Architecture
Structural
Geotechnical

ROCKY MOUNTAIN GROUP
EMPLOYEE OWNED

Materials Testing
Forensic
Civil/Planning

GEOLOGY AND SOILS STUDY

Lots 1-90
Townhomes at Ponderosa North
at Lorson Ranch, Filing No. 3
El Paso County, Colorado

PREPARED FOR:

Landhuis Company
212 N. Wahsatch Ave. Ste 301
Colorado Springs, CO

JOB NO. 172414

November 7, 2019
Revised November 8, 2019

Respectfully Submitted,

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1.0 GENERAL SITE AND PROJECT DESCRIPTION

1.1 Project Location

The project lies in the south central portion of Section 14, Township 14 South, Range 65 West of the 6th Principal Meridian in El Paso County, Colorado. The site is located 0.55 miles to the east and north of the intersection of Marksheffel Road and Fontaine Boulevard. The approximate location of the site is shown on the Site Vicinity Map, Figure 1.

1.2 Project Description

The total acreage involved in the project is approximately 10.38 acres. The proposed site development is to consist of 90 lots comprised of three to four-plex multi-family residential structures. The development will utilize sewer services provided by Widefield Water and Sanitation District. Individual wells and on-site wastewater treatment systems are not proposed.

Access to the lots is to be provided by two entrances from Old Glory Drive. The entrances are to be accessed from the west and north of the site. The roadways within the development are to be constructed with a 50-foot improved public ROW (Bearcat Loop) will be constructed to meet the requirements of an El Paso County Urban low volume residential local roadway. Bearcat Point is considered private and is proposed to be an alley with a modified 40' cross section.

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 Tony Munger, 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.

Tony Munger is a licensed professional engineer with over 19 years of experience in the construction engineering (residential) field. Mr. Munger and holds a Bachelor of Science in Architectural Engineering from the University of Wyoming.

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 08/27/2019 applicable sections include 8.4.8 and 8.4.9. and 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 where not available for our review, however, geotechnical engineering/geologic investigations for nearby sites were available for our review and are listed below:

1. *Preliminary Subsurface Soil Investigation, 207 Residential Lots, Ponderosa at Lorson Ranch, Filing No. 1, El Paso County, Colorado,* prepared by RMG Engineers Inc., Job No. 115519, last dated November 28, 2006.
2. *Preliminary Subsurface Soil Investigation, 207 Residential Lots, Ponderosa at Lorson Ranch, El Paso County, Colorado,* prepared by RMG Engineers Inc., Job No. 116278, last dated March 8, 2007.
3. *Subsurface Soil Investigation and Pavement Design, Ponderosa at Lorson Ranch, El Paso County, Colorado*, prepared by RMG Engineers, Inc., Job No. 117993, last dated June 30, 2007.
4. *36 Residential Lots, Lots 1-23 and 70-82, Ponderosa at Lorson Ranch, Filing No. 1, El Paso County, Colorado*, prepared by RMG Engineers, Inc., Job No. 120493, last dated May 7, 2008.

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

It is our understanding the proposed development is to consist of 90 lots comprised of three to four-plex multi-family residential structures. The proposed lots range from 1,500 to 1,962 square foot each. The development will utilize sewer services provided by Widefield Water and Sanitation District. Individual wells and on-site wastewater treatment systems are not proposed. Figure 1 presents the general boundaries of our investigation.

4.2 Topography

Based on our site observation on September 18, 2019, in general, the site topography is fairly flat and does not contain slopes. The approximate elevation difference from the northeast corner to the southwest corner of the property is 5 to 8 feet. Jimmy Camp Creek is located approximately 0.21 miles west of the western property boundary.

4.3 Vegetation

The majority of the site consists of low lying native grasses and weeds. Very few deciduous trees are located within the easement along the eastern portion of the property.

5.0 FIELD INVESTIGATION AND LABORATORY TESTING

The subsurface conditions within the property were explored by drilling three (3) exploratory borings extending to depths of approximately 20 feet below the existing ground surface. That is in excess of the minimum 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 borings 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 Preliminary Lot Layout with Test Boring Locations plan is presented in Figure 3. An Explanation of Test Boring Logs is shown in Figure 3, and the Test Boring Logs are shown in Figures 4 and 5.

Soil laboratory testing was performed as part of this investigation. The laboratory tests included moisture content, dry density, grain-size analyses, Atterberg Limits, and one Swell/Consolidation test. A Summary of Laboratory Test Results is presented in Figure 6. Soils Classification Data is presented in Figure 7. Swell/Consolidation Test Results are presented in Figure 8.

5.1 Groundwater

Groundwater was not encountered in the test borings during the field exploration or when checked five days subsequent to drilling. Conditions consistent with a wide-spread shallow groundwater table were not encountered nor observed within the lots or the proposed development, nor have we encountered significant signs of a wide-spread shallow groundwater table in the course of investigations we have performed on the surrounding properties.

Based on our knowledge of the area and engineering design and construction techniques employed in the El Paso County area at this time, it is our opinion that there is insufficient reason to preclude full-depth basements on any of the lots in this subdivision at this time. If shallow groundwater conditions are found to exist at the time of the site-specific Subsurface Soil Investigations, the feasibility of basement construction and/or any recommended mitigation measures are to be addressed at that time.

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

The site physiographically lies in the western portion of the Great Plains Physiographic Province south of the Palmer Divide. Approximately 11 miles to the west is a major structural feature known as the Rampart Range Fault. The fault marks the boundary between the Great Plains Physiographic and Southern Rocky Mountain Province. The bedrock underlying the site consists of the Pierre Shale

Formation. Overlying this formation are unconsolidated deposits of residual soils and alluvial soils of the Holocene and late Pleistocene Age. The surficial soils are alluvial soils which have been eroded and reshaped by water in some form and redeposited in a non-marine setting.

6.1 Subsurface Soil Conditions

The subsurface materials encountered in the test borings were visually identified in the field and classified within the laboratory using the Unified Soil Classification System (USCS). The materials were identified and classified as silty sand (SM), clayey sand (SC), low plasticity clay (CL) and high plasticity clay (CH).

Additional descriptions and the interpreted distribution (approximate depths) of the subsurface materials are presented on the Test Boring Logs. 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) beneath the site is considered to be part of the Pierre Shale formation. Bedrock was not encountered in the test borings performed for this investigation. Bedrock conditions are not anticipated to be encountered in the excavations or utility trenches for the proposed development.

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:

- 30 – Fort Collins loam, 0 to 3 percent slopes. The Fort Collins loam was mapped by the USDA to be located near the western portion of the property. The Fort Collins loam encompasses approximately 2.3 acres for a total of 21.9 percent of the property. Properties of the Fort Collins loam include, well-drained soil, depth of the water table is anticipated to be greater than 6.5 feet, runoff is anticipated to be low, frequency of flooding is none, and landforms are flat.

- 52 – Manzanst clay loam, 0 to 3 percent slopes. The Manzanst clay loam was mapped by the USDA to encompass the remainder of the property. The Manzanst clay loam encompasses approximately 8.2 acres for a total of 78.3 percent of the property. Properties of the clay loam include, well-drained soils, depth of the water table is anticipated to be greater than 6.5 feet, runoff is anticipated to be low, frequency of flooding is none, and landforms include terraces and drainage-ways.

The USDA Soil Survey Map is presented in Figure 10.

6.4 General Geologic Conditions

Based on our field observations, the U.S. Soil Conservation Service, United States Department of Agriculture (USDA) and the Geologic Map of the Fountain Quadrangle, a geologic map of significant

surficial deposits and features were mapped. The identified geologic conditions affecting the development are presented in the Engineering and Geology Map, Figure 9.

The site generally consists of silty to clayey sand (alluvium). One geologic unit was mapped at the site as:

- *Qa_3 – Alluvium three (lower to middle? Holocene)* – well sorted sand and clayey to silty sand that is occasionally mottled and stratified. Unit may contain gravel lenses. The unit forms broad terraces along Jimmy Camp creek. The unit is up to 50 ft thick with increased gravel content in the lower 15 feet. The soils may be prone to settlement or swelling. The alluvium was encountered in the three test borings performed by RMG to a depth of 20 feet.

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 or the surrounding the site or in the soil samples collected for laboratory testing.

6.6 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.

6.7 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 9.

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.

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, overall the surrounding area slopes down to the southwest towards Jimmy Camp Creek. Jimmy Camp Creek is currently a defined drainage way that is located approximately 0.21 miles from the western property boundary. It is anticipated the direction of groundwater is towards Jimmy Camp Creek. The creek is not anticipated to adversely impact the placement of the residences in the subdivision.

Groundwater and indications of seasonally shallow groundwater were not observed in the test borings performed by RMG at the time of the field observation or when checked five days subsequent to drilling.

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 3* 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 HAZARDS AND 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 Defintions of Specific Terms and Phrases). The following geologic hazards were not identified on the parcel:

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

The following geologic constraints were identified on the property:

8.1 Expansive Soils and Bedrock

Based on the test borings performed by RMG, the silty to clayey sand generally possesses low swell potential and the sandy clay generally possess low to moderate swell potential. Bedrock was not encountered on this site. Should expansive soils be encountered beneath foundations, mitigation will be required. 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
Shallow foundations are anticipated for structures within this development. Foundation design and construction are typically adjusted for expansive soils. Mitigation of expansive soils and bedrock (if encountered) 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.

Provided that appropriate mitigations and/or foundation design adjustments are implemented, the presence of expansive soils or bedrock (if encountered) is not considered to pose a risk to the proposed structures.

8.2 Hydrocompactive Soils (Moisture Sensitive Soils)

Based on the test borings performed by RMG, the silty to clayey sand generally possesses low to moderate hydrocompactive potential and the sandy clay generally possess low hydrocompactive potential. Should expansive soils be encountered beneath foundations, mitigation will be required. 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
Shallow foundations are anticipated for structures within this development. Foundation design and construction are typically adjusted for hydrocompactive soils. If loose or hyrdocompactive 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, 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 the proposed structures.

8.3 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. 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, but 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 at this site if minor shifting were to occur.

Mitigation

The Pikes Peak Regional Building Code, 2017 Edition, 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.

8.4 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, CO and the 80925 zip code located in Lorson Ranch, 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 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.

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

Preliminary grading plans were provided and reviewed at the time the report was issued. Based on this review, it is assumed that the excavations will encounter silty to clayey sands near the surface overlying sandstone bedrock. The on-site sand soils can be used as site grading fill.

The on-site soils are mildly susceptible to win 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.

Mitigation:
We anticipate that the deepest excavation cuts for basement level construction will be approximately 6 to 8 feet below the existing ground surface. 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

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 with interbedded 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 and sandstone (if encountered) 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 PAVEMENTS

The proposed roadways with in this development will require a new pavement design prepared in accordance with the El Paso County regulations.

The site plan provided by Thomas and Thomas has the interior roadway Bearcat Loop is classified as 50' urban low volume residential local. Bearcat Trail is classified as a "private road" intended for use as an alley. It is anticipated a modified cross section for the proposed alley will be required, in absence of a standard in the ECM. ***The actual pavement section design for individual streets will be completed following overlot grading and rough cutting of the street subgrade.***

The Lorson Ranch area has generally preferred to construct the roadways with a composite roadway section consisting of Hot Mix Asphalt over Cement-Treated Subgrade (CTS). For purposes of this

report, we anticipate the subgrade soils will primarily have American Association of State Highway and Transportation Officials (AASHTO) Soil Classifications of A-7-6 with indices ranging from 15 to 38 with an estimated design subgrade "R-values" on the order of 3 to 5.

Pavement materials should be selected, prepared, and placed in accordance with the El Paso County specification and the Pikes Peak Region Asphalt Paving Specifications. Tests should be performed in accordance with the applicable procedures presented in the final design.

12.0 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 structures. It is our understanding that basement excavations are proposed and the anticipated cut will be approximately 6 to 8 feet below the final ground surface not including overexcavation, if needed.

Expansive claystone was not encountered in the test borings performed for this study. However, interbedded seams of sandy clay are anticipated. 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 to 4 feet are typical for the soil conditions encountered. However, the final overexcavation depths may vary, and are to be determined in site-specific Subsurface Soil Investigations and confirmed at the time of the Open Excavation Observations for each lot.

If loose sands are encountered, they may require additional compaction to achieve the allowable bearing pressure as indicated in a site specific Subsurface Soil Investigation. In some cases, removal and recompaction 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 systems for the attached single family structures should be designed and constructed based upon recommendations developed in a site-specific Subsurface Soil Investigation. The recommendations presented in the Subsurface Soil Investigation should be verified following the excavations of each structure and evaluation of the building loads.

12.1 Subexcavation and Moisture-Conditioned Fill

Based upon the field exploration and laboratory testing for this development and surrounding developments, 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 the final grading plans.

12.2 Uncontrolled Fill

If undocumented fill is encountered during construction of the structures, it will be assumed that this fill was not moisture conditioned and compacted in a manner consistent with the **Structural Fill** recommendations contained within this report, unless appropriate documentation can be provided. If such fill is encountered, it is not considered suitable for support of shallow foundations. This unsuitable fill will require removal (overexcavation) and replacement with non-expansive, granular structural fill

below foundation components and floor slabs. The structural fill should be observed and tested during placement as indicated under the **Structural Fill** section of this report, to ensure proper compaction.

Following completion of the overexcavation and moisture conditioning process, it is imperative that the "as-compacted" moisture content be maintained prior to construction.

12.3 Foundation Stabilization

Groundwater was not encountered in the test boring performed for this study. Based on a review of previous geotechnical engineering/geologic investigations in the area, it is anticipated the groundwater will have adequate separation from the bottom of the proposed basement foundation components and floor slabs. 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, if groundwater were to 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.

12.4 Foundations Drains

A subsurface perimeter drain is recommended around portions of the structures 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 boring performed for this study or the previously reviewed geotechnical engineering/geologic investigations. Depending on the conditions encountered during the site-specific Subsurface Soil Investigation and the conditions observed at the time of 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.

12.5 Structural Fill

Areas to receive granular, non-expansive 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.

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.

12.6 Moisture-Conditioned Structural Fill

Areas to receive moisture-conditioned expansive soils used as 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.

Moisture-conditioned 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.

Moisture conditioned structural fill shall consist of a moisture-conditioned, on-site cohesive fill material. The fill material shall be moisture conditioned and replaced as follows:

- Fill shall be free of deleterious material and shall not contain rocks or cobbles greater than 6 inches in diameter.

- Claystone fill shall be thoroughly "pulverized" and shall not contain claystone chunks greater than 1 1/2 inches in diameter.

- When claystone is to be incorporated, the fill materials shall be processed in a stockpile **(processing these materials in the excavations will not be permitted)**. These stockpiled fill materials shall be moisture-conditioned to a minimum of 1 percent to 4 percent above optimum

moisture content (as determined by the Standard Proctor test, ASTM D-698), with an average of not less than 1 1/2 percent above optimum moisture content. These materials, once moisture conditioned and thoroughly mixed, should rest in the stockpile a minimum of 24 hours to ensure proper distribution of the moisture through the material. After resting, the materials should be re-wet and re-mixed to replace the surficial moisture lost to evaporation during the resting period. Fill materials not containing claystone do not require processing in a stockpile.

- Fill materials shall be moisture-conditioned to a minimum of 1 percent to 4 percent above optimum moisture content (as determined by the Standard Proctor test, ASTM D-698), with an average of not less than 1 1/2 percent above optimum moisture content.

- The moisture-conditioned materials should be placed in maximum 6" compacted lifts. These materials should be compacted to a minimum of 95 percent of the maximum dry density as determined by the Standard Proctor test (ASTM D-698). 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.

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.

12.7 Design Parameters

The allowable bearing pressure of the surface sands should be determined by a detailed site specific Subsurface Soil Investigation. Bearing directly on the clay and/or hydrocompactive sands is not recommended.

13.0 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 residences.

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.

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.

The foundation systems for the multi-family structures should be designed and constructed based upon recommendations developed in a site-specific Subsurface Soil Investigation.

Foundation 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 **Landhuis Company** 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

APPENDIX A

Additional Reference Documents

1. *Concept Plan, Ponderosa - Townhomes, El Paso County, Colorado*, prepared by Thomas and Thomas., Project No. 2816.16, last dated March 7, 2019.
2. *Lorson Ranch, a Planned Unit Development For Townhomes @ Ponderosa North at Lorson Ranch,* prepared by Thomas and Thomas, Project Number 2816.18, last dated July 3, 2019
3. *Ponderosa at Lorson Ranch, Filing No. 3, Early Overlot Grading and Erosion Control Plans Including Detailed Grading Plan, El Paso County Colorado,* prepared by Core Engineering Group, Project No. 100.050, last dated November 2019.
4. *Flood Insurance Rate Map, El Paso County, Colorado and Unincorporated Areas, Community Panel No. 081041C957F,* Federal Emergency Management Agency (FEMA), effective December 7, 2018, revised to reflect LOMR effective August 29, 2007.
5. *Geologic Map of the Fountain quadrangle, El Paso County, Colorado*, Jonathan L. White, Kassandra O. Lindsey, Matthew L. Morgan, and Shannon A. Mahan. Colorado Geological Survey Open-File Report OF-17-05.
6. *Fountain, Quadrangle, Environmental and Engineering Geologic Map for Land Use*, compiled by Dale M. Cochran, Charles S. Robinson & Associates, Inc., Golden, Colorado, 1977.
7. *Fountain, Quadrangle, Map of Potential Geologic Hazards and Surficial Deposits*, compiled by Dale M. Cochran, Charles S. Robinson & Associates, Inc., Golden, Colorado, 1977.
8. *Pikes Peak Regional Building Department:* https://www.pprbd.org/.
9. https://property.spatialest.com/co/elpaso/#/property/5514301027 Schedule No.: 5514301027.
10. *Colorado Geological Survey, USGS Geologic Map Viewer*: http://coloradogeologicalsurvey.org/geologic-mapping/6347-2/.
11. *Historical Aerials:* https://www.historicaerials.com/viewer, Images dated 1947, 1960, 1969, 1999, 2005, 2009, 2011, 2013, and 2015.
12. *USGS Historical Topographic Map Explorer:* http://historicalmaps.arcgis.com/usgs/ Colorado Springs and Fountain Quadrangles dated 1898, 1909, 1950, 1958, 1961, 1969, 1976 and 1981.
13. *Google Earth Pro*, Imagery dated 1999, 2003, 2004, 2005, 2006, 2011, 2015, and 2017.

REFERENCE
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SITE VICINITY MAP

TOWNHOMES AT PONDEROSA NORTH
AT LORSON RANCH
EL PASO COUNTY, COLORADO
LANDHUIS COMPNAY

JOB No. 172414

FIG No. 1

DATE 11-7-2019

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BASE MAP PROVIDED BY: THOMAS & THOMAS

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CHECKED BY:	TPM
ISSUED:	11-7-2019
REVISION:	DATE:
	JOB #:

PROPOSED LOT LAYOUT

SHEET No.
FIG-2

SOILS DESCRIPTION

CLAYEY SAND

SANDY CLAY

SILTY SAND

UNLESS NOTED OTHERWISE, ALL LABORATORY
TESTS PRESENTED HEREIN WERE PERFORMED BY:
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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. 172414

FIGURE No. 3

DATE 11/7/19

TEST BORING: **1** DATE DRILLED: 8/29/19 NO GROUNDWATER ON 9/3/19	DEPTH (IN)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
SAND, SILTY, light brown, loose, moist	5			11	7.3
SAND, CLAYEY, light brown, loose, moist	10			14	9.0
CLAY, SANDY, brown, stiff to very stiff, moist	15			24	25.3
	20			14	15.4

TEST BORING: **2** DATE DRILLED: 8/29/19 NO GROUNDWATER ON 9/3/19	DEPTH (IN)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
CLAY, SANDY, brown, stiff, moist	5			13	13.1
SAND, CLAYEY, light brown, loose, moist	10			11	8.1
CLAY, SANDY, brown, medium stiff to stiff, moist	15			8	17.4
	20			16	12.6

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TEST BORING LOG

JOB No. 172414

FIGURE No. 4

DATE 11/7/19

TEST BORING: **3**
DATE DRILLED:
8/29/19
NO GROUNDWATER ON
9/3/19

DEPTH (IN)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
CLAY, SANDY, light brown to brown, stiff to very stiff, moist				
5			16	10.3
10			17	20.9
15			13	22.7
20			20	32.9

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TEST BORING LOG

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FIGURE No. 5

DATE 11/7/19

Test Boring No.	Depth	Water Content (%)	Dry Density (pcf)	Liquid Limit	Plasticity Index	% Retained No.4 Sieve	% Passing No. 200 Sieve	Load (psf)	% Swell @ 1000 psf	USCS Classification
1	4.0	7.3								
1	9.0	9.0								
1	14.0	25.3	80.9	54	31		93.2		- 1.7	CH
1	19.0	15.4								
2	4.0	13.1		42	20	0.0	77.1			CL
2	9.0	8.1								
2	14.0	17.4								
2	19.0	12.6								
3	4.0	10.3								
3	9.0	20.9		58	36		95.1			CH
3	14.0	22.7								
3	19.0	32.9								

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SUMMARY OF LABORATORY TEST RESULTS

JOB No. 172414
FIGURE No. 6
PAGE 1 OF 1
DATE 11/7/19

Test Boring No.	Depth	Water Content (%)	Dry Density (pcf)	Liquid Limit	Plasticity Index	% Retained No.4 Sieve	% Passing No. 200 Sieve	Load (psf)	% Swell @ 1000 psf	USCS Classification
1	4.0	7.3								
1	9.0	9.0								
1	14.0	25.3	80.9	54	31		93.2		- 1.7	CH
1	19.0	15.4								
2	4.0	13.1		42	20	0.0	77.1			CL
2	9.0	8.1								
2	14.0	17.4								
2	19.0	12.6								
3	4.0	10.3								
3	9.0	20.9		58	36		95.1			CH
3	14.0	22.7								
3	19.0	32.9								

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SUMMARY OF LABORATORY TEST RESULTS

JOB No. 172414
FIGURE No. 7
PAGE 1 OF 1
DATE 11/7/19

PROJECT: **Ponderosa at Lorson Ranch, Filing No. 3 El Paso County, Colorado**
SAMPLE DESCRIPTION: **CLAY, SANDY**
NOTE: SAMPLE WAS INUNDATED WITH WATER AT 1,000 PSF

SAMPLE LOCATION: **1 @ 14 FT**
NATURAL DRY UNIT WEIGHT: **80.9 PCF**
NATURAL MOISTURE CONTENT: **25.3%**
PERCENT SWELL/COMPRESSION: **- 1.7**

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SWELL/CONSOLIDATION TEST RESULTS

JOB No. 172414

FIGURE No. 8

DATE 11/7/19

Geologic

Qa – Alluvium three (lower to middle? Holocene) – well–sorted sand and clayey to silty sand The deposit includes clean lenses of well–sorted arkosic sand, sporadic gravel lenses and interbedded seams of clay. .

Engineering

2A – stable alluvium, colluvium and bedrock on gentle to moderate slopes

◐ DENOTES APPROXIMATE LOCATION OF TEST BORINGS PERFORMED FOR THIS INVESTIGATION

NOT TO SCALE

BASE MAP PROVIDED BY: THOMAS & THOMAS

JOB No. 172414

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ENGINEERING AND GEOLOGY MAP

SHEET No.
FIG-9

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USDA SOILS SURVEY MAP

TOWNHOMES AT PONDEROSA NORTH
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JOB No. 172414

FIG No. 10

DATE 11-7-2019

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FOUNTAIN QUADRANGLE

TOWNHOMES AT PONDEROSA NORTH
AT LORSON RANCH
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FIG No. 11

DATE 11-7-2019

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FEMA MAP

TOWNHOMES AT PONDEROSA NORTH
AT LORSON RANCH
EL PASO COUNTY, COLORADO
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JOB No. 172414

FIG No. 12

DATE 11-7-2019