

**Geotechnical Investigation
Mountainside PRUD Phase 2
Eden, Utah**



October 24, 2022

Prepared by:



8143 South 2475 East, South Weber, Utah



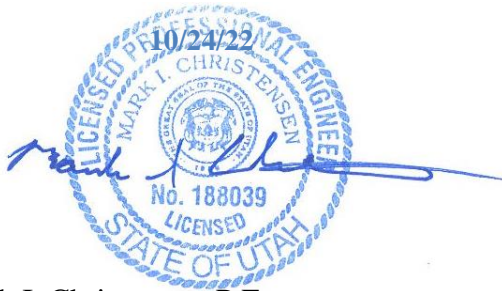
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Prepared for:

Lewis Homes
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Eden, Utah 84310

**Geotechnical Investigation
Mountainside PRUD Phase 2
Approximately 4560 North Seven Bridges Road
Eden, Utah
CG Project No.: 133-017**

Prepared by:



Mark I. Christensen, P.E.
Principal

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October 24, 2022

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1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE OF WORK

This report presents the results of a geotechnical investigation that was performed for the proposed Mountainside PRUD Phase 2 which is to be located at approximately 4560 North Seven Bridges Road in Eden, Utah. The general location of the project is indicated on the Project Vicinity Map, Plate 1. In general, the purposes of this investigation were to evaluate the subsurface conditions and the nature and engineering properties of the subsurface soils, and to provide recommendations for general site grading and for the design and construction of floor slabs, pavements, and foundations. This investigation included subsurface exploration, representative soil sampling, field and laboratory testing, engineering analysis, and preparation of this report. Prior to the completion of our report, the Geologic Hazards Evaluation for the development by Western Geologic, dated July 21, 2022, was reviewed to assist in our assessments.

The work performed for this report was authorized by Mr. Eric Householder and was conducted in accordance with the Christensen Geotechnical proposal dated June 1, 2022.

1.2 PROJECT DESCRIPTION

Based on a concept plan provided to us by Lewis Homes, we understand that the proposed phase area is approximately 14.86 acres in size and is to be developed with 38 single-family residences. The development will also include an access road, associated utilities, and landscaping. The structural loads for the proposed residences are anticipated to be on the order of 3 to 5 klf for walls and 150 psf for floors. If the actual structural loads are different from those anticipated, Christensen Geotechnical should be notified in order to reevaluate our recommendations.

2.0 METHODS OF STUDY

2.1 REVIEW OF PREVIOUS STUDIES

GeoStrata completed a geologic/geotechnical report for Phase 1 of the Parkside and Mountainside PRUDs (GeoStrata, 2018). Parkside and Mountainside PRUDs are both parts of the Bridges Development. GeoStrata's investigation included four borings and three test pits. GeoStrata's boring B-2 was located in the northeast corner of Mountainside PRUD Phase 2 and B-4 was located in the southeast corner. The soils encountered within the GeoStrata borings consisted of Sandy SILT (ML), Sandy Fat CLAY (CH), Clayey GRAVEL with sand (GC), Clayey SAND with gravel (SC), Sandy Lean CLAY with gravel (CL), Lean CLAY (CL), and Sandy Fat CLAY with gravel (CH). GeoStrata reported encountering perch groundwater in boring B-2 between a depth of 20 to 30 feet. GeoStrata further reported residual direct shear test results consist of an angle of internal friction of 15 to 18 degrees and a cohesion of 70 to 190 psf. Due to test irregularities, GeoStrata discounted the test result that produced the internal friction angle of 15 degrees and reduced the cohesion to zero, resulting in a residual strength of 18 degrees. For non-landslide soils and bedrock, GeoStrata assumed a strength consisting of 26 degrees and 250 cohesion.

GSH Geotechnical Inc. completed an engineering geology study for the eastern portion of the Bridges Development (GSH, 2016). The GSH study included the drilling of 5 borings, the excavation of 17 test pits, and the excavation of 2 trenches. Two of their test pits, TP-7 and TP-9, were located within the Mountainside PRUD Phase 2. One of the GSH borings, B-5, was located near the northeast corner of Phase 2. The soils encountered within the GSH explorations were reported to consist of Clay and SILT soils with varying amounts of sand, gravel, and cobbles. GSH reported measuring groundwater at depths of 0 to 10.5 feet within their borings. GSH also reported encountering groundwater within seven of their test pits and one of their trenches.

2.2 FIELD INVESTIGATION

The subsurface conditions at the site were explored by excavating seven test pits to depths of 8 to 12 feet below the existing site grade. The approximate test pit locations are shown on the Exploration Location Map, Plate 2. The subsurface conditions as encountered in the test pits were recorded at the time of excavation and are presented on the attached Test Pit Logs, Plates 3 to 9. A key to the symbols and terms used on the Test Pit Logs may be found on Plate 10.

The test pit excavations were accomplished with a tracked excavator. Disturbed and undisturbed soil samples were collected from the test pit sidewalls at the time of excavation. The disturbed

samples were collected and placed in bags and buckets. The undisturbed samples consisted of block samples which were placed in bags. The samples were visually classified in the field and portions of each sample were packaged and transported to our laboratory for testing. The classifications for the individual soil units are shown on the attached Test Pit Logs.

2.2 LABORATORY TESTING

Of the soils collected during the field investigation, representative samples were selected for testing in the laboratory in order to evaluate the pertinent engineering properties. The laboratory testing included moisture content and density determinations, Atterberg limits evaluations, gradation analyses, and a one-dimensional consolidation test. A summary of our laboratory testing is presented in the table below:

Table No. 1: Laboratory Test Results

| TEST HOLE NO. | DEPTH (ft.) | NATURAL DRY DENSITY (pcf) | NATURAL MOISTURE (%) | ATTERBERG LIMITS | | GRAIN SIZE DISTRIBUTION (%) | | | SOIL TYPE |
|---------------|-------------|---------------------------|----------------------|------------------|------------------|-----------------------------|------|--------------------|-----------|
| | | | | LIQUID LIMIT | PLASTICITY INDEX | GRAVEL (+ #4) | SAND | SILT/CLAY (- #200) | |
| TP-1 | 4 | | 7.1 | | | 55.1 | 13.3 | 31.6 | |
| TP-2 | 8 | | 8.5 | | | 59.3 | 7.6 | 33.1 | |
| TP-3 | 4 | 100.7 | 24.0 | 56 | 36 | | | 80.9 | CH |
| TP-4 | 5 | | 24.5 | 62 | 40 | | | 70.7 | CH |
| TP-5 | 3 | | 8.7 | | | 39.6 | 22.7 | 37.7 | |
| TP-6 | 11 | | 14.4 | | | 18.1 | 23.2 | 58.8 | |
| TP-7 | 3 | | 21.9 | 71 | 48 | | | 70.7 | CH |

The results of our laboratory tests are also presented on the Test Pit Logs, Plates 3 through 9, and more detailed laboratory results are presented on the laboratory testing plates, Plates 11 through 13.

The samples will be retained in our laboratory for 30 days following the date of this report, at which time they will be disposed of unless a written request for additional holding time is received prior to the disposal date.

3.0 GENERAL SITE CONDITIONS

3.1 SURFACE CONDITIONS

At the time of our investigation, an existing paved roadway (Seven Bridges Road) ran through the subject site from southeast to northwest. The remaining portion of the site was undeveloped land. The property generally sloped down to the southwest with grades of 5 to 20 percent. The vegetation at the site generally consisted of common grasses and weeds.

3.2 SUBSURFACE CONDITIONS

3.2.1 Soils

Based on the seven test pits that were completed for this investigation, the site is covered with 1 to 1½ feet of topsoil. The native soils below the topsoil generally consist of Clayey GRAVEL with sand (GC) with occasional zones of Fat CLAY with sand (CL).

3.2.2 Groundwater

Groundwater was encountered within Test Pit TP-4 at a depth of 10 feet below site grade at the time of excavation. It should be understood that groundwater is likely below its seasonal high and may fluctuate in response to seasonal changes, precipitation, and irrigation.

4.0 GEOLOGIC CONDITIONS

4.1 SEISMIC DESIGN CRITERIA

The State of Utah and Utah municipalities have adopted the 2018 International Building Code (IBC) for seismic design. The IBC seismic design is based on seismic hazard maps which depict probabilistic ground motions and spectral response; the maps, ground motions, and spectral response having been developed by the United States Geological Survey (USGS). Seismic design values, including the design spectral response, may be calculated for a specific site using the web-based application by the Applied Technology Council (ATC), the project site's approximate latitude and longitude, and its Site Class. Based on our field exploration, it is our opinion that this location is best described as a Site Class D, which represents a "stiff soil" profile. The spectral acceleration values obtained from the ATC's web-based application are shown below.

Table 2: IBC Seismic Response Spectrum Values

| Site Location: 41.342438° N -111.834015° W | |
|--|-------------------------|
| Name | Response Spectral Value |
| S_s | 0.965 |
| S_1 | 0.343 |
| S_{MS} | 1.075 |
| S_{M1} | See ASCE Section 11.4.8 |
| S_{DS} | 0.717 |
| S_{D1} | See ASCE Section 11.4.8 |
| PGA_M | 0.501 |

4.2 LIQUEFACTION

Certain areas in the intermountain west possess a potential for liquefaction. Liquefaction is a phenomenon in which soils lose their intergranular strength due to an increase of pore pressures during a dynamic event such as an earthquake. The potential for liquefaction is based on several factors, including 1) the grain-size distribution of the soil, 2) the plasticity of the fine fraction of the soil (material passing the No. 200 sieve), 3) the relative density of the soils, 4) earthquake strength (magnitude) and duration, 5) overburden pressures, and 6) the depth to groundwater.

The map titled "Special Study Areas, Wasatch Front and Nearby Areas, Utah" (Christenson et al., 2008) indicates that the subject site is located in an area designated as having a very low potential

for liquefaction. A site-specific liquefaction assessment was outside the scope of our services for this project. If a liquefaction assessment for this development is desired, Christensen Geotechnical should be contacted to discuss the additional work required.

5.0 ENGINEERING ANALYSIS AND RECOMMENDATIONS

5.1 GENERAL CONCLUSIONS

Based on the results of our field and laboratory investigations, it is our opinion that the subject site is suitable for the proposed construction provided that the recommendations contained in this report are incorporated into the design and construction of the project

5.2 EARTHWORK

5.2.1 General Site Preparation and Grading

Prior to site grading operations, all vegetation, topsoil, undocumented fill soils, and loose or disturbed soils should be stripped (removed) from the building pad and flatwork concrete areas. Following the stripping operations, the exposed soils should be proof rolled to a firm, unyielding condition. Site grading may then be conducted to bring the site to design grade.

Based on the test pits excavated at the site, the subject site is covered with 1 to 1½ feet of topsoil. This topsoil should be removed from below footings, concrete flatwork, and pavements. Where over-excavation is required, the excavation should extend at least 1 foot laterally for every foot of over-excavation. A Christensen Geotechnical representative should observe the site grading operations.

5.2.2 Soft Soil Stabilization

Once exposed through excavation, all subgrade soils should be proof rolled with a relatively large, wheeled vehicle to a firm, unyielding condition. Any localized soft areas encountered during the proof rolling should be removed and replaced with granular structural fill. If soft areas extend more than 18 inches deep, or if large areas are encountered, stabilization may be considered. The use of stabilization should be approved by the geotechnical engineer, but would likely consist of over-excavating the area by at least 18 inches and then placing a geofabric (such as Mirafi RS280i) at the bottom of the excavation. Over this, a stabilizing fill, consisting of angular coarse gravel with cobbles, would be placed to the design subgrade.

5.2.3 Temporary Construction Excavations

Based on OSHA requirements and the soil conditions encountered during our field investigation, we anticipate that temporary construction excavations at the site that have vertical walls that extend to depths of up to 5 feet may be occupied without shoring; however, where groundwater or fill

soils are encountered, flatter slopes may be required. Excavations that extend to more than 5 feet in depth should be sloped or shored in accordance with OSHA regulations for a type C soil. The stability of construction excavations is the contractor's responsibility. If the stability of an excavation becomes questionable, the excavation should be evaluated immediately by qualified personnel.

5.2.4 Structural Fill and Compaction

All fill that is placed for the support of structures, concrete flatwork, and pavements should consist of structural fill. The structural fill may consist of the native gravel soils. Due to their potential to swell, the native clay soils should not be used. Imported structural fill, if required, should consist of a relatively well-graded granular soil with a maximum particle size of 4 inches, with a maximum of 50 percent passing the No. 4 sieve and with a maximum of 30 percent passing the No. 200 sieve. The liquid limit of the fines (material passing the No. 200 sieve) should not exceed 35 and the plasticity index should be less than 15. Additionally, all structural fill, whether native soils or imported material, should be free of topsoil, vegetation, frozen material, particles larger than 4 inches in diameter, and any other deleterious materials. Any imported materials should be approved by the geotechnical engineer prior to importing.

The structural fill should be placed in loose lifts that are a maximum of 8 inches thick. The moisture content should be within 3 percent of optimum and the fill should be compacted to at least 95 percent of the maximum density as determined by ASTM D 1557. Where the fill heights exceed 5 feet, the level of compaction should be increased to 98 percent.

5.2.5 Permanent Cut and Fill Slopes

The existing slopes on the property should not be over-steepened by cutting or filling. We recommend that all non-retained cut and fill slopes be graded no steeper than a 3 to 1 (horizontal to vertical) grade. If steeper grades are required, additional slope stability assessments may be required.

5.3 FOUNDATIONS

The foundations for the planned structures may consist of conventional continuous and/or spread footings established either on undisturbed native gravel soil or on properly placed and compacted structural fill which extends down to undisturbed native gravel soil. Where foundation excavations expose clay soils, the clay should be over excavated to allow placement of at least 24 inches of properly placed and compacted structural fill. The footings for the proposed structures should be

a minimum of 20 inches and 30 inches wide for continuous and spot footings, respectively. The exterior footings should be established at a minimum of 30 inches below the lowest adjacent grade to provide frost protection and confinement. Interior footings that are not subject to frost should be embedded a minimum of 18 inches for confinement.

Continuous and spread footings that are established on undisturbed native soils or structural fill may be proportioned for a maximum net allowable bearing capacity of 2,500 psf. A one-third increase may be used for transient wind or seismic loads. All footing excavations should be observed by the geotechnical engineer prior to the construction of footings.

5.4 ESTIMATED SETTLEMENT

If the foundations are designed and constructed in accordance with the recommendations presented in this report, there is a low risk that total settlement will exceed 1 inch and a low risk that differential settlement will exceed ½ inch for a 30-foot span.

5.5 LATERAL EARTH PRESSURES

Buried structures, such as basement walls, should be designed to resist the lateral loads imposed by the soils retained. The lateral earth pressures on the below-grade walls and the distribution of those pressures will depend upon the type of structure, hydrostatic pressures, in-situ soils, backfill, and tolerable movements. Basement and retaining walls are usually designed with triangular stress distributions, which are based on an equivalent fluid pressure and calculated from lateral earth pressure coefficients. If soils similar to the native soils are used to backfill the basement walls, then the walls may be designed using the following ultimate values:

Table No. 3: Lateral Earth Pressures

| Condition | Lateral Pressure Coefficient | Equivalent Fluid Density (pcf) |
|-----------------|------------------------------|--------------------------------|
| Active Static | 0.26 | 32 |
| Active Seismic | 0.20 | 24 |
| At Rest | 0.46 | 55 |
| Passive Static | 3.39 | 407 |
| Passive Seismic | -1.62 | -194 |

We recommend that walls which are allowed little or no wall movement be designed using “at rest” conditions. Walls that are allowed to rotate at least 0.4 percent of the wall height may be designed with “active” pressures. The coefficients and densities that are presented above assume

a level backfill with no buildup of hydrostatic pressures. If anticipated, hydrostatic pressures and any surcharge loads should be added to the presented values. If sloping backfill is present, we recommend that the geotechnical engineer be consulted to provide more appropriate lateral pressure parameters once the design geometry is established.

The seismic active and passive earth pressure coefficients provided in the table above are based on the Mononobe-Okabe method and only account for the dynamic horizontal force produced by a seismic event. The resulting dynamic pressure should therefore be added to the static pressure to determine the total pressure on the wall. The dynamic pressure distribution can be represented as an inverted triangle, with stress decreasing with depth, and the resultant force acting approximately 0.6 times the height of the retaining wall, measured upward from the bottom of the wall.

Lateral building loads will be resisted by frictional resistance between the footings and the foundation soils and by passive pressure developed by backfill against the wall. For footings on native soils, we recommend that an ultimate coefficient of friction of 0.40 be used. If passive resistance is used in conjunction with frictional resistance, the passive resistance should be reduced by ½. The passive earth pressure from soils subject to frost or heave should usually be neglected in design.

The coefficients and equivalent fluid densities presented above are ultimate values and should be used with an appropriate factor of safety against overturning and sliding. A value of 1.5 is typically used.

5.6 CONCRETE SLAB-ON-GRADE CONSTRUCTION

Concrete slabs-on-grade should be constructed over at least 4 inches of compacted gravel to help distribute floor loads, break the rise of capillary water, and to aid in the curing process. The gravel should consist of free-draining gravel compacted to a firm, unyielding condition. To help control normal shrinkage and stress cracking, the floor slab should have adequate reinforcement for the anticipated floor loads, with the reinforcement continuous through the interior joints. In addition, we recommend adequate crack control joints to control crack propagation.

5.7 MOISTURE PROTECTION AND SURFACE DRAINAGE

Any wetting of the foundation soils will likely cause some degree of volume change within the soil and should be prevented both during and after construction. We recommend that the following precautions be taken at this site:

1. The ground surface should be graded to drain away from the structures in all directions, with a minimum fall of 8 inches in the first 10 feet.
2. Roof runoff should be collected in rain gutters with downspouts that are designed to discharge well outside of the backfill limits.
3. Sprinkler heads should be aimed away from and placed at least 12 inches from foundation walls.
4. There should be adequate compaction of backfill around foundation walls, to a minimum of 90% density (ASTM D 1557). Water consolidation methods should not be used.

5.8 SUBSURFACE DRAINAGE

Due to the relatively high elevation of the subject site, we recommend that all basement walls incorporate a foundation drain. The foundation drain should consist of a 4-inch-diameter slotted pipe placed at or below the bottom of footings and encased in at least 12 inches of free-draining gravel. The gravel should extend up the foundation wall to within 2 feet of the final ground surface, and a filter fabric, such as Mirafi 140N, should separate the gravel from the native soils. The pipe should be graded to drain to the land drains, a storm drain or to another free-gravity outfall unless provisions for pumped sumps are made. The gravel which extends up the wall may be replaced by a fabricated drain panel such as Mirafi G200N or equivalent.

5.9 SLOPE STABILITY

As recommended in the Geologic Hazards Evaluation by Western Geologic, a slope stability assessment was performed using the Slide computer program and the modified Bishop's method of slices. The location of the profile assessed is shown on Plate 2 and is based on the cross section presented in The Western Geologic report for the development. The alluvial fan deposits were assumed to have a strength consisting of an angle of internal friction of 35 degrees and a cohesion of 50 psf. The landslide deposits and the Maple Canyon Formation bedrock strength values were based on the 2018 GeoStrata report and consisted of a friction angle of 18 degrees and no cohesion for the landslide deposits and an angle of internal friction of 26 degrees and 250 psf cohesion for the bedrock. For the imported gravel, we assumed a strength value consisting of an angle of internal friction of 36 degrees and 20 psf cohesion.

The profile was assessed under static and pseudo static conditions. The pseudo static condition is used to assess the slope during a seismic event. As indicated in Section 4.1, the peak ground acceleration at this site is estimated to be 0.501g. As is common practice, half of this value was used in our pseudo static assessments. Minimum factors of safety of 1.5 and 1.0 for static and

seismic conditions, respectively, were considered acceptable. Our analyses indicate that the profile has a safety factor greater than 1.5 for the static condition; however, a safety factor less than 1.0 was assessed for the pseudo static. Further assessment indicates a pseudo static factor of safety greater than 1.0 for Lots 25 to 50. For Lots 72 to 83, a safety factor greater than 1.0 was achieved when the landslide deposits in the vicinity of the proposed homes are removed and replaced with a gravel structural fill.

Based on these results, it is our opinion that the factors of safety with regard to slope stability are adequate for residential construction at Lots 25 to 50 in the sites current condition. At lots 72 to 83, adequate factors of safety are achieved when all landslide deposits are removed from below the structures and replaced with gravel structural fill. We recommend that the gravel fill extend down to non-deformed, weathered bedrock and extend at least 15 feet beyond the edge of the structures. We estimate that the landslide deposits on these lots are 5 to 25 feet thick. Once the landslide deposits are removed and replaced with gravel structural fill in the vicinity of structures, Lots 72 to 83 will be suitable for residential construction.

The slope stability analysis presented above is based on the assumption that no significant cuts or fills will occur during the development of the site. Significant changes to the site grade, such as the steepening of slopes with cuts or fills, may adversely affect the stability of the slopes and increase the risk of slope failures. If cuts or fills over 8 feet are planned, additional slope stability assessments may be necessary and Christensen Geotechnical should be contacted to provide the additional assessments. The results of our slope stability assessments may be found on Plates 14 through 17.

5.10 PAVEMENT DESIGN

Pavement sections for roadways within the proposed development were assessed using the PAS computer program (prepared by the American Concrete Pavement Association) and an assumed CBR value of 10 percent. No traffic information was available at the time this report was prepared; Christensen Geotechnical has therefore assumed a traffic load for the roadways based on our experience with similar projects. We have assumed that traffic will consist of 300 passenger cars per day, 4 medium trucks per day and 4 heavy trucks per day. We have further assumed no increase in traffic over the life of the pavement. Based on this information, we recommend a pavement section consisting of 3 inches of asphalt over 8 inches of untreated base. The asphalt should consist of a high-stability plant mix and should be compacted to at least 96 percent of the Marshall maximum density. The untreated base should meet the material requirements for Weber County

or UDOT and should be compacted to at least 95 percent of the maximum dry density as determined by ASTM D 1557.

6.0 LIMITATIONS

The recommendations contained in this report are based on limited field exploration, laboratory testing, and our understanding of the proposed construction. The subsurface data used in this report was obtained from the explorations that were made specifically for this investigation. It is possible that variations in the soil and groundwater conditions could exist between and beyond the points explored. The nature and extent of variations may not be evident until construction occurs. If any conditions are encountered at this site that are different from those described in this report, Christensen Geotechnical should be immediately notified so that we may make any necessary revisions to the recommendations contained in this report. In addition, if the scope of the proposed construction changes from that described in this report, Christensen Geotechnical should be notified.

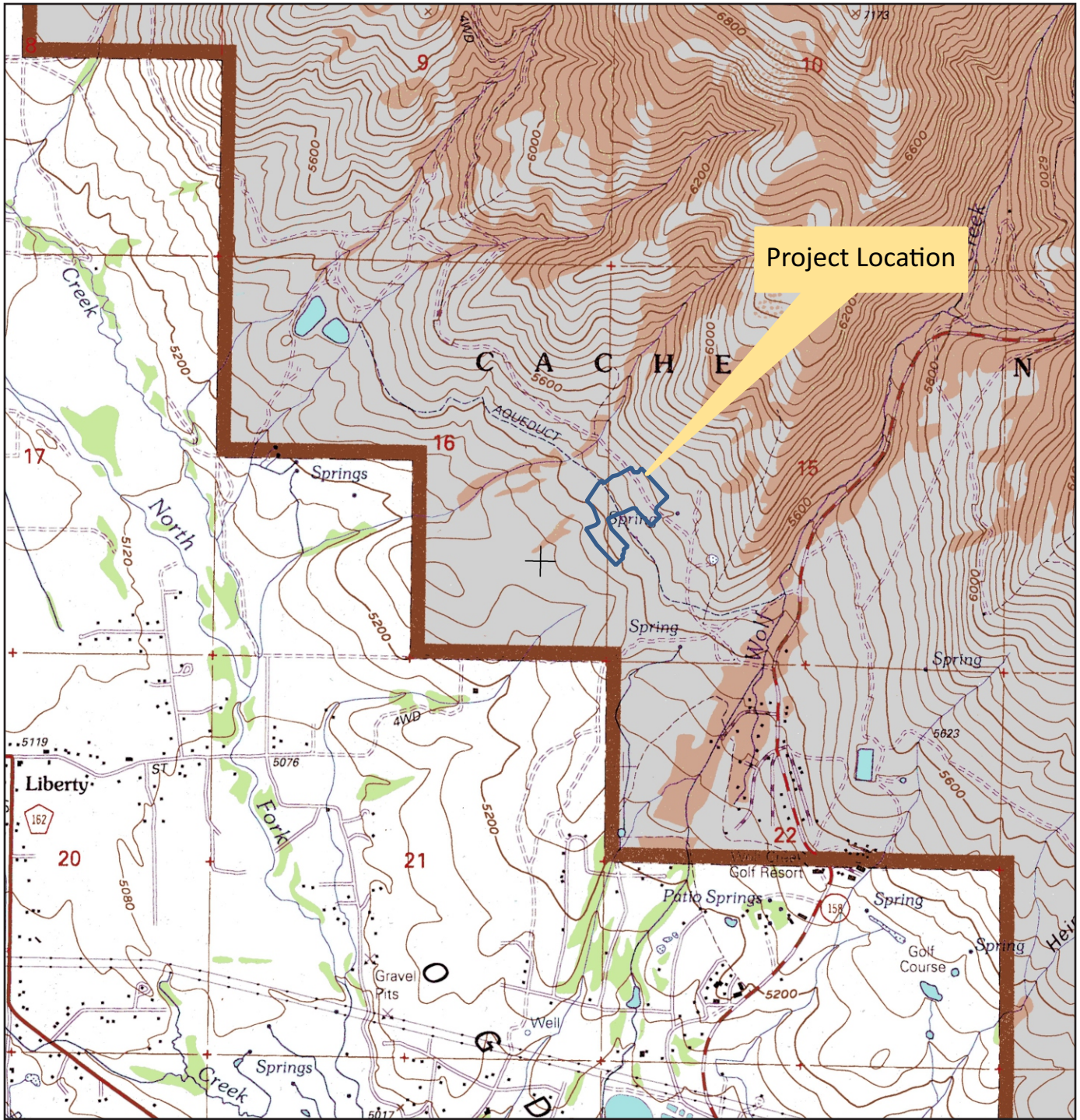
This report was prepared in accordance with the generally accepted standard of practice at the time the report was written. No other warranty, expressed or implied, is made.

It is the client's responsibility to see that all parties to the project, including the designer, contractor, subcontractors, etc., are made aware of this report in its entirety. The use of information contained in this report for bidding purposes should be done at the contractor's option and risk.

The recommendations presented within this report are based on the assumption that an adequate program of tests and observations will be followed during construction to verify compliance with our recommendations. We also assume that we will review the project plans and specifications to verify that our conclusions and recommendations are incorporated and remain appropriate (based on the actual design).

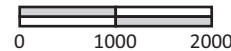
7.0 REFERENCES

- Black, Bill, July 21, 2022, “Geologic Hazards Evaluation, Mountainside P.R.U.D. Phase 2, About 4560 North Seven Bridges Road, Eden, Weber County, Utah,” Western Geologic, consultant’s unpublished report.
- Christenson, Gary E. and Shaw, Lucas M., 2008, “Liquefaction Special Study Areas, Wasatch Front and Nearby Areas, Utah,” Utah Geological Survey, Supplement Map to Utah Circular 106.
- Geostrata, February 15, 2018, “Geotechnical Investigation, Phase 1 – Mountainside and Parkside Communities, the Bridges at Wolf Creek Development, Eden, Utah,” unpublished consultant’s report.
- GSH, July 25, 2016, “Report – Engineering Geology Study, The Bridges at Wolf Creek East Phase 1, parts of Sections 15, 16, and 22 Township 7 North, Ranch 1 East, SLBM, Eden, Utah,” unpublished consultant’s report.




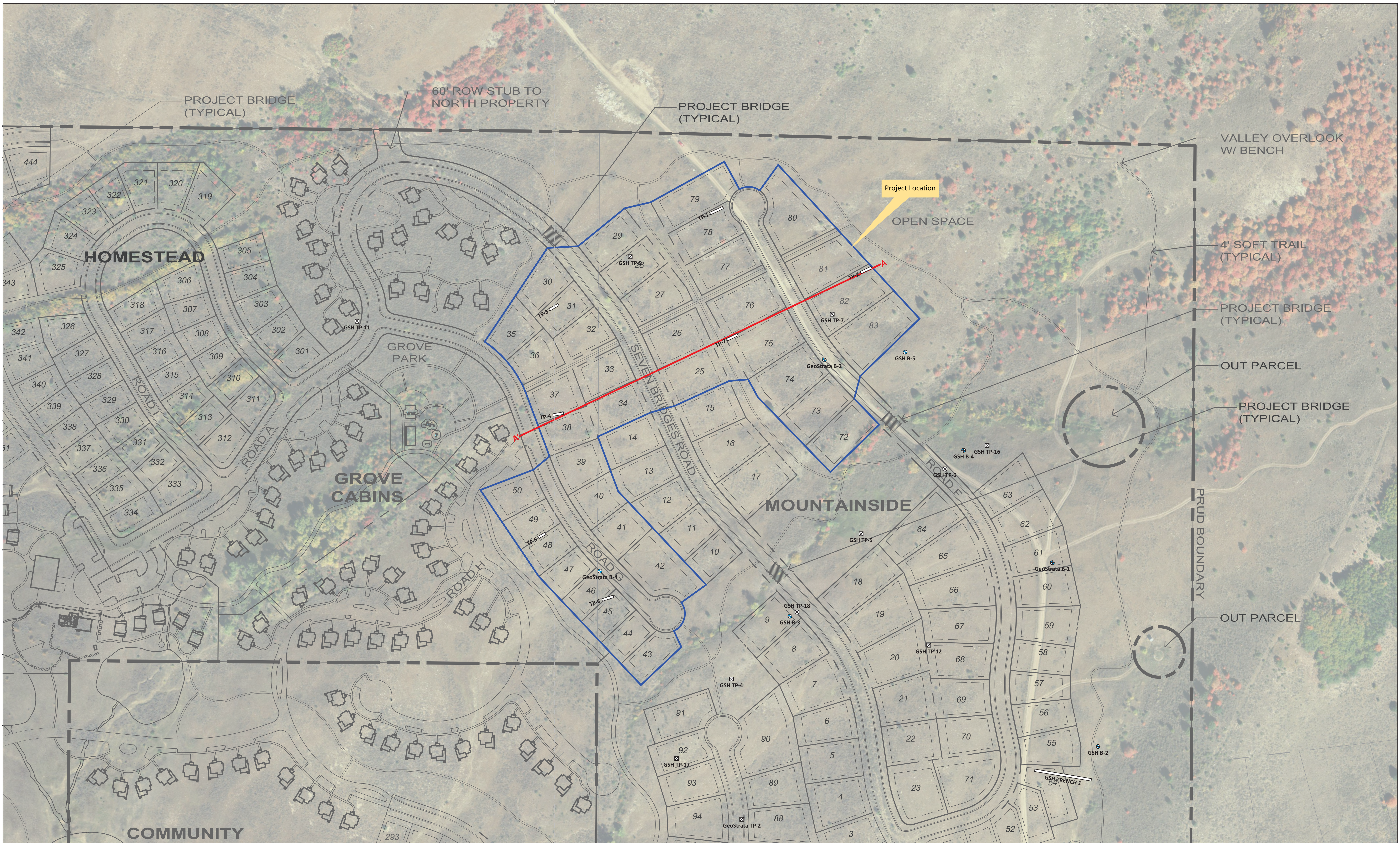
Base: U.S. Geological Survey topographic map, Huntsville quadrangle

 Approximate Project Boundary

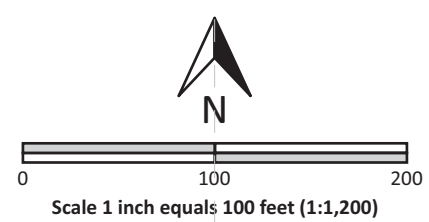


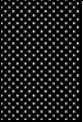
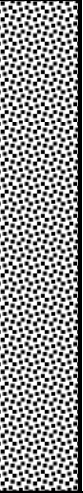






Scale 1 inch equals 2,000 feet (1:24,000)


| | | |
|---|---|---------------------------|
|  | <p>Lewis Homes Mountainside PRUD Phase 2 Eden, Weber County, Utah Project No. 133-017</p> | <p>Plate 1</p> |
| <p>Vicinity Map</p> | | |





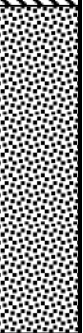





Base: Utah Geographic Resource Center high resolution orthophoto. Site plan modified from Langvardt Design Group overall site plan sheet P1.2 dated June 2019.



| Date | | TEST PIT LOG | | | Logged By: M Christensen Equipment: Trackhoe Location: See Plate 2 | | Test Pit No. TP-1 | | | |
|--|---|--------------|--|--------------|---|-------------------|-----------------------------|------------------------------|--------------|------------------|
| Started: 6/27/2022 | | | | | | | Sheet 1 of 1 | | | |
| Completed: 6/27/2022 | | | | | | | | | | |
| Backfilled: --- | | | | | | | | | | |
| Depth (feet) | Sample Type | Groundwater | Graphic Log | Group Symbol | Material Description | Dry Density (pcf) | Moisture Content (%) | Minus #200 (%) | Liquid Limit | Plasticity Index |
| | | |  | | Topsoil; Clayey Gravel with sand - moist, dark brown | | | | | |
| | | |  | GC | Clayey GRAVEL with sand - dense, slightly moist, brown, with cobbles and boulders up to 2 feet in diameter | | 7.1 | 31.6 | | |
| 5 |  | | | | | | | | | |
| | | | | | Bottom of test pit at 7½ feet | | | | | |
| 10 | | | | | | | | | | |
| 15 | | | | | | | | | | |
|  Bulk/Bag Sample  Undisturbed Sample | | | | |  Stabilized Groundwater  Groundwater At Time of Excavation | | | | | |
|  | | | | | Lewis Homes Mountainside PRUD Phase 2 Eden, Utah Project No.: 133-017 | | | Plate 3 | | |

| Date | | TEST PIT LOG | | | Logged By: M Christensen Equipment: Trackhoe Location: See Plate 2 | | Test Pit No. TP-2 | | | |
|---|-------------|--------------|-------------|--------------|--|-------------------|-----------------------------|------------------------------|--------------|------------------|
| Started: 6/27/2022 | | | | | | | Sheet 1 of 1 | | | |
| Completed: 6/27/2022 | | | | | | | | | | |
| Backfilled: --- | | | | | | | | | | |
| Depth (feet) | Sample Type | Groundwater | Graphic Log | Group Symbol | Material Description | Dry Density (pcf) | Moisture Content (%) | Minus #200 (%) | Liquid Limit | Plasticity Index |
| | | | | | Topsoil; Clayey Gravel with sand - moist, dark brown | | | | | |
| | | | | | Clayey GRAVEL with sand - dense, slightly moist, brown, with cobbles and boulders up to 2 feet in diameter | | | | | |
| 5 | X | | | GC | | | 8.5 | 33.1 | | |
| | X | | | | | | | | | |
| 10 | | | | | Bottom of test pit at 9 feet | | | | | |
| 15 | | | | | | | | | | |
| <div style="display: flex; justify-content: space-between;"> <div> <p>☒ Bulk/Bag Sample</p> <p>▨ Undisturbed Sample</p> </div> <div> <p>▼ Stabilized Groundwater</p> <p>⚡ Groundwater At Time of Excavation</p> </div> </div> | | | | | | | | | | |
|  | | | | | Lewis Homes Mountainside PRUD Phase 2 Eden, Utah Project No.: 133-017 | | | Plate 4 | | |

| Date | | TEST PIT LOG | | | Logged By: M Christensen Equipment: Trackhoe Location: See Plate 2 | | Test Pit No. TP-3 | | | |
|----------------------|---|--------------|--|--------------|--|-------------------|-----------------------------|----------------|--------------|------------------|
| Started: 6/27/2022 | | | | | | | Sheet 1 of 1 | | | |
| Completed: 6/27/2022 | | | | | | | | | | |
| Backfilled: --- | | | | | | | | | | |
| Depth (feet) | Sample Type | Groundwater | Graphic Log | Group Symbol | Material Description | Dry Density (pcf) | Moisture Content (%) | Minus #200 (%) | Liquid Limit | Plasticity Index |
| | | |  | | Topsoil; Clayey Gravel with sand - moist, dark brown | | | | | |
| | | |  | GC | Clayey GRAVEL with sand - dense, slightly moist, brown | | | | | |
| | | |  | CH | Fat CLAY with sand - stiff, moist, gray | | | | | |
| 5 |  | |  | GC | Clayey GRAVEL with sand - dense, slightly moist, brown, with cobbles and boulders up to 2 feet in diameter | 100.7 | 24.0 | 80.9 | 56 | 36 |
| 10 |  | | | | Bottom of test pit at 9 feet | | | | | |
| 15 | | | | | | | | | | |

 Bulk/Bag Sample
 Undisturbed Sample

 Stabilized Groundwater
 Groundwater At Time of Excavation



Lewis Homes
Mountainside PRUD Phase 2
Eden, Utah
Project No.: 133-017

Plate
5

| | | | | |
|------|----------------------|---------------------|--------------------------|-----------------------------|
| Date | Started: 6/27/2022 | TEST PIT LOG | Logged By: M Christensen | Test Pit No. TP-4 |
| | Completed: 6/27/2022 | | Equipment: Trackhoe | |
| | Backfilled: --- | | Location: See Plate 2 | |

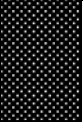
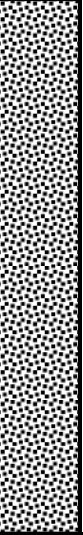







Sheet 1 of 1


| Depth (feet) | Sample Type | Groundwater | Graphic Log | Group Symbol | Material Description | Dry Density (pcf) | Moisture Content (%) | Minus #200 (%) | Liquid Limit | Plasticity Index |
|--------------|-------------|-------------|-------------|--------------|--|-------------------|----------------------|----------------|--------------|------------------|
| | | | | | Topsoil; Clayey Gravel with sand - moist, dark brown | | | | | |
| | | | | GC | Clayey GRAVEL with sand - dense, slightly moist, brown | | | | | |
| 5 | | | | CH | Fat CLAY with sand - stiff, moist, gray | | 24.5 | 70.7 | 62 | 40 |
| | | | | GC | Clayey GRAVEL with sand - dense, slightly moist, brown, with cobbles and boulders up to 2 feet in diameter | | | | | |
| 10 | | | | | - wet below 10 feet | | | | | |
| | | | | | Bottom of test pit at 11 feet | | | | | |
| 15 | | | | | | | | | | |

Bulk/Bag Sample
 Undisturbed Sample

Stabilized Groundwater
 Groundwater At Time of Excavation

| | | |
|--|--|------------------------------|
| | Lewis Homes Mountainside PRUD Phase 2 Eden, Utah Project No.: 133-017 | Plate 6 |
|--|--|------------------------------|

| Date | | TEST PIT LOG | | | Logged By: M Christensen Equipment: Trackhoe Location: See Plate 2 | | Test Pit No. TP-5 | | | |
|--|---|--------------|--|--------------|---|-------------------|-----------------------------|------------------------------|--------------|------------------|
| Started: 6/27/2022 | | | | | | | Sheet 1 of 1 | | | |
| Completed: 6/27/2022 | | | | | | | | | | |
| Backfilled: --- | | | | | | | | | | |
| Depth (feet) | Sample Type | Groundwater | Graphic Log | Group Symbol | Material Description | Dry Density (pcf) | Moisture Content (%) | Minus #200 (%) | Liquid Limit | Plasticity Index |
| | | |  | | Topsoil; Clayey Gravel with sand - moist, dark brown | | | | | |
| | | |  | GC | Clayey GRAVEL with sand - dense, slightly moist, brown, with cobbles and boulders up to 2 feet in diameter | | 8.7 | 37.7 | | |
| 5 |  | | | | | | | | | |
| |  | | | | | | | | | |
| | | | | | Bottom of test pit at 8 feet | | | | | |
| 10 | | | | | | | | | | |
| 15 | | | | | | | | | | |
|  Bulk/Bag Sample  Undisturbed Sample | | | | |  Stabilized Groundwater  Groundwater At Time of Excavation | | | | | |
|  | | | | | Lewis Homes Mountainside PRUD Phase 2 Eden, Utah Project No.: 133-017 | | | Plate 7 | | |

| Date | | TEST PIT LOG | | | Logged By: M Christensen Equipment: Trackhoe Location: See Plate 2 | | Test Pit No. TP-6 | | | |
|--|-------------|--------------|-------------|--------------|--|-------------------|-----------------------------|----------------|--------------|------------------------------|
| Started: 6/27/2022 | | | | | | | Sheet 1 of 1 | | | |
| Completed: 6/28/2022 | | | | | | | | | | |
| Backfilled: --- | | | | | | | | | | |
| Depth (feet) | Sample Type | Groundwater | Graphic Log | Group Symbol | Material Description | Dry Density (pcf) | Moisture Content (%) | Minus #200 (%) | Liquid Limit | Plasticity Index |
| | | | | | Topsoil; Clayey Gravel with sand - moist, dark brown | | | | | |
| | | | | | Sandy Fat CLAY with gravel - stiff, slightly moist, brown | | | | | |
| 5 | X | | | CL | | | | | | |
| 10 | X | | | | | | 14.4 | 58.8 | | |
| | | | | | Bottom of test pit at 12 feet | | | | | |
| 15 | | | | | | | | | | |
| <input checked="" type="checkbox"/> Bulk/Bag Sample <input checked="" type="checkbox"/> Stabilized Groundwater <input checked="" type="checkbox"/> Undisturbed Sample <input checked="" type="checkbox"/> Groundwater At Time of Excavation | | | | | | | | | | |
|  | | | | | Lewis Homes Mountainside PRUD Phase 2 Eden, Utah Project No.: 133-017 | | | | | Plate 8 |


| | | | | |
|------|----------------------|-----------------------|--------------------------|-------------------------------|
| Date | Started: 6/27/2022 | <h1>TEST PIT LOG</h1> | Logged By: M Christensen | Test Pit No. <h1>TP-7</h1> |
| | Completed: 6/30/2022 | | Equipment: Trackhoe | |
| | Backfilled: --- | | Location: See Plate 2 | |

Sheet 1 of 1

| Depth (feet) | Sample Type | Groundwater | Graphic Log | Group Symbol | Material Description | Dry Density (pcf) | Moisture Content (%) | Minus #200 (%) | Liquid Limit | Plasticity Index |
|--------------|-------------|-------------|-------------|--------------|--|-------------------|----------------------|----------------|--------------|------------------|
| | | | | | Topsoil; Clayey Gravel with sand - moist, dark brown | | | | | |
| | | | | GC | Clayey GRAVEL with sand - dense, slightly moist, brown | | | | | |
| | | | | CH | Fat CLAY with sand - stiff, slightly moist, gray | | 21.9 | 70.7 | 71 | 48 |
| 5 | | | | GC | Clayey GRAVEL with sand - dense, slightly moist, brown, with cobbles and boulders up to 2 feet in diameter | | | | | |
| 10 | | | | | Bottom of test pit at 10 feet | | | | | |
| 15 | | | | | | | | | | |

Bulk/Bag Sample
 Undisturbed Sample

Stabilized Groundwater
 Groundwater At Time of Excavation

| | | |
|---|--|--------------------------------|
|  | Lewis Homes Mountainside PRUD Phase 2 Eden, Utah Project No.: 133-017 | Plate <h1>9</h1> |
|---|--|--------------------------------|

RELATIVE DENSITY – COURSE GRAINED SOILS

| Relative Density | SPT (blows/ft.) | 3 In OD California Sampler (blows/ft.) | Relative Density (%) | Field Test |
|------------------|-----------------|--|----------------------|---|
| Very Loose | <4 | <5 | 0 – 15 | Easily penetrated with a ½ inch steel rod pushed by hand |
| Loose | 4 – 10 | 5 – 15 | 15 – 35 | Difficult to penetrate with a ½ inch steel rod pushed by hand |
| Medium Dense | 10 – 30 | 15 – 40 | 35 – 65 | Easily penetrated 1-foot with a steel rod driven by a 5 pound hammer |
| Dense | 30 – 50 | 40 – 70 | 65 – 85 | Difficult to penetrate 1-foot with a steel rod driven by a 5 pound hammer |
| Very Dense | >50 | >70 | 85 – 100 | Penetrate only a few inches with a steel rod driven by a 5 pound hammer |

CONSISTENCY – FINE GRAINED SOILS

| Consistency | SPT (blows/ft) | Torvane Undrained Shear Strength (tsf) | Pocket Penetrometer Undrained Shear Strength (tsf) | Field Test |
|--------------|----------------|--|--|--|
| Very Soft | <2 | <0.125 | <0.25 | Easily penetrated several inches with thumb |
| Soft | 2 – 14 | 0.125 – 0.25 | 0.25 – 0.5 | Easily penetrated one inch with thumb |
| Medium Stiff | 4 – 8 | 0.25 – 0.5 | 0.5 – 1.0 | Penetrated over ½ inch by thumb with moderate effort. Molded by strong finger pressure |
| Stiff | 8 – 15 | 0.5 – 1.0 | 1.0 – 2.0 | Indented ½ inch by thumb with great effort |
| Very Stiff | 15 – 30 | 1.0 – 2.0 | 2.0 – 4.0 | Readily indented with thumbnail |
| Hard | >30 | >2.0 | >4.0 | Indented with difficulty with thumbnail |

CEMENTATION

| | |
|------------|--|
| Weakly | Crumbles or breaks with handling or little finger pressure |
| Moderately | Crumbles or breaks with considerable finger pressure |
| Strongly | Will not crumble or break with finger pressure |

MOISTURE

| | |
|-------|--|
| Dry | Absence of moisture, dusty, dry to the touch |
| Moist | Damp but no visible water |
| Wet | Visible water, usually below water table |

GRAIN SIZE

| Description | Sieve Size | Grain Size (in) | Approximate Size |
|-------------|------------|-----------------|------------------------|
| Boulders | >12" | >12" | Larger than basketball |
| Cobbles | 3" – 12" | 3" – 12" | Fist to basketball |
| Gravel | Coarse | 3/4" - 3" | Thumb to fist |
| | Fine | #4 – 3" | Pea to thumb |
| Sand | Coarse | #10 - #4 | Rock salt to pea |
| | Medium | #40 - #10 | Sugar to rock salt |
| | Fine | #200 - #40 | Flour to sugar |
| Silt/Clay | <#200 | <0.0029 | Flour sized or smaller |

STRATIFICATION

| | |
|------------|-------------------------------------|
| Occasional | One or less per foot of thickness |
| Frequent | More than one per foot of thickness |

MODIFIERS

| | |
|-------|-------|
| Trace | <5% |
| Some | 5-12% |
| With | >12% |

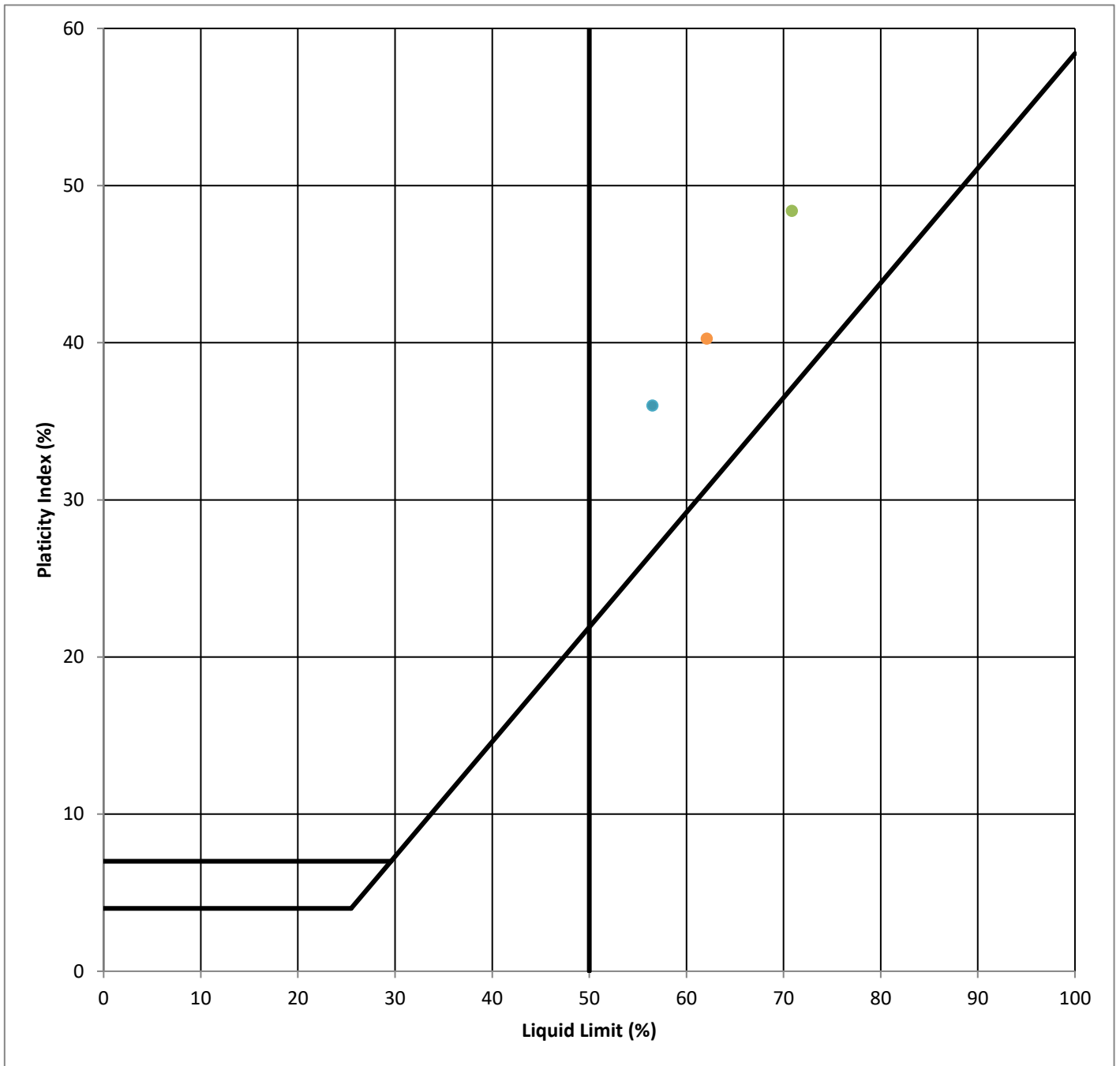
STRATIFICATION

| | |
|-------|------------------|
| Seam | 1/16 to 1/2 inch |
| Layer | 1/2 to 12 inch |


NOTES

- The logs are subject to the limitations and conclusions presented in the report.
- Lines separating strata represent approximate boundaries only. Actual transitions may be gradual.
- Logs represent the soil conditions at the points explored at the time of our investigation.
- Soils classifications shown on logs are based on visual methods. Actual designations (based on laboratory testing) may vary.

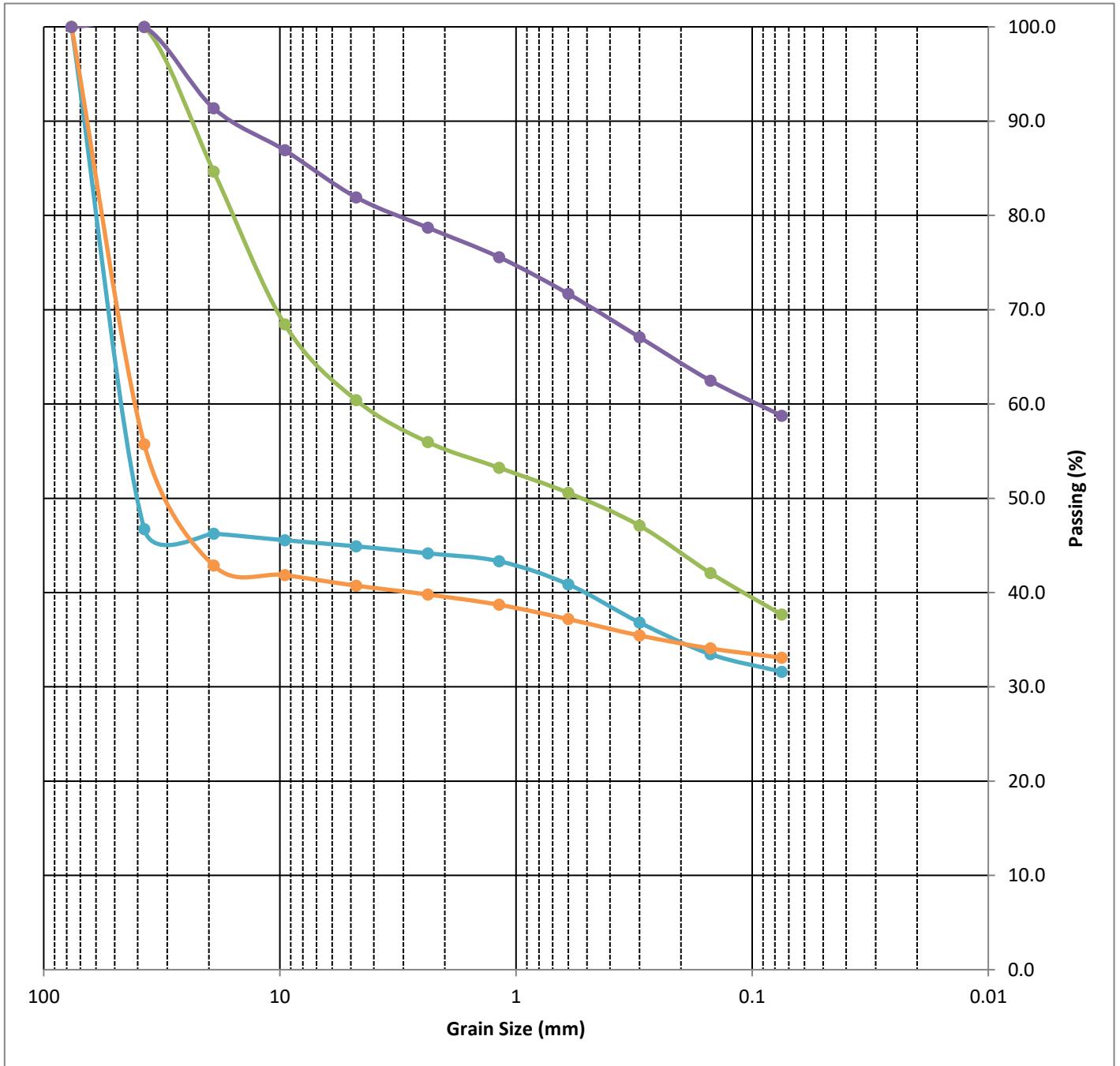
Atterberg Limits




| Location | Depth (ft) | | Classification | Liquid Limit | PI |
|----------|------------|---|--------------------|--------------|----|
| TP-3 | 4 | ● | Fat CLAY with sand | 56 | 36 |
| TP-4 | 5 | ● | Fat CLAY with sand | 62 | 40 |
| TP-7 | 3 | ● | Fat CLAY with sand | 71 | 48 |

| | | |
|---|--|----------------------------|
|  | <p>Lewis Homes Mountainside PRUD Phase 2 Eden, Utah Project No.: 133-017</p> | <p>Plate 11</p> |
|---|--|----------------------------|

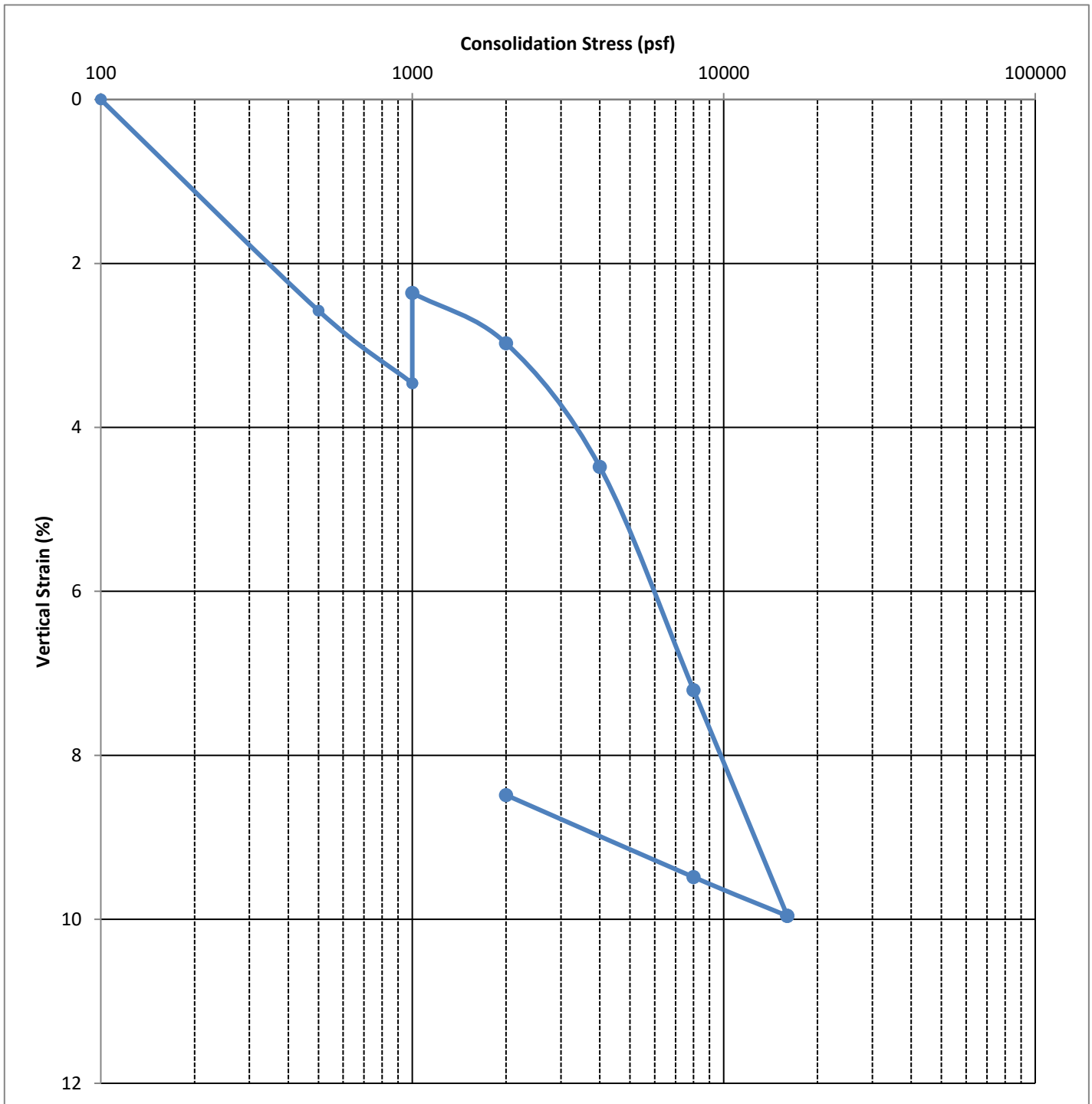
Grain Size Distribution




| Location | Depth | | Classification | % Gravel | % Sand | % Silt and Clay |
|----------|-------|---|----------------------------|----------|--------|-----------------|
| TP-1 | 4 | ● | Clayey GRAVEL with sand | 55.1 | 13.3 | 31.6 |
| TP-2 | 8 | ● | Clayey GRAVEL with sand | 59.3 | 7.6 | 33.1 |
| TP-5 | 3 | ● | Clayey GRAVEL with sand | 39.6 | 22.7 | 37.7 |
| TP-6 | 11 | ● | Sandy Fat CLAY with gravel | 18.1 | 23.2 | 58.8 |

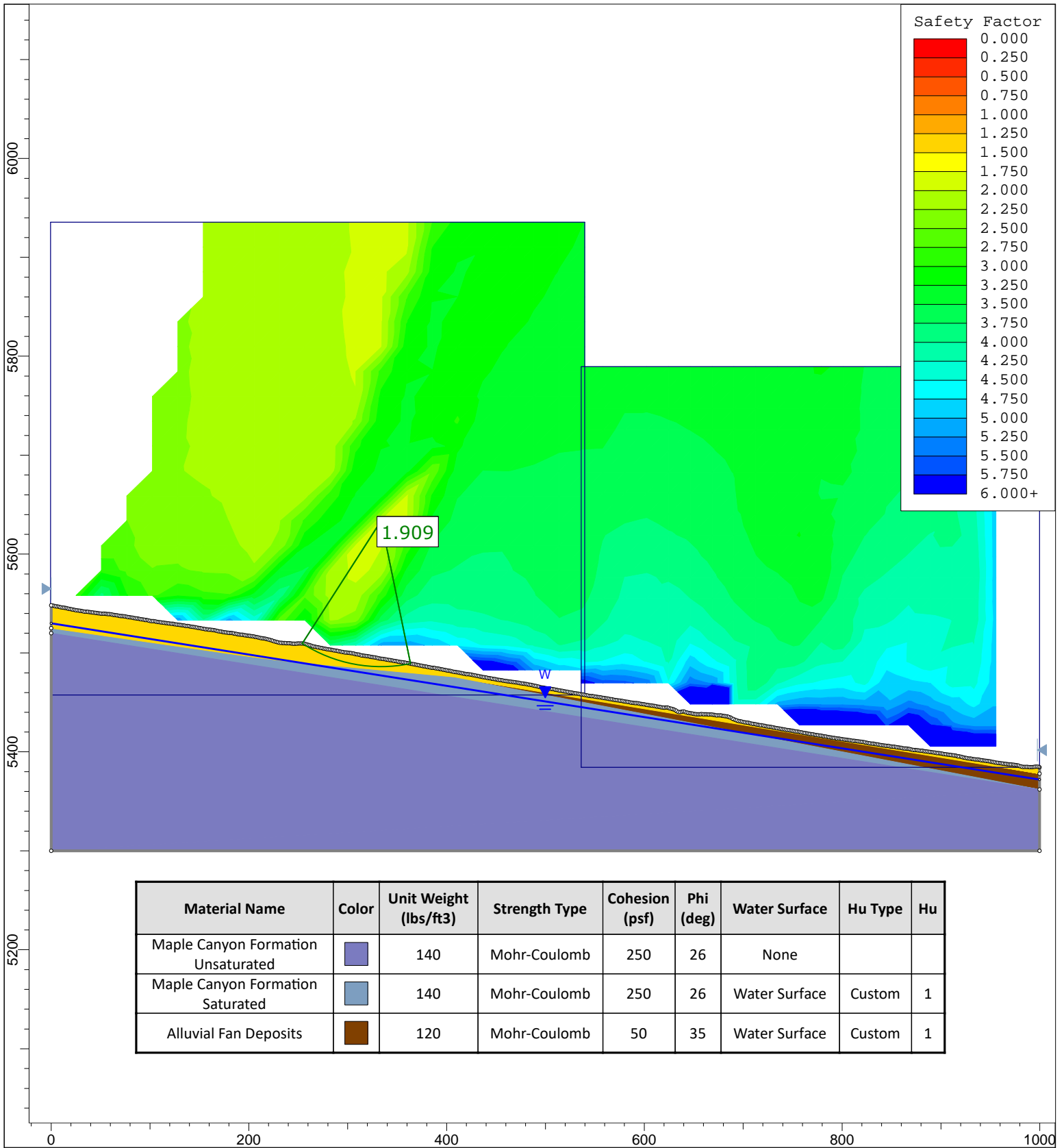
| | | |
|---|---|---|
|  | <p>Lewis Homes Mountainside PRUD Phase 2 Eden, Utah Project No.: 133-017</p> | <p>Plate 12</p> |
|---|---|---|

1-D Consolidation



| Location | Depth (ft) | Dry Density (pcf) | Moisture Content (%) | σ_o (psf) | σ_p (psf) | C_c | C_r | OCR |
|----------|------------|-------------------|----------------------|------------------|------------------|-------|-------|-----|
| TP-3 | 4 | 100.7 | 24.0 | 500 | 3,000 | 0.091 | 0.016 | 6.0 |

| | | |
|---|--|--------------------|
|  | Lewis Homes Mountainside PRUD Phase 2 Eden, Utah Project No.: 133-017 | Plate 13 |
|---|--|--------------------|

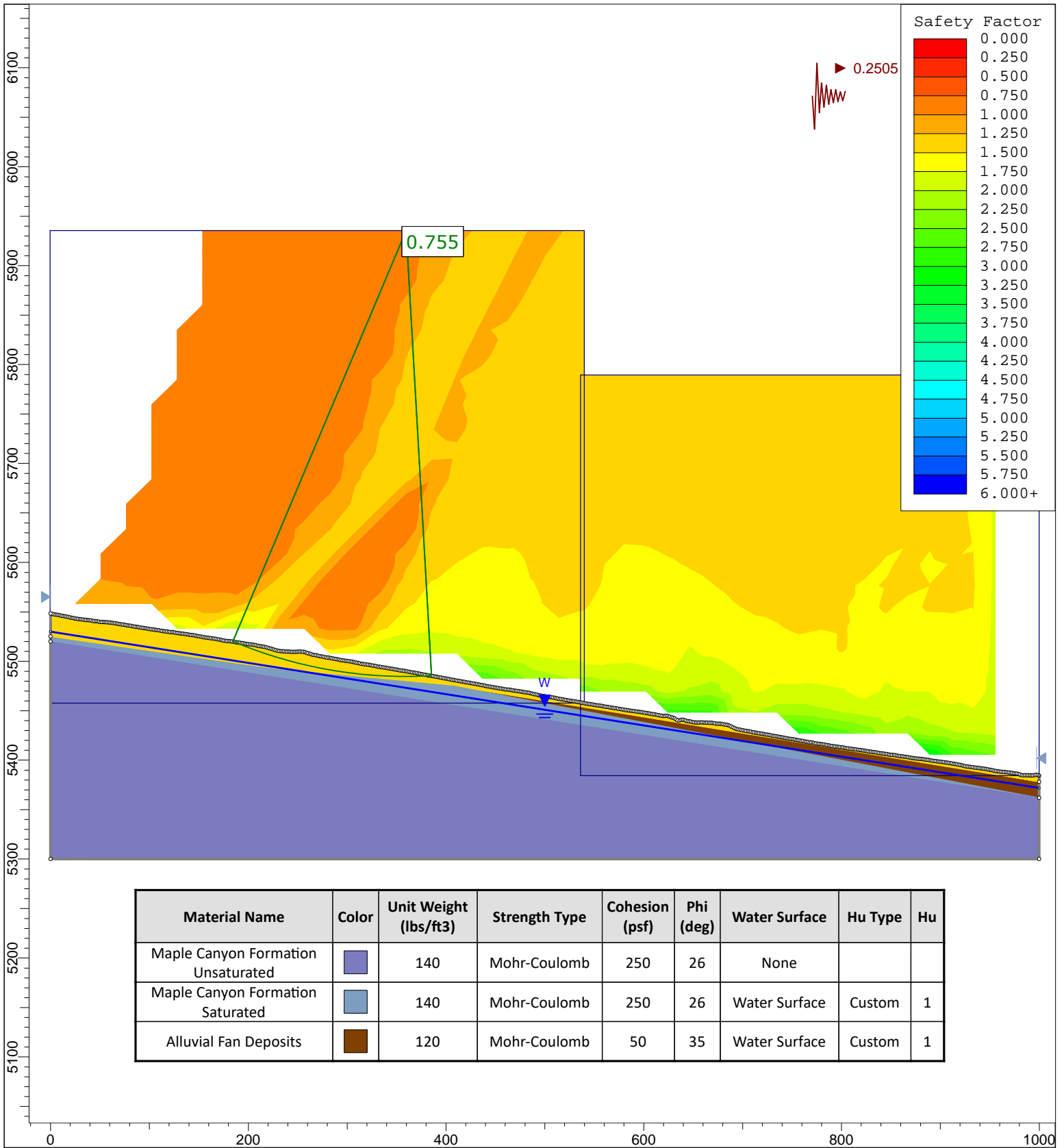


Global Stability - Static



Lewis Homes
 Mountainside PRUD Phase 2
 Eden, Utah
 133-017

Plate
14

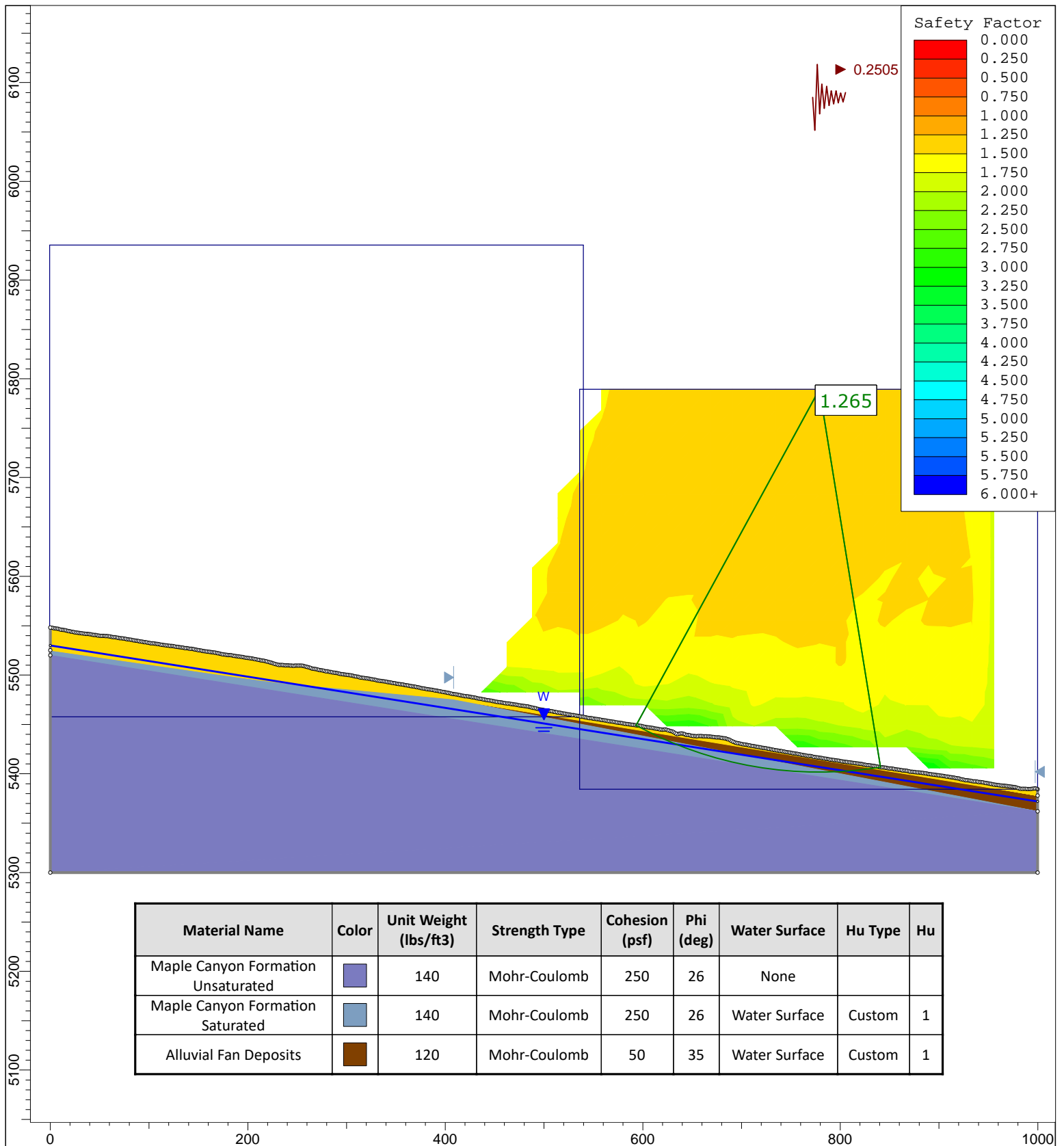


Global Stability - Pseudo Static



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Eden, Utah
133-017

Plate
15

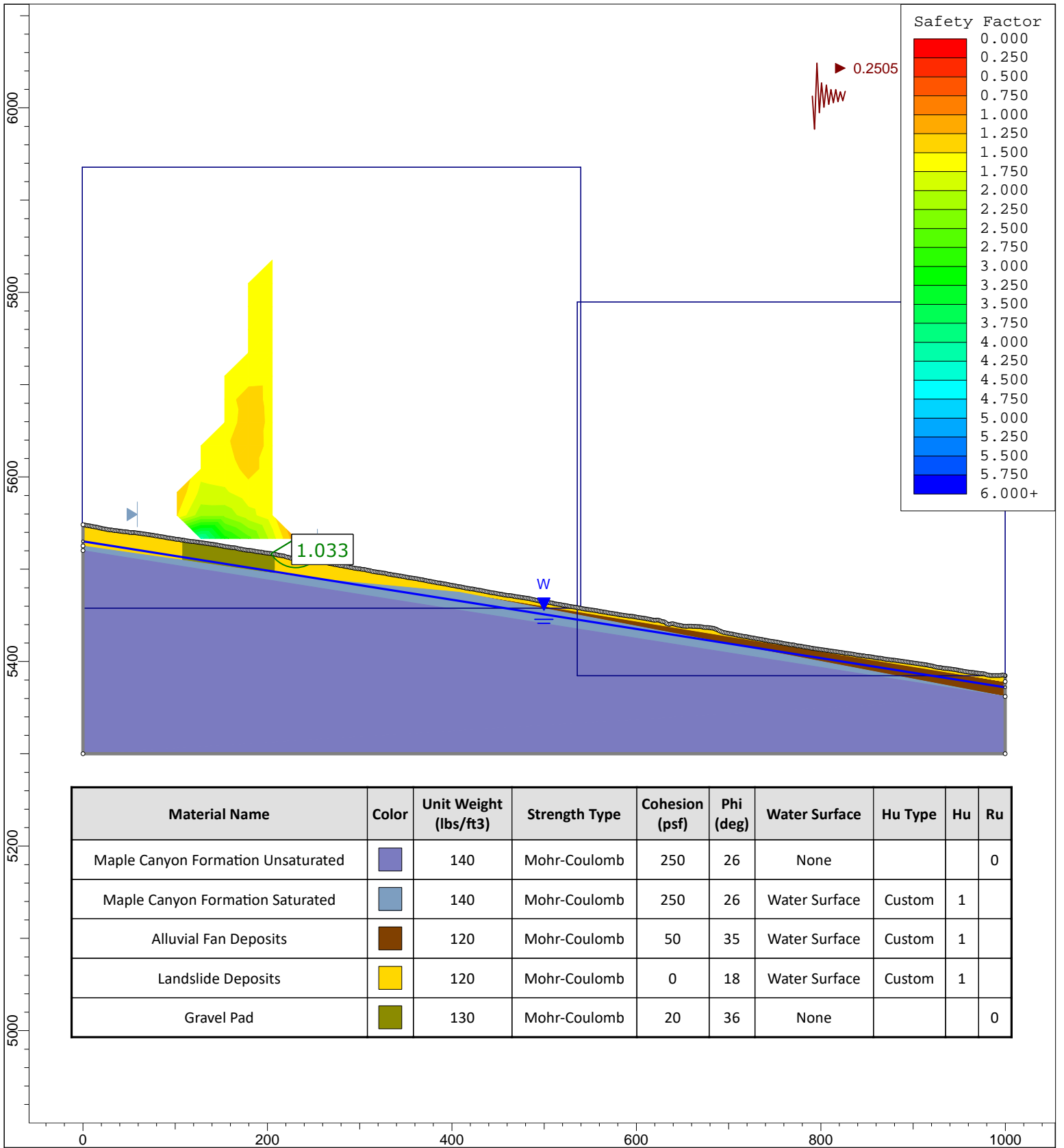


Global Stability - Pseudo Static Lots 25 to 50



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 133-017

Plate
16



Global Stability - Pseudo Static Lots 72 to 83 with Gravel Pad



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Plate
17