 2005, 2006, 2011, 2015, 2017 and 2018.