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Geotechnical Investigation for the Ridge Development
Eden City, Utah

GeoStrata Job No. 924-001

December 3, 2013

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Attention: Mr. Eric Householder

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1.0 EXECUTIVE SUMMARY

This report presents the results of a geotechnical investigation conducted for The Ridge Development located at approximately 5150 Moose Hollow Drive in Eden, Utah. The purposes of this investigation were to assess the nature and engineering properties of the subsurface soils at the proposed site and to provide recommendations for general site grading and the design and construction of foundations, slabs-on-grade, and pavements.

Based on the subsurface conditions encountered at the site, it is our opinion that the subject site is suitable for the proposed construction provided that the recommendations contained in this report are complied with.

Subsurface conditions were investigated by excavating seventeen test pits across the proposed development to a depth of 5 to 14 feet below the existing site grade. Based on soils encountered in the test pits the area of the proposed development is overlain by 2 to 4 feet of topsoil composed of Lean CLAY(CL) and Sandy Lean CLAY (CL) with gravel. Underlying the topsoil we encountered Holocene-aged colluvium and slopewash deposits associated with post-Bonneville cycle processes. Groundwater was encountered in test pits 1, 2, 12, and 13 at depths of 7 to 12 feet below the existing site grade.

The foundation for the proposed structure may consist of conventional strip and/or spread footings founded on undisturbed native soils. Strip and spread footings should be a minimum of 20 and 36 inches wide, respectively, and exterior shallow footings should be embedded at least 30-inches below final grade for frost protection and confinement. Interior footings not subject to frost should be embedded at least 18 inches below final grade to provide confinement. Conventional strip and spread footings founded on undisturbed native soils may be proportioned for a maximum net allowable bearing capacity of **1,400 psf**. Recommendations for general site grading, design of foundations, slabs-on-grade, moisture protection as well as other aspects of construction are included in this report.

Due to high groundwater encountered in our test pits, we recommend that basements be established at least 3 feet above the groundwater elevation unless a foundation drain is installed. If the groundwater elevation is not established at the time of construction we recommend that basements extend not more than 4 feet below site grade as it existed at the time of this report unless a foundation drain is installed.

Pavements for access roads in the subdivisions may consist of 3 inches of asphalt over 24 inches of untreated base course. As alternative, an equivalent pavement section of 3 inches of asphalt over 10 inches of untreated base course and 16 inches of granular borrow may be used.

NOTE: This executive summary is not intended to replace the report of which it is part and should not be used separately from the report. The executive summary omits a number of details, any one of which could be crucial to the proper application of this report.

2.0 INTRODUCTION

2.1 PURPOSE AND SCOPE OF WORK

This report presents the results of a geotechnical investigation conducted for The Ridge Development located at approximately 5150 Moose Hollow Drive in Eden, Utah. The purposes of this investigation were to assess the nature and engineering properties of the subsurface soils at the proposed site and to provide recommendations for general site grading and the design and construction of foundations, slabs-on-grade, and pavements.

The scope of work completed for this study included a site reconnaissance, subsurface exploration, soil sampling, laboratory testing, engineering analyses, and preparation of this report. Our services were performed in accordance with our proposal dated October 30, 2013. The recommendations contained in this report are subject to the limitations presented in the "Limitations" section of this report.

2.2 PROJECT DESCRIPTION

The project site is an irregular-shaped property located at approximately 5150 Moose Hollow Drive in Eden, Utah (see Plate A-1, *Site Vicinity Map*). Based on conversations with the client, we understand that the proposed project will consist of 12 four-plex residential buildings and a clubhouse building. The development will also include approximately 1200 lineal feet of roadway and parking areas.

3.0 METHOD OF STUDY

3.1 SUBSURFACE INVESTIGATION

As part of this investigation, subsurface soil conditions were explored by excavating seventeen test pits. The test pits extended to depths of approximately 5 to 14 feet below the site grade as it existed at the time our site investigation. The approximate locations of the explorations are shown in the *Exploration Location Map*, Plate A-2 in Appendix A. Exploration points were selected to provide a representative cross section of the subsurface soils conditions in the anticipated vicinity of the proposed structures. Subsurface soil conditions as encountered in the explorations were logged at the time of our investigation by a qualified geotechnical engineer and are presented on the enclosed Test Pit Logs, Plates B-1 to B-17 in Appendix B. A *Key to USCS Soil Symbols and Terminology* is presented on Plate B-18.

The test pits were excavated using a trackhoe. Bulk soil samples were obtained in the test pit explorations and were collected using bags and buckets. All samples were transported to our laboratory for testing to evaluate engineering properties of the various earth materials observed. The soils were classified according to the *Unified Soil Classification System* (USCS) by the Geotechnical Engineer. Classifications for the individual soil units are shown on the attached Test Pit Logs.

3.2 LABORATORY TESTING

Geotechnical laboratory tests were conducted on selected relatively undisturbed and bulk soil samples obtained during our field investigation. The laboratory testing program was designed to evaluate the engineering characteristics of onsite earth materials. Laboratory tests conducted during this investigation include:

- Grain Size Distribution Analysis (ASTM D422)
- Atterberg Limits Test (ASTM 4318)
- Collapse/Swell (ASTM 4546)
- Standard Proctor Moisture-Density Relationship Test (ASTM D698)
- California Bearing Ratio (CBR) Test (ASTM D1883)

The results of laboratory tests are presented on the test pit logs in Appendix B (Plates B-1 to B-17), the Laboratory Summary Table and the test result plates presented in Appendix C (Plates C-1 to C-10).

3.3 ENGINEERING ANALYSIS

Engineering analyses were performed using soil data obtained from the laboratory test results and empirical correlations from material density, depositional characteristics and classification. Appropriate factors of safety were applied to the results consistent with industry standards and the accepted standard of care.

4.0 GENERALIZED SITE CONDITIONS

4.1 SURFACE CONDITIONS

At the time of our subsurface investigation, the property existed as an undeveloped parcel which was undergoing grading in preparation for development. Native grasses were present across the site along with few trees along the eastern border of the property. The property is located at an approximate elevation of 5,150 to 5,250 feet and slopes to the south. Maximum topographic relief across the site is estimated to be approximately 100 feet.

4.2 SUBSURFACE CONDITIONS

As mentioned previously, the subsurface soil conditions were explored at the subject property by excavating seventeen test pits to a depth of 5 to 14 feet below the existing site grade. Subsurface soil conditions were logged during our field investigation and are included on the test pit logs in Appendix B (Plates B-1 to B-17). The soil and moisture conditions encountered during our investigation are discussed below.

4.2.1 Soils

Based on our observations and geologic literature review, the area of the proposed development is overlain by 2 to 4 feet of topsoil composed of Lean CLAY (CL) and Sandy Lean CLAY (CL) with gravel. Underlying the topsoil we encountered Holocene-aged colluvium and slopewash deposits associated with post-Bonneville cycle processes. Descriptions of the soil units encountered are described below:

Topsoil: Generally consists of dark brown Lean CLAY (CL) and Sandy Lean CLAY (CL) with gravel. This unit also has an organic appearance and texture, with roots throughout.

Holocene-aged Colluvium and Slopewash Deposits: Generally consists of Lean CLAY (CL), Sandy Lean CLAY (CL), and Sandy Lean CLAY (CL) with gravel. These soils appear to have been formed of highly weathered bedrock. Stream deposits along the eastern boundary of the property consisted of Silty GRAVEL (GM) with sand, cobbles, and boulders with a maximum diameter of approximately 14-inches. Gravels, cobbles, and boulders were largely subrounded to rounded. These soils persisted to the full depth of our investigation.

Oligocene to Upper Eocene Norwood Tuff – Bedrock: Where observed, this unit generally consisted of highly to completely weathered, friable, light grey to green, fine-grained volcanic tuff. This unit is thought to have been deposited by water processes, and in part has been reworked. From an engineering standpoint, this unit disaggregates into a Lean CLAY (CL), Fat CLAY (CH) and Elastic SILT (MH). This unit was encountered in 13 of the 17 test pits excavated as part of this investigation, and was easily excavated to a depth of 14 feet.

The stratification lines shown on the enclosed test pit logs represent the approximate boundary between soil types (Plates B-1 to B-17). The actual in-situ transition may be gradual. Due to the nature and depositional characteristics of the native soils, care should be taken in interpolating subsurface conditions between and beyond the exploration locations.

4.2.2 Groundwater Conditions

Groundwater was encountered in test pits 1, 2, 12, and 13 at depths of approximately 7 to 14 feet below the existing site grade. Seasonal fluctuations in precipitation, surface runoff from adjacent properties, or other on or offsite sources may increase moisture conditions; groundwater conditions can be expected to rise several feet seasonally depending on the time of year. Dewatering systems should be anticipated if excavations extending more than 4 feet below existing grade or possibly shallower.

5.0 GEOLOGIC CONDITIONS

5.1 GEOLOGIC SETTING

The site is located at an elevation ranging from 5,150 to 5,250 feet above the mean sea level in an area described by Stokes (1986) as the Hinterlands portion of the Rocky Mountain physiographic province and is situated in the Wasatch Mountains in the northern foothills of the Ogden Valley. The Ogden Valley is a fault trough bounded on both the east and west by faults that dip towards the middle of the valley. In this fault trough was deposited a great thickness of clay, silt, sand and gravel. The total thicknesses of this material is unknown, but are believed to exceed 600 feet. These sediments are chiefly stream and lake deposits. Their deposition covered a long period and was more rapid at certain times than at others.

The near-surface (top 100 feet) of the valley filling was deposited in an ancient lake bed that at its highest stage stood about 400 feet higher than the lowest part of the present valley. This lake was connected with the large ancient lake Bonneville by an arm of water occupying Ogden Canyon. Lake Bonneville occupied the area lying west of the Wasatch Mountains. Surface sediments at the site are mapped as Holocene-aged colluvium and slopewash deposits consisting of clay, silt, sand, gravel, and locally boulder-rich sediment (Sorensen and Crittenden, 1979).

5.2 SEISMICITY AND FAULTING

The site lies within the north-south trending belt of seismicity known as the Intermountain Seismic Belt (ISB) (Hecker, 1993). The ISB extends from northwestern Montana through southwestern Utah. An active fault is defined as a fault that has had activity within the Holocene (<11ka). No active faults are mapped through or immediately adjacent to the site (Black et. al, 2003). The site is located approximately 5¾ miles east of the Weber Segment of the Wasatch fault zone. The most recent movement along the Weber Segment of the Wasatch Fault Zone occurred during the Quaternary Period, and there is evidence that as many as 10 to 15 earthquakes have occurred along this segment in the last 15,000 years (Hecker, 1993). A location near Kaysville Utah indicated that the Weber Segment has a measurable offset of 1.4 to 3.4 meters per event (McCalpin, and others, 1994). The Weber Segment may be capable of producing earthquakes as large as magnitude 7.5 (Ms) and has a recurrence interval of approximately 1,200 years. The site is also located approximately 31¾ miles east of the East Great Salt Lake Fault Zone (Hecker, 1993). Evidence suggests that this fault zone has been active during the Holocene (0 to 30,000 yrs) and has segment lengths comparable to that of the Wasatch

Fault Zone, indicating that it is capable of producing earthquakes of a comparable magnitude (7.5 Ms). Analyses of ground shaking hazard along the Wasatch Front suggests that the Wasatch Fault Zone is the single greatest contributor to the seismic hazard in the Wasatch Front region. Each of the faults listed above show evidence of Holocene-aged movement, and is therefore considered active. Two additional faults, the Ogden Valley north fork fault and the Ogden Valley southwestern margin faults are located approximately 1¼ and 2½ miles away from the subject property, respectively. These faults are not thought to have been active during the Holocene, and as such are not considered active.

Seismic hazard maps depicting probabilistic ground motions and spectral response have been developed for the United States by the U.S. Geological Survey as part of NEHRP/NSHMP (Frankel et al, 1996). These maps have been incorporated into both *NEHRP Recommended Provisions for Seismic Regulations for New Buildings and Other Structures* (FEMA, 1997) and the *International Building Code* (IBC) (International Code Council, 2009). Spectral responses for the Maximum Considered Earthquake (MCE) are shown in the table below. These values generally correspond to a two percent probability of exceedance in 50 years (2PE50) for a "firm rock" site. To account for site effects, site coefficients which vary with the magnitude of spectral acceleration are used. Based on our field exploration, it is our opinion that this location is best described as a Site Class D. The spectral accelerations are shown in the table below. The spectral accelerations are calculated based on the site's approximate latitude and longitude of 41.3218° and -111.8233° respectively and the United States Geological Survey 2009 ground motion calculator version 5.1.0 (USGS, 2011). Based on IBC, the site coefficients are F_a=1.00 and F_v= 1.42. From this procedure the peak ground acceleration (PGA) is estimated to be 0.42g. The MCE PGA and design response spectrum are presented in Appendix D on Plate D-1.

MCE Seismic Response Spectrum Spectral Acceleration Values for IBC Site Class D[a]

Site Location: **Latitude = 41.3218N** **Longitude = -111.8233W**	**Site Class D Site Coefficients:** **Fa = 1.00** **Fv = 1.42**
Spectral Period (sec)	**Response Spectrum Spectral Acceleration (g)**
0.2	$\mathbf{S_{MS}}$=($F_a * S_s$=1.00*1.04) = 1.04
1.0	$\mathbf{S_{M1}}$=($F_v * S_1$=1.42*0.39) = 0.55

[a] IBC 1615.1.3 recommends scaling the MCE values by 2/3 to obtain the design spectral response acceleration values; values reported in the table above have not been reduced.

5.3 OTHER GEOLOGIC HAZARDS

Geologic hazards can be defined as naturally occurring geologic conditions or processes that could present a danger to human life or property or result in increased construction costs. These hazards must be considered before development of the site. There are several hazards in addition to seismicity and faulting that if present at the site, should be considered in the design of critical and essential facilities such as communication towers. The other identified geologic hazards considered for this site are liquefaction, seiche, lake flooding, landslides, and shallow bedrock. A complete list of potential geologic hazards is included in the *Summary of Geologic Hazards Table* in Appendix D (Plate D-2).

5.3.1 Liquefaction

Certain areas within the intermountain region possess a potential for liquefaction during seismic events. Liquefaction is a phenomenon whereby loose, saturated, granular soil deposits lose a significant portion of their shear strength due to excess pore water pressure buildup resulting from dynamic loading, such as that caused by an earthquake. Among other effects, liquefaction can result in densification of such deposits causing settlements of overlying layers after an earthquake as excess pore water pressures are dissipated. The primary factors affecting liquefaction potential of a soil deposit are: (1) level and duration of seismic ground motions; (2) soil type and consistency; and (3) depth to groundwater.

Based on our review of the *Liquefaction-Potential Map for a Part of Weber County, Utah.* map prepared by the Utah Geological Survey, the site is located in an area currently designated as having a “Very Low” liquefaction potential. “Very Low” liquefaction potential indicates that there is less than a 5% probability of having an earthquake within a 100-year period that will be strong enough to cause liquefaction. The near-surface soils generally consisted partially of fine-grained sediment (silt and clay), and of bedrock, both of which are not typically considered susceptible to liquefaction. Although unlikely, it is possible that potentially liquefiable soils are present at depths greater than those covered in our investigation. A liquefaction analysis was beyond the scope of the project; however, if the owner wishes to have greater understanding of the liquefaction potential of the soils at greater depths, a liquefaction analysis should be completed at the site.

5.3.2 Seiches

Oscillations in the surface of a landlocked body of water can produce unusually large waves, or sieches. Seiches may be generated by wind, landslides, and/or earthquake effects such as ground shaking or surface fault rupture. The magnitude of the seiches caused by landslides or surface fault rupture depends on the amount of water and ground displacement, whereas the magnitude of the seiches caused by wind and ground shaking is determined by the degree or resonance between the water body and periodic driving force.

Pineview Reservoir is located approximately 2 miles south of the subject property. Man-made reservoirs, such as Pineview Reservoir, are thought to have a greater seismic-seiche hazard than valley lakes and reservoirs. However, considering that the subject property is located approximately 300 feet higher in elevation than the measured elevation of the surface of Pineview Reservoir, and considering the distance between the subject property and the nearest shoreline, the potential for the subject property to be impacted by a seiche during a seismic event is considered very low.

5.3.3 Lake Flooding, Ponding, and Sheet Flooding

A flood is the stage or height of water above some given datum, such as a commonly occupied lake shoreline. Floods are recurrent natural events which become a hazard to residents of a flood plain or shoreline whenever water rises to the extent that life and property are threatened. Although fluctuating water levels are a problem in lakes, they are especially acute in lakes which, like the Great Salt Lake, have no outlet. Natural factors causing fluctuations include precipitation, evaporation, runoff, groundwater, ice, aquatic growth, and wind.

As discussed previously, the subject property is located approximately 300 feet higher in elevation than the surface elevation of Pineview reservoir. In addition, the surface elevation of the reservoir can be maintained through the use of spillways associated with Pineview Dam. As such, it is considered very unlikely that the subject property will be impacted by lake flooding.

Ponding and sheet flooding are flood hazards that could occur in mudflats, and usually result from periods of intense, cloudburst rainfall, or rapid melting snow. Any runoff or precipitation that reaches the mudflats usually evaporates, but ponding often occurs in the winter and early spring. Localized, high-intensity, cloudburst rainstorms, which last from a few minutes to a few hours, are unpredictable and likely cause most of the ponding and sheet flooding. These rainstorms are characterized by high peak, high velocity, short duration, and small volume runoff. Snow melt floods may also cause ponding and sheet flooding. Although this flooding in generally not life-threatening, it will likely cause permanent property loss or damage.

Proper site grading and maintaining storm drains and evaporation ponds will reduce the potential for the site being impacted by ponding and sheet flooding.

5.3.4 Landslides

There are several types of landslides that should be considered when evaluating geologic hazards at a site with relatively steep terrain. These include shallow debris slides, deep-seated earth or rock slumps and earth flows.

Landslides can be described as being *older*, *younger*, or *historical* (Harty, 1992). This division is based on the degree to which the characteristic features of these landslides are preserved. *Historical* landslides are characterized by hummocky topography, numerous internal scarps, and chaotic bedding, as well as more recent evidence such as tilted trees, fresh scarps, and damaged roads, utilities, or other structures. The characteristics of *younger* landslides are similar to those of *historic* landslides but do not appear to be as recent. The characteristic features of *older* landslides are morphologically subtle and sometimes indistinguishable.

None of these landslide types are reported at or adjacent to the subject site (Harty, 1992), and based on the presence of bedrock at a relatively shallow depth, the potential for a landslide to impact the proposed construction is considered low. Although no landslides are mapped within the subject site, it should be noted that the absence of a mapped landslide does not preclude the possibility of the existence of a landslide.

5.3.5 Shallow Bedrock

Shallow bedrock, when found at or just below the surface, often is expensive and time consuming to remove. Shallow bedrock should be considered when grading plans indicate excavations into areas with potential shallow bedrock.

While bedrock outcrops were encountered in several of the test pits completed as part of this investigation, they tended to be highly weathered and easily excavated to the depths reaching 14 feet. It should be noted that although unlikely, it is possible that areas underlain by competent, near-surface bedrock may be encountered, and it is possible that heavy ripping equipment and/or blasting may be necessary to excavate to desired depths. The bedrock underlying the site is mapped as Oligocene- to Eocene-aged Norwood Tuff, which is composed of fine-grained, friable, and white to buff-weathering tuff.

5.3.6 Shallow Groundwater

Shallow groundwater flooding is a hazard that can cause the flooding of excavated areas where the depth of excavation exceeds the depth of the local water table. Shallow groundwater can lead to increased construction costs and delays, as well as potentially dangerous conditions in excavated trenches. Shallow groundwater flooding should be considered when designing habitable structures that require excavation that may exceed the depth to the shallow groundwater.

During our subsurface investigation, shallow groundwater was observed at depths ranging from 7 feet to over 14 feet below existing grade. It should be anticipated that the groundwater can rise several feet during wet cycles and could impact site developments. The contractor should anticipate dewatering trenches and excavations within this area that are deeper than 7 feet or possibly shallower during spring or other times of the year when groundwater may fluctuate.

5.3.7 Stream/Canal Flooding

Stream flooding is a hazard related to spring snowmelt, run-off and flash-flooding from summer rainstorms. Flood hazards should be considered when planning for development for critical facilities located in areas having a potential flood risk.

An unnamed natural drainage sourced by Heinz Canyon is located adjacent to the subject property to the east. Sediment observed in test pits excavated near this drainage indicate that material up to 14-inches in diameter have been mobilized by the flow of this drainage. The drainage was dry at the time of our investigation. It is the opinion of GeoStrata that this drainage does pose a risk of flooding and even possible debris flows during extreme weather events. Strategic site grading should be implemented to reduce the potential for damage resulting from flooding of this stream.

6.0 ENGINEERING ANALYSIS AND RECOMMENDATIONS

6.1 GENERAL CONCLUSIONS

Supporting data upon which the following recommendations are based have been presented in the previous sections of this report. The recommendations presented herein are governed by the physical properties of the earth materials encountered and tested as part of our subsurface exploration and the anticipated design data discussed in the **PROJECT DESCRIPTION** section. If subsurface conditions other than those described herein are encountered in conjunction with construction, and/or if design and layout changes are initiated, GeoStrata must be informed so that our recommendations can be reviewed and revised as changes or conditions may require.

Based on the subsurface conditions encountered at the site, it is our opinion that the subject site is suitable for the proposed development provided that the recommendations contained in this report are incorporated into the design and construction of the project.

6.2 EARTHWORK

Prior to the placement of foundations and pavements, general site grading is recommended to provide proper support for foundations, exterior concrete flatwork, and concrete slabs-on-grade. Site grading is also recommended to provide proper drainage and moisture control on the subject property and to aid in preventing differential settlement of foundations as a result of variations in subgrade moisture conditions.

6.2.1 General Site Preparation and Grading

Within areas to be graded (below proposed structures, fill sections, concrete flatwork, or pavement sections), any existing vegetation, debris, collapsible, or otherwise unsuitable soils should be removed. Any soft, loose, disturbed or undocumented fill soils should also be removed. Where over-excavation is required, the excavation should extend a minimum of one foot laterally for every foot of depth of over-excavation. Excavations should extend laterally at least two feet beyond flatwork, pavements, and slabs-on-grade. Following the removal of vegetation, unsuitable soils, and loose or disturbed soils, as described above, site grading may be conducted to bring the site to design elevations.

A GeoStrata representative should observe the site preparation and grading operations to assess that the recommendations presented in this report are complied with.

6.2.2 Soft Soil Stabilization

Soft or pumping soils may be exposed in excavations at the site. Once exposed, all subgrade surfaces beneath the proposed structures, pavements, and flat work concrete should be proof rolled with a piece of heavy wheeled-construction equipment. If soft or pumping soils are encountered, these soils should be stabilized prior to construction of footings. Stabilization of the subgrade soils can be accomplished using a clean, coarse angular material worked into the soft subgrade. We recommend the material be greater than 2 inch diameter, but less than 6 inches. A locally available pit-run gravel may be suitable but should contain a high percentage of particles larger than 2 inches and have less than 7 percent fines (material passing the No. 200 sieve). A pit-run gravel may not be as effective as a coarse, angular material in stabilizing the soft soils and may require more material and greater effort. The stabilization material should be worked (pushed) into the soft subgrade soils until a firm relatively unyielding surface is established. Once a firm, relatively unyielding surface is achieved, the area may be brought to final design grade using structural fill.

In large areas of soft subgrade soils, stabilization of the subgrade may not be practical using the method outlined above. In these areas it may be more economical to place a woven geotextile fabric against the soft soils covered by 18 inches of coarse, sub-rounded to rounded material over the woven geotextile. An inexpensive non-woven geotextile "filter" fabric should also be placed over the top of the coarse, sub-rounded to rounded fill prior to placing structural fill or pavement section soils to reduce infiltration of fines from above. The woven geotextile should be Amoco 2004 or prior approved equivalent. The filter fabric should consist of an Amoco 4506, Amoco 4508, or equivalent as approved by the Geotechnical Engineer.

6.2.3 Excavation Stability

Based on Occupational Safety and Health Administration (OSHA) guidelines for excavation safety, trenches with vertical walls up to 5 feet in depth may be occupied, however, the presence of fill soils, loose soils, or wet soils may require that the walls be flattened to maintain safe working conditions. When the trench is deeper than 5 feet, we recommend a trench-shield or shoring be used as a protective system to workers in the trench. Based on our soil observations, laboratory testing, and OSHA guidelines, native soils at the site classify as Type C soils. Deeper excavations, if required, should be constructed with side slopes no steeper than one and one-half horizontal to one vertical (1.5H:1V). If wet conditions are encountered, side slopes should be further flattened to maintain slope stability. Alternatively shoring or trench boxes may be used to improve safe work conditions in trenches. The contractor is ultimately responsible for trench and site safety. Pertinent OSHA requirements should be met to provide a safe work environment. If site specific conditions arise that require engineering analysis in accordance with OSHA regulations, GeoStrata can respond and provide recommendations as needed.

We recommend that a GeoStrata representative be on-site during all excavations to assess the exposed foundation soils. We also recommend that the Geotechnical Engineer be allowed to review the grading plans when they are prepared in order to evaluate their compatibility with these recommendations.

6.2.4 Structural Fill and Compaction

All fill placed for the support of structures, concrete flatwork or pavements should consist of structural fill. Due to the high plasticity of the native soils and bedrock at the site, native soils and bedrock should not be used as structural fill. Structural fill should consist of an imported material. Imported structural fill should consist of a relatively well graded granular soil with a maximum of 50 percent passing the No. 4 mesh sieve and a maximum fines content (minus No.200 mesh sieve) of 25 percent. All structural fill, should be free of vegetation and debris, and contain no materials larger than 3-inches in nominal size. All structural fill soils should be approved by the Geotechnical Engineer prior to placement. Clay and silt particles in imported structural fill should have a liquid limit less than 35 and a plasticity index less than 15 based on the Atterberg Limit's test (ASTM D-4318).

All structural fill should be placed in maximum 6-inch loose lifts if compacted by small hand-operated compaction equipment, maximum 8-inch loose lifts if compacted by light-duty rollers, and maximum 12-inch loose lifts if compacted by heavy duty compaction equipment that is capable of efficiently compacting the entire thickness of the lift. We recommend that all structural fill be compacted on a horizontal plane, unless otherwise approved by the geotechnical engineer. Structural fill with an overall thickness of 6 feet or less should be compacted to at least 95% of the maximum dry density (MDD), as determined by ASTM D-1557 (modified proctor). The moisture content should be within 3% of the optimum moisture content (OMC) at the time of placement and compaction. Also, prior to placing any fill, the excavations should be observed by the geotechnical engineer to observe that any unsuitable materials or loose soils have been removed. In addition, proper grading should precede placement of fill, as described in the *General Site Preparation and Grading* subsection of this report (Section 6.2.1).

Fill soils placed for subgrade below exterior flat work should be within 3% of the OMC when placed and compacted to at least 95% of the MDD as determined by ASTM D-1557. All utility trenches backfilled below the proposed structure, pavements, and flatwork concrete, should be backfilled with structural fill that is within 3% of the OMC when placed and compacted to at least 95% of the MDD as determined by ASTM D-1557. All other trenches, in landscape areas, should be backfilled and compacted to at least 90% of the MDD (ASTM D-1557).

The gradation, placement, moisture, and compaction recommendations contained in this section meet our minimum requirements, but may not meet the requirements of other governing agencies such as city, county, or state entities. If their requirements exceed our recommendations, their specifications should override those presented in this report.

6.3 FOUNDATIONS

The foundation for the proposed structure may consist of conventional strip and/or spread footings founded on undisturbed native soils. Strip and spread footings should be a minimum of 20 and 36 inches wide, respectively, and exterior shallow footings should be embedded at least 30-inches below final grade for frost protection and confinement.

Conventional strip footings founded entirely on undisturbed native soils or on properly placed and compacted structural fill may be proportioned for a maximum net allowable bearing capacity of **1,400 psf**. The net allowable bearing capacity may be increased (typically by one-third) for temporary loading conditions such as transient wind and seismic loads. All footing excavations should be observed by the Geotechnical Engineer prior to footing placement.

Settlements of properly designed and constructed conventional footings, founded as described above, are anticipated to be less than 1 inch. Differential settlements should be on the order of half the total settlement over 30 feet.

6.4 CONCRETE SLAB-ON-GRADE CONSTRUCTION

Concrete slabs-on-grade should be constructed over at least 4 inches of compacted gravel overlying undisturbed native soil or a zone of structural fill that is at least 12 inches thick.

Disturbed native soils should be compacted to at least 95% of the MDD as determined by ASTM D-1557 (modified proctor) prior to placement of gravel. The gravel should consist of road base or clean drain rock with a ¾-inch maximum particle size and no more than 12 percent fines passing the No. 200 mesh sieve. The gravel layer should be compacted to at least 95 percent of the MDD of modified proctor or until tight and relatively unyielding if the material is non-proctorable. The maximum load on the floor slab should not exceed 300 psf; greater loads would require additional subgrade preparation and additional structural fill. All concrete slabs should be designed to minimize cracking as a result of shrinkage. Consideration should be given to reinforcing the slab with welded wire, re-bar, or fiber mesh.

As noted above, groundwater was encountered at 7½ to 10 feet below site grade in our test pits. Due to the high groundwater, we do not recommend basement deeper than 4½ feet below existing grades unless foundation drains are installed as recommended in Section 6.5 of this report.

6.5 FOUNDATION DRAINAGE

Due to high groundwater encountered in our test pits, we recommend that basements be established at least 3 feet above the groundwater elevation unless a foundation drain is installed. If the groundwater elevation is not established at the time of construction we recommend that basements extend not more than 4 feet below site grade as it existed at the time of this report unless a foundation drain is installed. The foundation drain should consist of a 4 inch perforated pipe placed at or below the footing elevation. The pipe should be covered with at least 12 inches of free draining gravel (containing less than 5 percent passing the No 4 sieve) and be graded to a free gravity out fall or to a pumped sump. A separator fabric, such as Mirafi 140N, should separate the free draining gravel and native soil (i.e. the separator fabric should be placed between the gravel and the native soils at the bottom of the gravel, the side of the gravel where the gravel does not lie against the concrete footing or foundation, and at the top of the gravel). We recommend that the gravel extend up the foundation wall to within 2 feet of the final ground surface. As an alternative, the gravel extending up the foundation wall may be replaced with a prefabricated drain panel, such as Ecodrain-E.

6.6 EARTH PRESSURES AND LATERAL RESISTANCE

Lateral forces imposed upon conventional foundations due to wind or seismic forces may be resisted by the development of passive earth pressures and friction between the base of the footing and the supporting subgrade. In determining the frictional resistance, a coefficient of friction of 0.33 should be used for native soils.

Ultimate lateral earth pressures from backfill acting against buried walls and structures may be computed from the lateral pressure coefficients or equivalent fluid densities presented in the following table:

Condition	**Lateral Pressure Coefficient**	**Equivalent Fluid Density (pounds per cubic foot)**
Active*	0.39	47
At-rest**	0.56	67
Passive*	2.58	310
Seismic Active***	0.48	57
Seismic Passive***	-0.76	-91

* Based on Coulomb's equation

** Based on Jaky

*** Based on Mononobe-Okabe Equation

These coefficients and densities assume level, fine-grained backfill with no buildup of hydrostatic pressures. The force of the water should be added to the presented values if hydrostatic pressures are anticipated. If sloping backfill is present, we recommend the geotechnical engineer be consulted to provide more accurate lateral pressure parameters once the design geometry is established.

Walls and structures allowed to rotate slightly should use the active condition. If the element is constrained against rotation, the at-rest condition should be used. These values should be used with an appropriate factor of safety against overturning and sliding. A value of 1.5 is typically used. Additionally, if passive resistance is calculated in conjunction with frictional resistance, the passive resistance should be reduced by ½.

For seismic analyses, the *active* and *passive* earth pressure coefficient provided in the table is based on the Mononobe-Okabe pseudo-static approach and only accounts for the dynamic horizontal thrust produced by ground motion. Hence, the resulting dynamic thrust pressure *should be added* to the static pressure to determine the total pressure on the wall. The pressure distribution of the dynamic horizontal thrust may be closely approximated as an inverted triangle with stress decreasing with depth and the resultant acting at a distance approximately 0.6 times the loaded height of the structure, measured upward from the bottom of the structure.

The coefficients shown assume a vertical wall face. Hydrostatic and surcharge loadings, if any, should be added. Over-compaction behind walls should be avoided. Resisting passive earth pressure from soils subject to frost or heave, or otherwise above prescribed minimum depths of embedment, should usually be neglected in design.

6.7 MOISTURE PROTECTION AND SURFACE DRAINAGE

Precautions should be taken during and after construction to minimize the potential for saturation of foundation soils. Over wetting the soils prior to or during construction may result in increased softening and pumping, causing equipment mobility problems and difficulty in achieving compaction.

Moisture should not be allowed to infiltrate the soils in the vicinity of, or upslope from, the structures. We recommend that roof runoff devices be installed to direct all runoff a minimum of 10 feet away from structures. The grade within 10 feet of the structures should be sloped a minimum of 5% away from the structure in accordance with the IBC, 2009.

6.8 PAVEMENT SECTION

For pavement design a CBR value for the near surface subgrade soils of 4.3 was used in our analysis. No traffic information was available at the time this report was prepared, therefore, GeoStrata has assumed traffic counts for access roads and parking areas. We assumed that vehicle traffic in and out of paved area would consist of approximately 1000 passenger car trips per day, 15 light trucks, and 2 large trucks per day with a 20 year design life. Based on these assumptions our analysis use 370,000 ESAL's for the traffic over the life of the pavement. Asphalt has been assumed to be a high stability plant mix and base course material (road base) composed of crushed stone with a minimum CBR of 70. We have further assumed that the traffic will be relatively consistent over the design life of the pavement sections. Therefore, no growth factor was applied in calculation of loading for each pavement sections' design life. Based on this information we recommend a pavement section consisting of 3 inches of asphalt over 23 inches of untreated base course. As alternative, an equivalent pavement section of 3 inches of asphalt over 10 inches of untreated base course and 16 inches of granular borrow may be used. Granular borrow should meet the material and placement recommendations of imported structural fill presented in Section 6.2.4.

7.0 CLOSURE

7.1 LIMITATIONS

The recommendations contained in this report are based on our limited field exploration, laboratory testing, and understanding of the proposed construction. The subsurface data used in the preparation of this report were obtained from the explorations made 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, GeoStrata should be immediately notified so that we may make any necessary revisions to recommendations contained in this report. In addition, if the scope of the proposed construction changes from that described in this report, GeoStrata should be notified.

This report was prepared in accordance with the generally accepted standard of practice at the time the report was written. No 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.

7.2 ADDITIONAL SERVICES

The recommendations made in this report are based on the assumption that an adequate program of tests and observations will be made during construction. GeoStrata staff should be on site to verify compliance with these recommendations. These tests and observations should include, but not necessarily be limited to, the following:

- Observations and testing during site preparation, earthwork and structural fill placement.
- Observation of foundation soils to assess their suitability for footing placement.
- Observation of soft/loose soils over-excavation.
- Observation of temporary excavations and shoring.
- Consultation as may be required during construction.
- Quality control and observation of concrete placement.

We also recommend that project plans and specifications be reviewed by GeoStrata to verify compatibility with our conclusions and recommendations. Additional information concerning the scope and cost of these services can be obtained from our office.

We appreciate the opportunity to be of service on this project. Should you have any questions regarding the report or wish to discuss additional services, please do not hesitate to contact us at your convenience at (801) 501-0583.

8.0 REFERENCES CITED

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Lewis Homes
The Ridge Development
Eden, UT
Project Number: 924-001

Site Vicinity Map

Plate A-1

0 125 250 500 750 1,000 Feet

1:5,000

N

GeoStrata

Legend

Approximate Test Pit Location - ⊗

Approximate Site Boundary - —

Lewis Homes
The Ridge Development
Eden, UT
Project Number: 924-001

Exploration Location Map

Plate A-2

DATE	
STARTED:	11/4/13
COMPLETED:	11/4/13
BACKFILLED:	11/4/13

Lewis Homes
The Ridge Development
Eden, UT
Project Number 924-001

GeoStrata Rep: D. Brown
Rig Type: Trackhoe

TEST PIT NO:
TP-01
Sheet 1 of 1

LOCATION
NORTHING | EASTING | ELEVATION

DEPTH METERS	DEPTH FEET	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits (Plastic Limit / Moisture Content / Liquid Limit; 10 20 30 40 50 60 70 80 90)
0	0					TOPSOIL; Lean CLAY with sand - dark brown, moist, roots, some pinholes						
1					CL	Sandy Lean CLAY - stiff, light grey-green, moist to wet						
	5											
2												
		Grab sample						31.2	62.7	40	16	
3	10											
		Grab sample	Measured									
						Bottom of Test Pit @ 11.5 Feet						
4												
	15											

GeoStrata

SAMPLE TYPE
- GRAB SAMPLE
- 2.5" O.D. THIN-WALLED HAND SAMPLER

WATER LEVEL
- MEASURED
- ESTIMATED

NOTES:

Plate

B-1

DATE				
STARTED: 11/4/13	Lewis Homes The Ridge Development Eden, UT Project Number 924-001	GeoStrata Rep: D. Brown	TEST PIT NO:	TP-02
COMPLETED: 11/4/13		Rig Type: Trackhoe	Sheet 1 of 1	
BACKFILLED: 11/4/13				

LOCATION

NORTHING EASTING ELEVATION

DEPTH (METERS)	DEPTH (FEET)	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits
0	0					TOPSOIL; Lean CLAY - dark brown, moist, roots, trace pinholes						
1						BEDROCK - weathered, friable, light grey-green, disaggregates into Lean CLAY						
	5											
2												
3	10											
		Grab sample	Measured		CL							
4						Bottom of Test Pit @ 13 Feet						
	15											

Moisture Content and Atterberg Limits: Plastic Limit — Moisture Content — Liquid Limit; scale 10 20 30 40 50 60 70 80 90

GeoStrata

SAMPLE TYPE
- GRAB SAMPLE
- 2.5" O.D. THIN-WALLED HAND SAMPLER

WATER LEVEL
- MEASURED
- ESTIMATED

NOTES:

Plate

B-2

DATE	
STARTED:	11/4/13
COMPLETED:	11/4/13
BACKFILLED:	11/4/13

Lewis Homes
The Ridge Development
Eden, UT
Project Number 924-001

GeoStrata Rep: D. Brown
Rig Type: Trackhoe

TEST PIT NO: **TP-03**
Sheet 1 of 1

LOCATION: NORTHING | EASTING | ELEVATION

DEPTH (METERS)	DEPTH (FEET)	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index
0	0					TOPSOIL; Lean CLAY - dark brown, moist, roots, pinholes					
1						BEDROCK - highly weathered, friable, light grey-green, disaggregates into Silty SAND					
2		Grab sample					78.1	22.3	25.3	NP	NP
						Bottom of Test Pit @ 7 Feet					
3	10										
4											
	15										

Moisture Content and Atterberg Limits (Plastic Limit, Moisture Content, Liquid Limit): 10 20 30 40 50 60 70 80 90

SAMPLE TYPE
- GRAB SAMPLE
- 2.5" O.D. THIN-WALLED HAND SAMPLER

WATER LEVEL
- MEASURED
- ESTIMATED

NOTES:

GeoStrata

Plate B-3

DATE	
STARTED:	11/4/13
COMPLETED:	11/4/13
BACKFILLED:	11/4/13

Lewis Homes
The Ridge Development
Eden, UT
Project Number 924-001

GeoStrata Rep: D. Brown
Rig Type: Trackhoe

TEST PIT NO: **TP-04**
Sheet 1 of 1

LOCATION
NORTHING | EASTING | ELEVATION

DEPTH (FEET)	SAMPLES	MATERIAL DESCRIPTION	Dry Density (pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index
0		TOPSOIL; Lean CLAY - dark brown, moist, roots, some pinholes					
~4		BEDROCK - weathered, friable, light grey-green, disaggregates into Lean CLAY					
~11	Grab sample						
12		Bottom of Test Pit @ 12 Feet					

Moisture Content and Atterberg Limits: Plastic Limit — Moisture Content — Liquid Limit; 10 20 30 40 50 60 70 80 90

Depth scale: METERS 0–4; FEET 0, 5, 10, 15

SAMPLE TYPE
- GRAB SAMPLE
- 2.5" O.D. THIN-WALLED HAND SAMPLER

WATER LEVEL
- MEASURED
- ESTIMATED

NOTES:

Plate B-4

DATE		
STARTED:	11/4/13	
COMPLETED:	11/4/13	
BACKFILLED:	11/4/13	

Lewis Homes
The Ridge Development
Eden, UT
Project Number 924-001

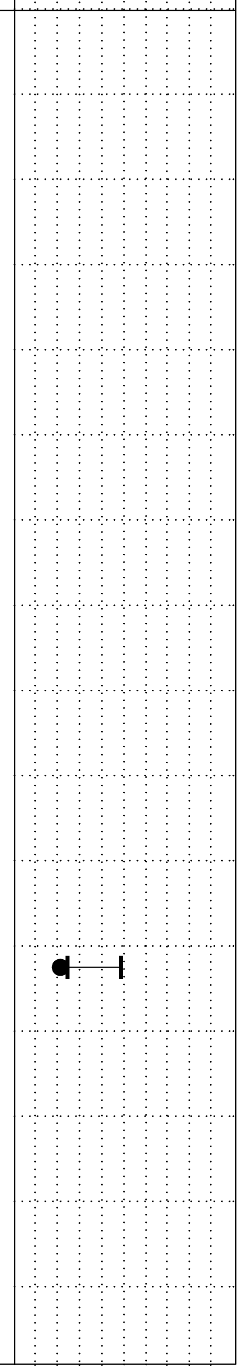
GeoStrata Rep: D. Brown
Rig Type: Trackhoe

TEST PIT NO: **TP-05**
Sheet 1 of 1

LOCATION: NORTHING / EASTING / ELEVATION

Depth (Meters)	Depth (Feet)	Samples	Water Level	Graphical Log	Unified Soil Classification	Material Description	Dry Density (pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index
0	0					TOPSOIL; Lean CLAY - dark brown, moist, roots, some pinholes					
1						BEDROCK - highly weathered, friable, light grey-green, disaggregates into Sandy Lean CLAY					
3–4	10–12	Grab						21.0	58.4	48	24
	12					Bottom of Test Pit @ 12 Feet					

Moisture Content and Atterberg Limits (Plastic Limit, Moisture Content, Liquid Limit; scale 10 20 30 40 50 60 70 80 90)



SAMPLE TYPE
- GRAB SAMPLE
- 2.5" O.D. THIN-WALLED HAND SAMPLER

WATER LEVEL
- MEASURED
- ESTIMATED

NOTES:

Plate B-5

DATE		
STARTED:	11/4/13	
COMPLETED:	11/4/13	
BACKFILLED:	11/4/13	

Lewis Homes
The Ridge Development
Eden, UT
Project Number 924-001

GeoStrata Rep: D. Brown
Rig Type: Trackhoe

TEST PIT NO:
TP-06
Sheet 1 of 1

LOCATION

NORTHING EASTING ELEVATION

DEPTH (METERS)	DEPTH (FEET)	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits (Plastic Limit, Moisture Content, Liquid Limit; 10 20 30 40 50 60 70 80 90)
0	0					TOPSOIL; Lean CLAY - dark brown, moist, roots, some pinholes						
1						BEDROCK - highly weathered, friable, light grey-green, disaggregates into Lean CLAY						
2, 3, 4	5, 10, 15	Grab sample (approx. 11–11.5 ft)				Bottom of Test Pit @ 12 Feet						

GeoStrata

SAMPLE TYPE
- GRAB SAMPLE
- 2.5" O.D. THIN-WALLED HAND SAMPLER

WATER LEVEL
- MEASURED
- ESTIMATED

NOTES:

Plate B-6

DATE		
STARTED:	11/4/13	
COMPLETED:	11/4/13	
BACKFILLED:	11/4/13	

Lewis Homes
The Ridge Development
Eden, UT
Project Number 924-001

GeoStrata Rep: D. Brown
Rig Type: Trackhoe

TEST PIT NO:
TP-07
Sheet 1 of 1

LOCATION
NORTHING EASTING ELEVATION

DEPTH METERS	DEPTH FEET	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits (Plastic Limit, Moisture Content, Liquid Limit; 10 20 30 40 50 60 70 80 90)
0	0					TOPSOIL; Lean CLAY - dark brown, moist, roots, some pinholes						
1						BEDROCK - highly weathered, friable, light grey-green, disaggregates into Sandy SILT						
	5											
2		▯					75.0	21.8	35.1	41	9	
						Bottom of Test Pit @ 8 Feet						
3	10											
4												
	15											

GeoStrata

SAMPLE TYPE
▯ - GRAB SAMPLE
▨ - 2.5" O.D. THIN-WALLED HAND SAMPLER

WATER LEVEL
▼ - MEASURED
▽ - ESTIMATED

NOTES:

Plate
B-7

DATE		
STARTED:	11/4/13	
COMPLETED:	11/4/13	
BACKFILLED:	11/4/13	

Lewis Homes
The Ridge Development
Eden, UT
Project Number 924-001

GeoStrata Rep: D. Brown
Rig Type: Trackhoe

TEST PIT NO:
TP-08
Sheet 1 of 1

LOCATION

NORTHING | EASTING | ELEVATION

DEPTH (METERS)	DEPTH (FEET)	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits (Plastic Limit – Moisture Content – Liquid Limit; 10 20 30 40 50 60 70 80 90)
0	0					TOPSOIL; Lean CLAY - dark brown, moist, roots, pinholes						
1						BEDROCK - highly weathered, friable, light grey-green, disaggregates into Lean CLAY						
	5											
2												
3	10											
4		Grab sample										
						Bottom of Test Pit @ 14 Feet						
	15											

GeoStrata

SAMPLE TYPE
- GRAB SAMPLE
- 2.5" O.D. THIN-WALLED HAND SAMPLER

WATER LEVEL
- MEASURED
- ESTIMATED

NOTES:

Plate
B-8

DATE		Lewis Homes The Ridge Development Eden, UT Project Number 924-001	GeoStrata Rep: D. Brown Rig Type: Trackhoe	TEST PIT NO: TP-09 Sheet 1 of 1
STARTED:	11/4/13			
COMPLETED:	11/4/13			
BACKFILLED:	11/4/13			

LOCATION

NORTHING | EASTING | ELEVATION

DEPTH METERS	DEPTH FEET	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits (Plastic Limit / Moisture Content / Liquid Limit; 10 20 30 40 50 60 70 80 90)
0	0					TOPSOIL; Lean CLAY - dark brown, moist, roots, pinholes						
						BEDROCK - highly weathered, friable, light grey-green, disaggregates into Elastic SILT						
1		Grab sample							85.0	58	25	Plastic limit approx. 33, liquid limit approx. 58 (plotted)
	5					Bottom of Test Pit @ 5 Feet						
2												
3	10											
4												
	15											

GeoStrata

SAMPLE TYPE
- GRAB SAMPLE
- 2.5" O.D. THIN-WALLED HAND SAMPLER

WATER LEVEL
- MEASURED
- ESTIMATED

NOTES:

Plate B-9

DATE	
STARTED:	11/5/13
COMPLETED:	11/5/13
BACKFILLED:	11/5/13

Lewis Homes
The Ridge Development
Eden, UT
Project Number 924-001

GeoStrata Rep: D. Brown
Rig Type: Trackhoe

TEST PIT NO:
TP-10
Sheet 1 of 1

LOCATION

NORTHING | EASTING | ELEVATION

DEPTH METERS	DEPTH FEET	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index
0	0					TOPSOIL; Lean CLAY - dark brown, moist, roots, pineholes					
1					CL	Sandy Lean CLAY - stiff, brown to light brown, moist					
	5				SM	Silty SAND - medium dense, brown to light brown, moist					
2		Grab sample					100.9	10.6	25.2	NP	NP
						Bottom of Test Pit @ 7.5 Feet					
3	10										
4											
	15										

Moisture Content and Atterberg Limits

Plastic Limit — Moisture Content — Liquid Limit

10 20 30 40 50 60 70 80 90

LOG OF TEST PITS (B) TEST PIT LOGS.GPJ GEOSTRATA.GDT 12/3/13

GeoStrata

SAMPLE TYPE
- GRAB SAMPLE
- 2.5" O.D. THIN-WALLED HAND SAMPLER

WATER LEVEL
- MEASURED
- ESTIMATED

NOTES:

Plate

B-10

DATE	
STARTED:	11/5/13
COMPLETED:	11/5/13
BACKFILLED:	11/5/13

Lewis Homes
The Ridge Development
Eden, UT
Project Number 924-001

GeoStrata Rep: D. Brown
Rig Type: Trackhoe

TEST PIT NO:
TP-11
Sheet 1 of 1

LOCATION

NORTHING EASTING ELEVATION

DEPTH: METERS, FEET | SAMPLES | WATER LEVEL | GRAPHICAL LOG | UNIFIED SOIL CLASSIFICATION

MATERIAL DESCRIPTION

Dry Density(pcf) | Moisture Content % | Percent minus 200 | Liquid Limit | Plasticity Index

Moisture Content and Atterberg Limits
Plastic Limit | Moisture Content | Liquid Limit
10 20 30 40 50 60 70 80 90

Depth (ft)	Material Description
0	TOPSOIL; Lean CLAY - dark brown, moist, roots, pinholes
~2	BEDROCK - highly weathered, moderately friable, light brown to brown, disaggregates into Silty SAND
6	Bottom of Test Pit @ 6 Feet

Depth scale: Meters 0, 1, 2, 3, 4; Feet 0, 5, 10, 15. Grab sample at approx. 4.5–5 ft.

SAMPLE TYPE
- GRAB SAMPLE
- 2.5" O.D. THIN-WALLED HAND SAMPLER

WATER LEVEL
▼- MEASURED
▽- ESTIMATED

NOTES:

Plate

B-11

DATE	
STARTED:	11/5/13
COMPLETED:	11/5/13
BACKFILLED:	11/5/13

Lewis Homes
The Ridge Development
Eden, UT
Project Number 924-001

GeoStrata Rep: D. Brown
Rig Type: Trackhoe

TEST PIT NO:
TP-12
Sheet 1 of 1

LOCATION
NORTHING EASTING ELEVATION

DEPTH METERS	DEPTH FEET	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index
0	0					TOPSOIL; Sandy Lean CLAY with gravel - dark brown, moist, roots, few pinholes					
					GM	Silty GRAVEL with sand, cobbles and boulders - dense, grey-brown, moist, boulders observed up to 14" in diameter					
1											
	5	▯						4.1	18.7		
2			▼								
						Bottom of Test Pit @ 8 Feet					
3	10										
4											
	15										

Moisture Content and Atterberg Limits
Plastic Limit — Moisture Content ● — Liquid Limit
10 20 30 40 50 60 70 80 90

SAMPLE TYPE
▯ - GRAB SAMPLE
▨ - 2.5" O.D. THIN-WALLED HAND SAMPLER

WATER LEVEL
▼- MEASURED
▽- ESTIMATED

NOTES:

GeoStrata

Plate
B-12

DATE		Lewis Homes	GeoStrata Rep: D. Brown	TEST PIT NO:
STARTED:	11/5/13	The Ridge Development		TP-13
COMPLETED:	11/5/13	Eden, UT	Rig Type: Trackhoe	
BACKFILLED:	11/5/13	Project Number 924-001		Sheet 1 of 1

LOCATION

NORTHING EASTING ELEVATION

DEPTH (METERS)	DEPTH (FEET)	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index
0	0					TOPSOIL; Lean CLAY with gravel - dark brown, moist, roots, pinholes					
					CL	Lean CLAY - stiff, moist to wet, brown to grey-brown					
1	5										
2											
					CH	Fat CLAY - stiff, moist to wet, brown to grey-brown					
3	10	Grab sample	Measured				66.0	40.1	72.2	93	58
						Bottom of Test Pit @ 12 Feet					
4											
	15										

Moisture Content and Atterberg Limits

Plastic Limit — Moisture Content — Liquid Limit

10 20 30 40 50 60 70 80 90

GeoStrata

SAMPLE TYPE
- GRAB SAMPLE
- 2.5" O.D. THIN-WALLED HAND SAMPLER

WATER LEVEL
- MEASURED
- ESTIMATED

NOTES:

Plate

B-13

DATE	
STARTED:	11/5/13
COMPLETED:	11/5/13
BACKFILLED:	11/5/13

Lewis Homes
The Ridge Development
Eden, UT
Project Number 924-001

GeoStrata Rep: D. Brown
Rig Type: Trackhoe

TEST PIT NO: **TP-14**
Sheet 1 of 1

LOCATION: NORTHING | EASTING | ELEVATION

Depth (Feet)	Samples	Material Description	Dry Density (pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index
0		TOPSOIL; Sandy Lean CLAY - dark brown, moist, roots, pinholes					
~1.5		BEDROCK - weathered, friable, light grey-green, disaggregates to Lean CLAY					
~13	Grab sample			7.6	93.5	31	10
14		Bottom of Test Pit @ 14 Feet					

Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (scale 10 20 30 40 50 60 70 80 90)

SAMPLE TYPE
- GRAB SAMPLE
- 2.5" O.D. THIN-WALLED HAND SAMPLER

WATER LEVEL
- MEASURED
- ESTIMATED

NOTES:

Plate B-14

DATE	
STARTED:	11/5/13
COMPLETED:	11/5/13
BACKFILLED:	11/5/13

Lewis Homes
The Ridge Development
Eden, UT
Project Number 924-001

GeoStrata Rep: D. Brown
Rig Type: Trackhoe

TEST PIT NO:
TP-15
Sheet 1 of 1

LOCATION
NORTHING EASTING ELEVATION

MATERIAL DESCRIPTION

DEPTH (METERS)	DEPTH (FEET)	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index
0	0					TOPSOIL; Lean CLAY - dark brown, moist, roots, pinholes					
						BEDROCK - weathered, friable, light grey-green, disaggreates into Lean CLAY					
		Grab sample					82.6	6.3			
	8					Bottom of Test Pit @ 8 Feet					

Moisture Content and Atterberg Limits
Plastic Limit — Moisture Content — Liquid Limit
10 20 30 40 50 60 70 80 90

SAMPLE TYPE
- GRAB SAMPLE
- 2.5" O.D. THIN-WALLED HAND SAMPLER

WATER LEVEL
- MEASURED
- ESTIMATED

NOTES:

Plate

B-15

DATE		Project	GeoStrata Rep / Rig Type	TEST PIT NO:
STARTED:	11/5/13	Lewis Homes The Ridge Development Eden, UT Project Number 924-001	GeoStrata Rep: D. Brown Rig Type: Trackhoe	TP-16 Sheet 1 of 1
COMPLETED:	11/5/13			
BACKFILLED:	11/5/13			

LOCATION: NORTHING | EASTING | ELEVATION

Depth (Meters)	Depth (Feet)	Samples	Water Level	Graphical Log	Unified Soil Classification	Material Description	Dry Density (pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index
0	0					TOPSOIL; Lean CLAY with gravel - dark brown, moist, roots					
	~2.5					BEDROCK - weathered, friable, light green-grey, disaggregates into Lean CLAY					
	~12	Grab sample						27.9	72.7	NP	NP
	13					Bottom of Test Pit @ 13 Feet					

Moisture Content and Atterberg Limits: Plastic Limit — Moisture Content — Liquid Limit (scale 10 20 30 40 50 60 70 80 90)

SAMPLE TYPE
- GRAB SAMPLE
- 2.5" O.D. THIN-WALLED HAND SAMPLER

WATER LEVEL
- MEASURED
- ESTIMATED

NOTES:

Plate B-16

DATE	
STARTED:	11/5/13
COMPLETED:	11/5/13
BACKFILLED:	11/5/13

Lewis Homes
The Ridge Development
Eden, UT
Project Number 924-001

GeoStrata Rep: D. Brown
Rig Type: Trackhoe

TEST PIT NO:
TP-17
Sheet 1 of 1

LOCATION
NORTHING EASTING ELEVATION

DEPTH METERS	DEPTH FEET	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	Dry Density (pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits (Plastic Limit, Moisture Content, Liquid Limit; 10 20 30 40 50 60 70 80 90)
0	0					BEDROCK - weathered, friable, light grey-green, disaggregates into Sandy SILT						
1												
	5								59.1	NP	NP	
						Bottom of Test Pit @ 5.5 Feet						
2												
3	10											
4												
	15											

LOG OF TEST PITS (B) TEST PIT LOGS.GPJ GEOSTRATA.GDT 12/3/13

GeoStrata

SAMPLE TYPE
- GRAB SAMPLE
- 2.5" O.D. THIN-WALLED HAND SAMPLER

WATER LEVEL
- MEASURED
- ESTIMATED

NOTES:

Plate
B-17

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			USCS SYMBOL	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS (More than half of material is larger than the #200 sieve)	GRAVELS (More than half of coarse fraction is larger than the #4 sieve)	CLEAN GRAVELS WITH LITTLE OR NO FINES	GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
			GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
		GRAVELS WITH OVER 12% FINES	GM	SILTY GRAVELS, GRAVEL-SILT-SAND MIXTURES
			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
	SANDS (More than half of coarse fraction is smaller than the #4 sieve)	CLEAN SANDS WITH LITTLE OR NO FINES	SW	WELL-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES
			SP	POORLY-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES
		SANDS WITH OVER 12% FINES	SM	SILTY SANDS, SAND-GRAVEL-SILT MIXTURES
			SC	CLAYEY SANDS SAND-GRAVEL-CLAY MIXTURES
FINE GRAINED SOILS (More than half of material is smaller than the #200 sieve)	SILTS AND CLAYS (Liquid limit less than 50)		ML	INORGANIC SILTS & VERY FINE SANDS, SILTY OR CLAYEY FINE SANDS, CLAYEY SILTS WITH SLIGHT PLASTICITY
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			OL	ORGANIC SILTS & ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS (Liquid limit greater than 50)		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILT
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH	ORGANIC CLAYS & ORGANIC SILTS OF MEDIUM-TO-HIGH PLASTICITY
HIGHLY ORGANIC SOILS			PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

LOG KEY SYMBOLS

BORING SAMPLE LOCATION	TEST-PIT SAMPLE LOCATION
WATER LEVEL (level after completion)	WATER LEVEL (level where first encountered)

CEMENTATION

DESCRIPTION	DESCRIPTION
WEAKELY	CRUMBLES OR BREAKS WITH HANDLING OR SLIGHT FINGER PRESSURE
MODERATELY	CRUMBLES OR BREAKS WITH CONSIDERABLE FINGER PRESSURE
STRONGLY	WILL NOT CRUMBLE OR BREAK WITH FINGER PRESSURE

OTHER TESTS KEY

C	CONSOLIDATION	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	DS	DIRECT SHEAR
UC	UNCONFINED COMPRESSION	T	TRIAXIAL
S	SOLUBILITY	R	RESISTIVITY
O	ORGANIC CONTENT	RV	R-VALUE
CBR	CALIFORNIA BEARING RATIO	SU	SOLUBLE SULFATES
COMP	MOISTURE/DENSITY RELATIONSHIP	PM	PERMEABILITY
CI	CALIFORNIA IMPACT	-200	% FINER THAN #200
COL	COLLAPSE POTENTIAL	Gs	SPECIFIC GRAVITY
SS	SHRINK SWELL	SL	SWELL LOAD

MODIFIERS

DESCRIPTION	%
TRACE	<5
SOME	5 - 12
WITH	>12

GENERAL NOTES

1. Lines separating strata on the logs represent approximate boundaries only. Actual transitions may be gradual.
2. No warranty is provided as to the continuity of soil conditions between individual sample locations.
3. Logs represent general soil conditions observed at the point of exploration on the date indicated.
4. In general, Unified Soil Classification designations presented on the logs were evaluated by visual methods only. Therefore, actual designations (based on laboratory tests) may vary.

MOISTURE CONTENT

DESCRIPTION	FIELD TEST
DRY	ABSENCE OF MOISTURE, DUSTY, DRY TO THE TOUCH
MOIST	DAMP BUT NO VISIBLE WATER
WET	VISIBLE FREE WATER, USUALLY SOIL BELOW WATER TABLE

STRATIFICATION

DESCRIPTION	THICKNESS
SEAM	1/16 - 1/2"
LAYER	1/2 - 12"

DESCRIPTION	THICKNESS
OCCASIONAL	ONE OR LESS PER FOOT OF THICKNESS
FREQUENT	MORE THAN ONE PER FOOT OF THICKNESS

APPARENT / RELATIVE DENSITY - COARSE-GRAINED SOIL

APPARENT DENSITY	SPT (blows/ft)	MODIFIED CA. SAMPLER (blows/ft)	CALIFORNIA SAMPLER (blows/ft)	RELATIVE DENSITY (%)	FIELD TEST
VERY LOOSE	<4	<4	<5	0 - 15	EASILY PENETRATED WITH 1/2-INCH REINFORCING ROD PUSHED BY HAND
LOOSE	4 - 10	5 - 12	5 - 15	15 - 35	DIFFICULT TO PENETRATE WITH 1/2-INCH REINFORCING ROD PUSHED BY HAND
MEDIUM DENSE	10 - 30	12 - 35	15 - 40	35 - 65	EASILY PENETRATED A FOOT WITH 1/2-INCH REINFORCING ROD DRIVEN WITH 5-LB HAMMER
DENSE	30 - 50	35 - 60	40 - 70	65 - 85	DIFFICULT TO PENETRATED A FOOT WITH 1/2-INCH REINFORCING ROD DRIVEN WITH 5-LB HAMMER
VERY DENSE	>50	>60	>70	85 - 100	PENETRATED ONLY A FEW INCHES WITH 1/2-INCH REINFORCING ROD DRIVEN WITH 5-LB HAMMER

CONSISTENCY - FINE-GRAINED SOIL

CONSISTENCY	SPT (blows/ft)	TORVANE UNTRAINED SHEAR STRENGTH (tsf)	POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH (tsf)	FIELD TEST
VERY SOFT	<2	<0.125	<0.25	EASILY PENETRATED SEVERAL INCHES BY THUMB. EXUDES BETWEEN THUMB AND FINGERS WHEN SQUEEZED BY HAND.
SOFT	2 - 4	0.125 - 0.25	0.25 - 0.5	EASILY PENETRATED ONE INCH BY THUMB. MOLDED BY LIGHT FINGER PRESSURE.
MEDIUM STIFF	4 - 8	0.25 - 0.5	0.5 - 1.0	PENETRATED OVER 1/2 INCH BY THUMB WITH MODERATE EFFORT. MOLDED BY STRONG FINGER PRESSURE.
STIFF	8 - 15	0.5 - 1.0	1.0 - 2.0	INDENTED ABOUT 1/2 INCH BY THUMB BUT PENETRATED ONLY WITH GREAT EFFORT.
VERY STIFF	15 - 30	1.0 - 2.0	2.0 - 4.0	READILY INDENTED BY THUMBNAIL.
HARD	>30	>2.0	>4.0	INDENTED WITH DIFFICULTY BY THUMBNAIL.

GeoStrata

Soil Symbols Description Key

Lewis Homes
The Ridge Development
Eden, UT
Project Number: 924-001

Plate B-18

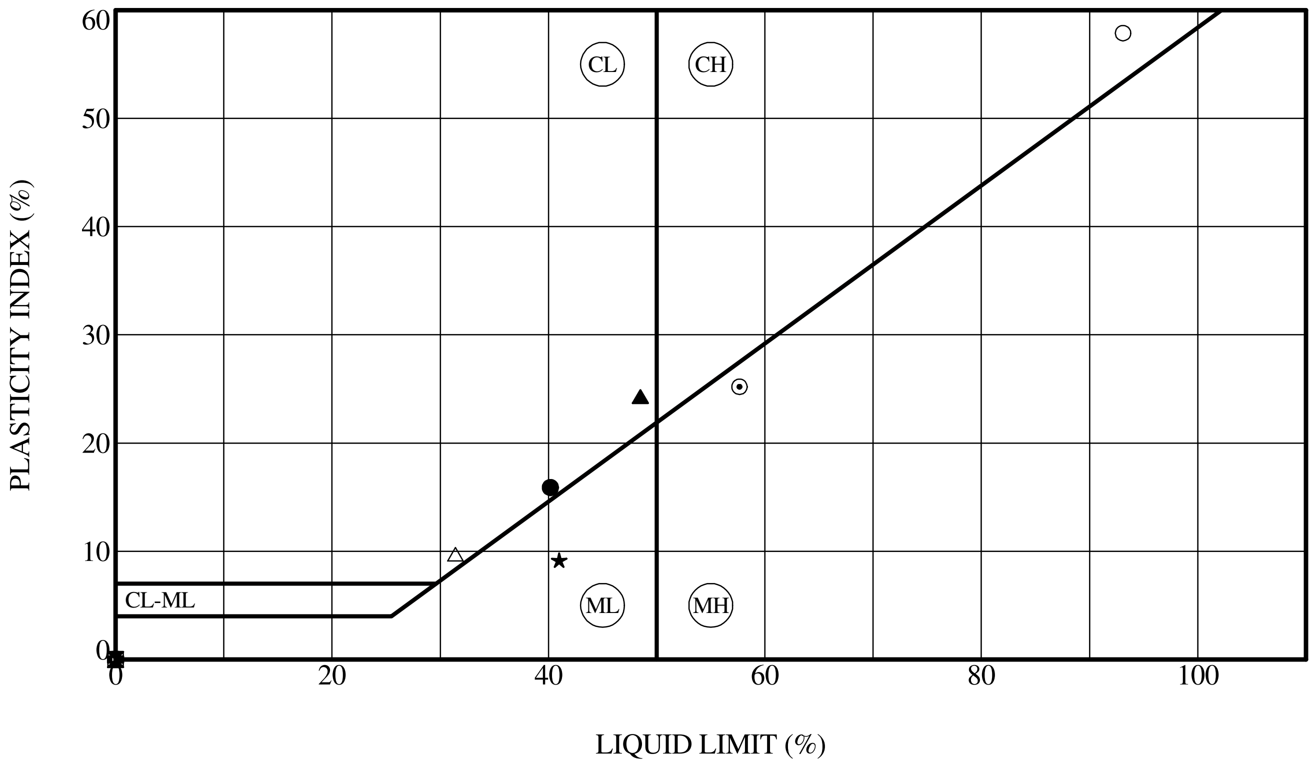
Test Pit No.	Sample Depth (feet)	USCS Soil Classification	Natural Moisture Content (%)	Natural Dry Density (pcf)	Optimum Moisture Content (%)	Maximum Dry Density (pcf)	Gradation			Atterberg		Collapse (%)	Swell (%)	CBR (%)
							Gravel (%)	Sand (%)	Fines (%)	LL	PI			
TP-1	9.0	CL					37.3		62.7	40	16			
TP-3	6.0	SM	22.8	78.1			74.7		25.3	NP	NP		0.67	
TP-5	11.0	CL					41.6		58.4	48	24			
TP-7	7.0	SM	29.7	75.0			64.9		35.1	41	9		0.46	
TP-9	4.0	MH			25.0	81.5	0.0	15.0	85.0	58	26			4.3
TP-10	6.0	SM	10.1	100.9			74.8		25.2	NP	NP	0.07		
TP-12	5.0	GM					36.0	21.8	18.7					
TP-13	10.5	CH	42.2	66.0			27.8		72.2	93.0	58.0	0.28		
TP-14	13.0	CL					6.5		93.5	31.0	9.0			
TP-15	7.0	CL	6.3	82.6									0.50	
TP-16	12.0	ML					27.3		72.7	NP	NP			
TP-17	5.0	ML					5.6	35.3	59.1	NP	NP			

GeoStrata

Lab Summary Report

Lewis Homes
The Ridge Development
Eden, UT
Project Number: 924-001

Plate C - 1



	Sample Location	Depth (ft)	LL (%)	PL (%)	PI (%)	Fines (%)	Classification
●	**TP-01**	**9.0**	**40**	**24**	**16**	**62.7**	**Sandy Lean CLAY**
⊠	**TP-03**	**6.0**	**NP**	**NP**	**NP**	**25.3**	**Silty SAND**
▲	**TP-05**	**11.0**	**48**	**24**	**24**	**58.4**	**Sandy Lean CLAY**
★	**TP-07**	**7.0**	**41**	**32**	**9**	**35.1**	**Silty SAND**
⊙	**TP-09**	**4.0**	**58**	**32**	**26**	**85.0**	**Elastic SILT with sand**
✪	**TP-10**	**6.0**	**NP**	**NP**	**NP**	**25.2**	**Silty SAND**
○	**TP-13**	**10.5**	**93**	**35**	**58**	**72.2**	**Fat CLAY with sand**
△	**TP-14**	**13.0**	**31**	**22**	**9**	**93.5**	**Lean CLAY**

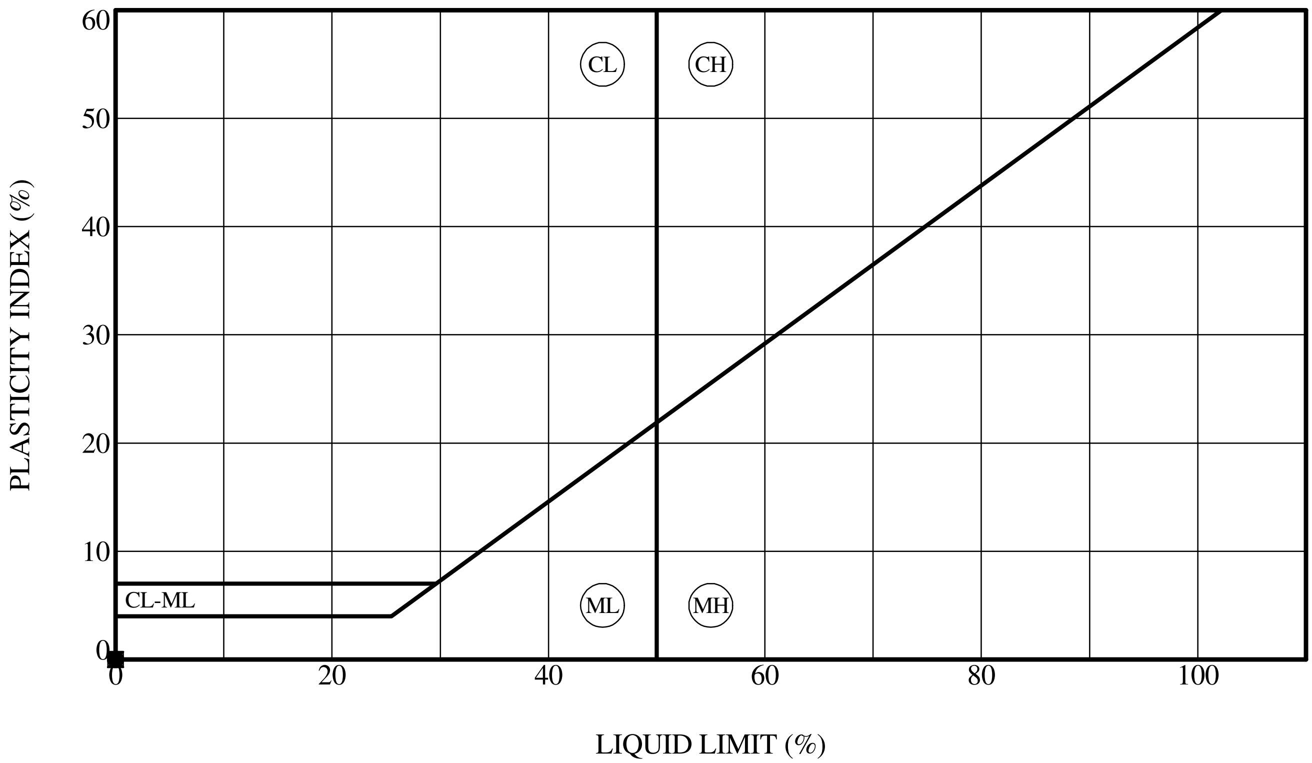
GeoStrata

ATTERBERG LIMITS' RESULTS - ASTM D 4318

Lewis Homes
The Ridge Development
Eden, UT
Project Number: 924-001

Plate

C - 2



	Sample Location	Depth (ft)	LL (%)	PL (%)	PI (%)	Fines (%)	Classification
●	**TP-16**	**12.0**	**NP**	**NP**	**NP**	**72.7**	**SILT with sand**
⊠	**TP-17**	**5.0**	**NP**	**NP**	**NP**	**59.1**	**Sandy SILT**

GeoStrata

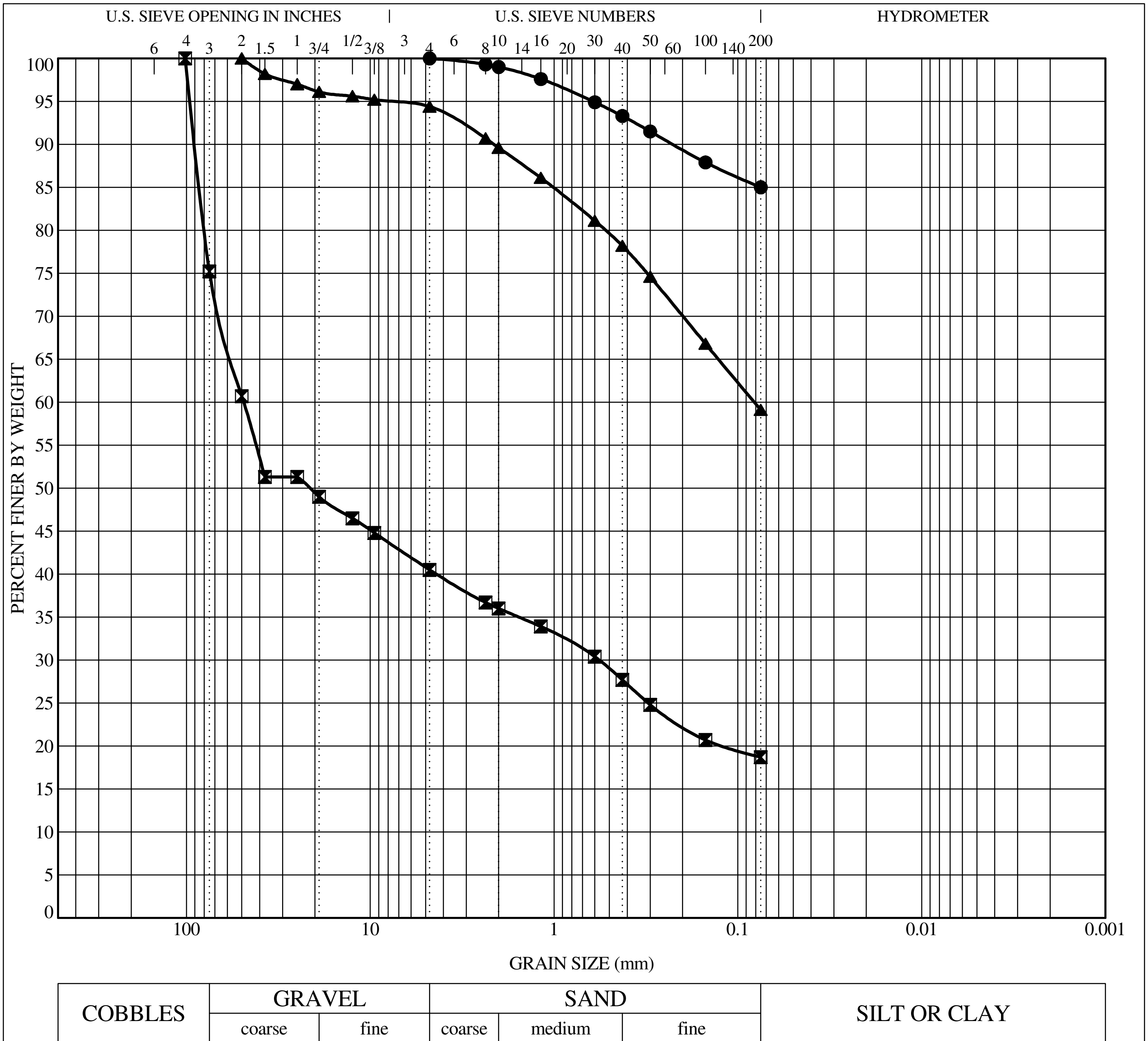
ATTERBERG LIMITS' RESULTS - ASTM D 4318

Lewis Homes
The Ridge Development
Eden, UT
Project Number: 924-001

Plate

C - 3

C_ATTERBERG TEST PIT LOGS.GPJ GEOSTRATA.GDT 12/3/13



	Sample Location	Depth	Classification	LL	PL	PI	Cc	Cu
●	**TP-09**	**4.0**	**Elastic SILT with sand**	**58**	**32**	**26**		
⊠	**TP-12**	**5.0**	**Silty GRAVEL with sand**					
▲	**TP-17**	**5.0**	**Sandy SILT**	**NP**	**NP**	**NP**		

	Sample Loctaion	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**TP-09**	**4.0**	**4.75**				**0.0**	**15.0**	**85.0**	
⊠	**TP-12**	**5.0**	**101.6**	**48.94**	**0.57**		**36.0**	**21.8**	**18.7**	
▲	**TP-17**	**5.0**	**50**	**0.081**			**5.6**	**35.3**	**59.1**	

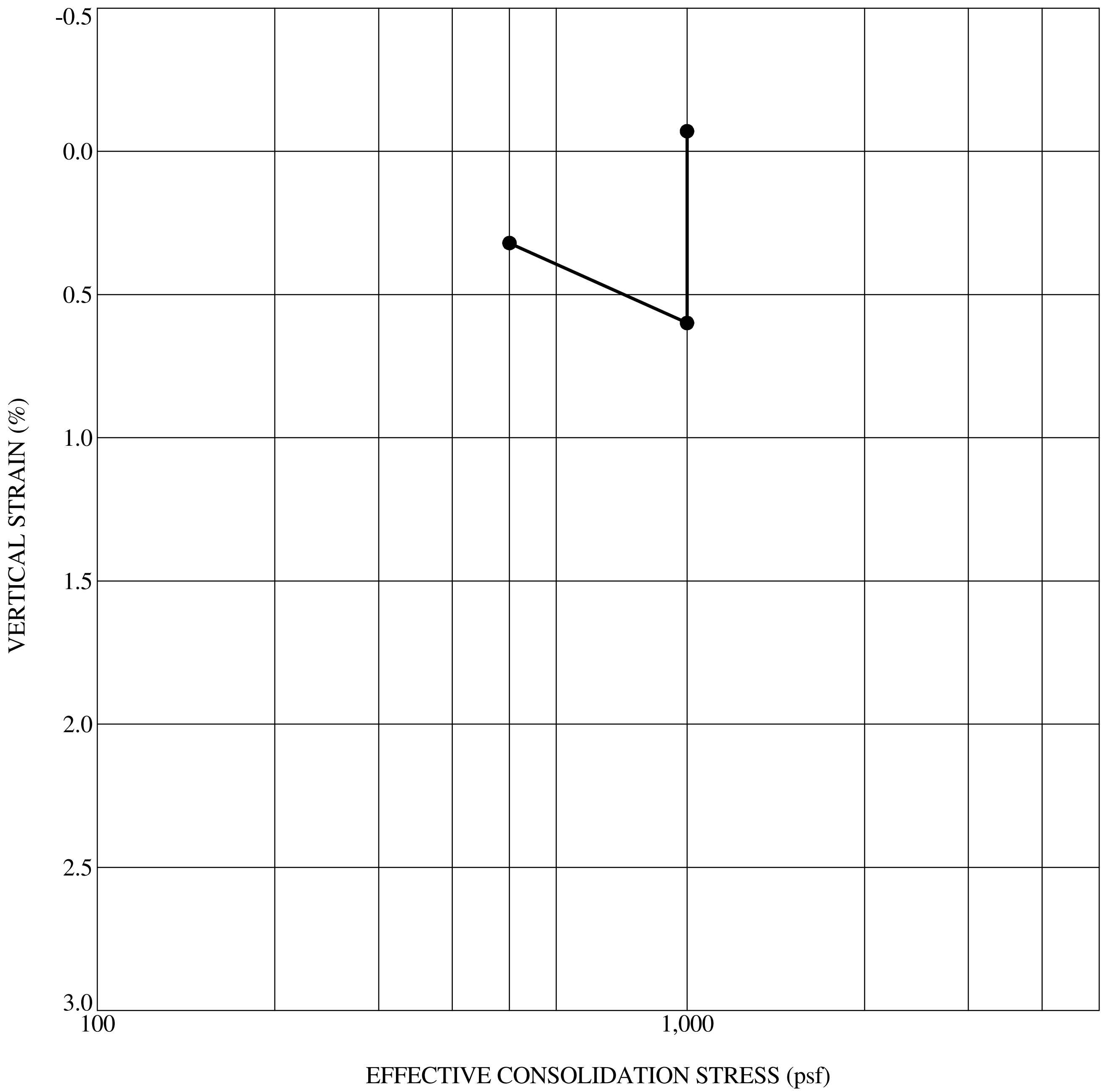
GeoStrata

GRAIN SIZE DISTRIBUTION - ASTM D422

Lewis Homes
The Ridge Development
Eden, UT
Project Number: 924-001

Plate

C - 4



	Sample Location	Depth (ft)	Classification	γ_d (pcf)	MC (%)	Inundation Load (psf)	Swell (%)	Collapse (%)
●	**TP-03**	**6.0**	**Silty SAND**	**78**	**23**	**1000**	**0.67**	**---**
⊠								
▲								
★								
⊙								

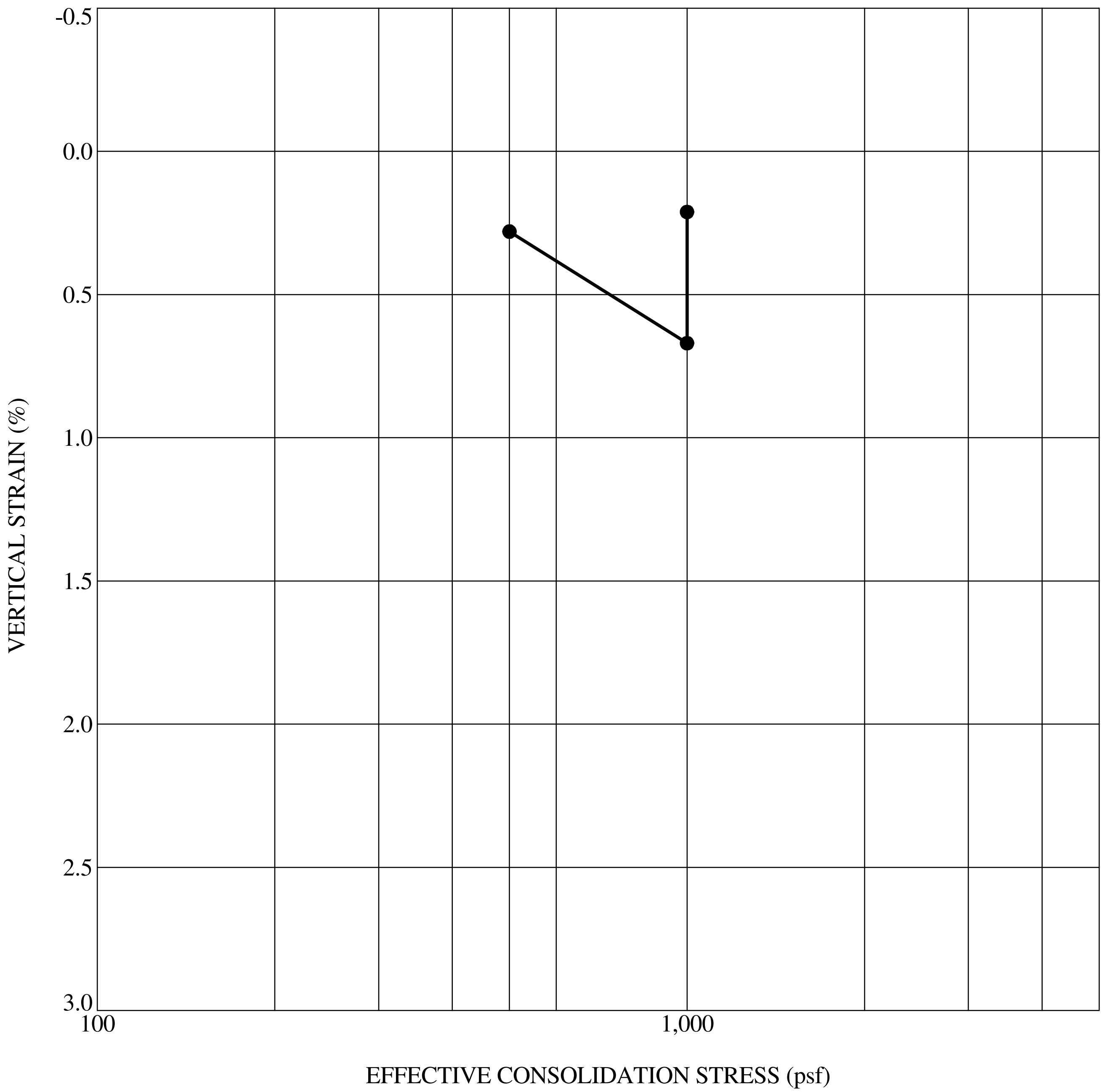
GeoStrata

1-D SWELL/COLLAPSE TEST

Lewis Homes
The Ridge Development
Eden, UT
Project Number: 924-001

Plate

C - 5



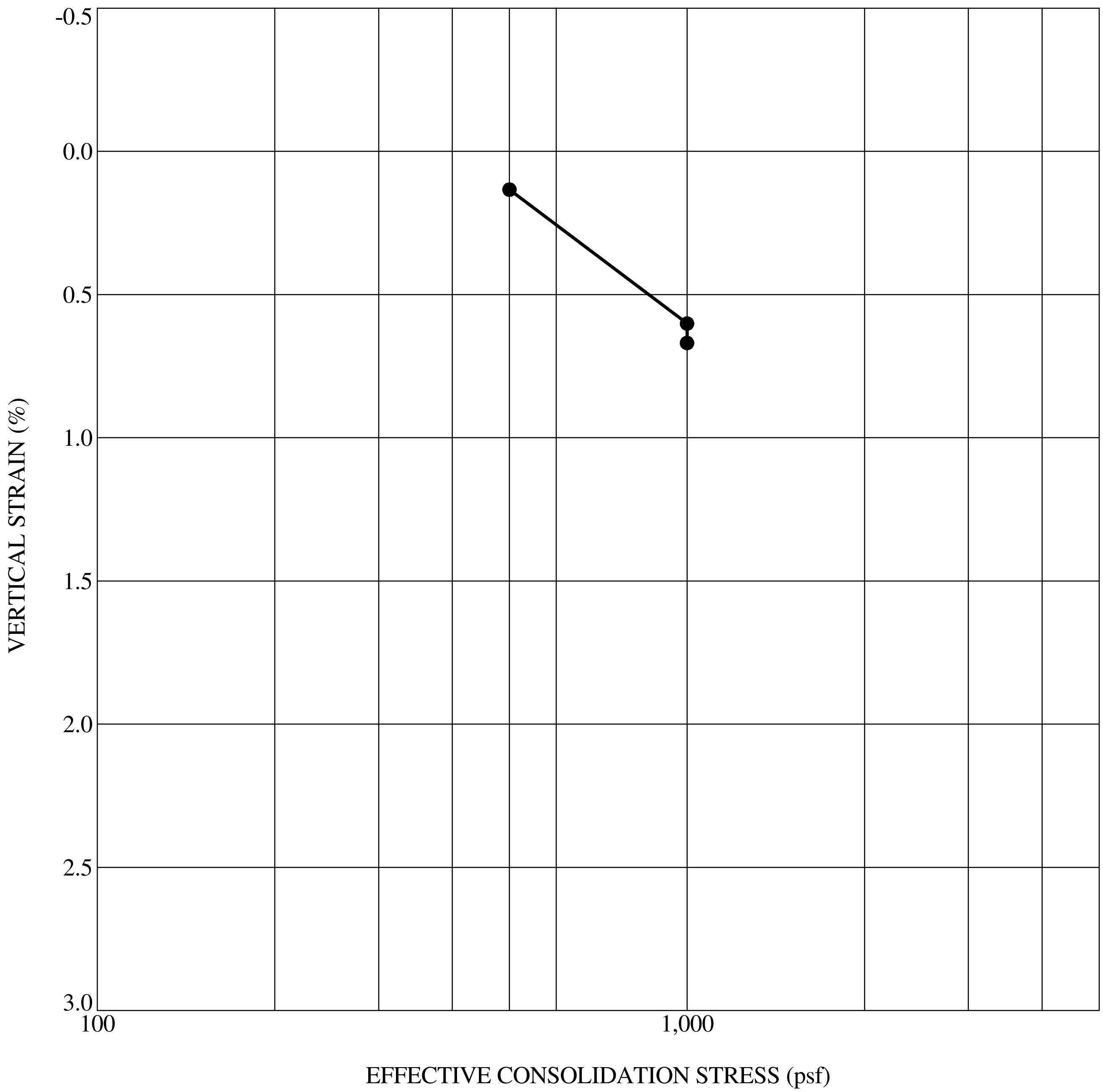
	Sample Location	Depth (ft)	Classification	γ_d (pcf)	MC (%)	Inundation Load (psf)	Swell (%)	Collapse (%)
●	**TP-07**	**7.0**	**Silty SAND**	**75**	**30**	**1000**	**0.46**	**---**
⊠								
▲								
★								
⊙								

1-D SWELL/COLLAPSE TEST

Lewis Homes
The Ridge Development
Eden, UT
Project Number: 924-001

Plate

C - 6



	Sample Location	Depth (ft)	Classification	γ_d (pcf)	MC (%)	Inundation Load (psf)	Swell (%)	Collapse (%)
●	**TP-10**	**6.0**	**Silty SAND**	**101**	**10**	**1000**	**---**	**0.07**
⊠								
▲								
★								
⊙								

GeoStrata

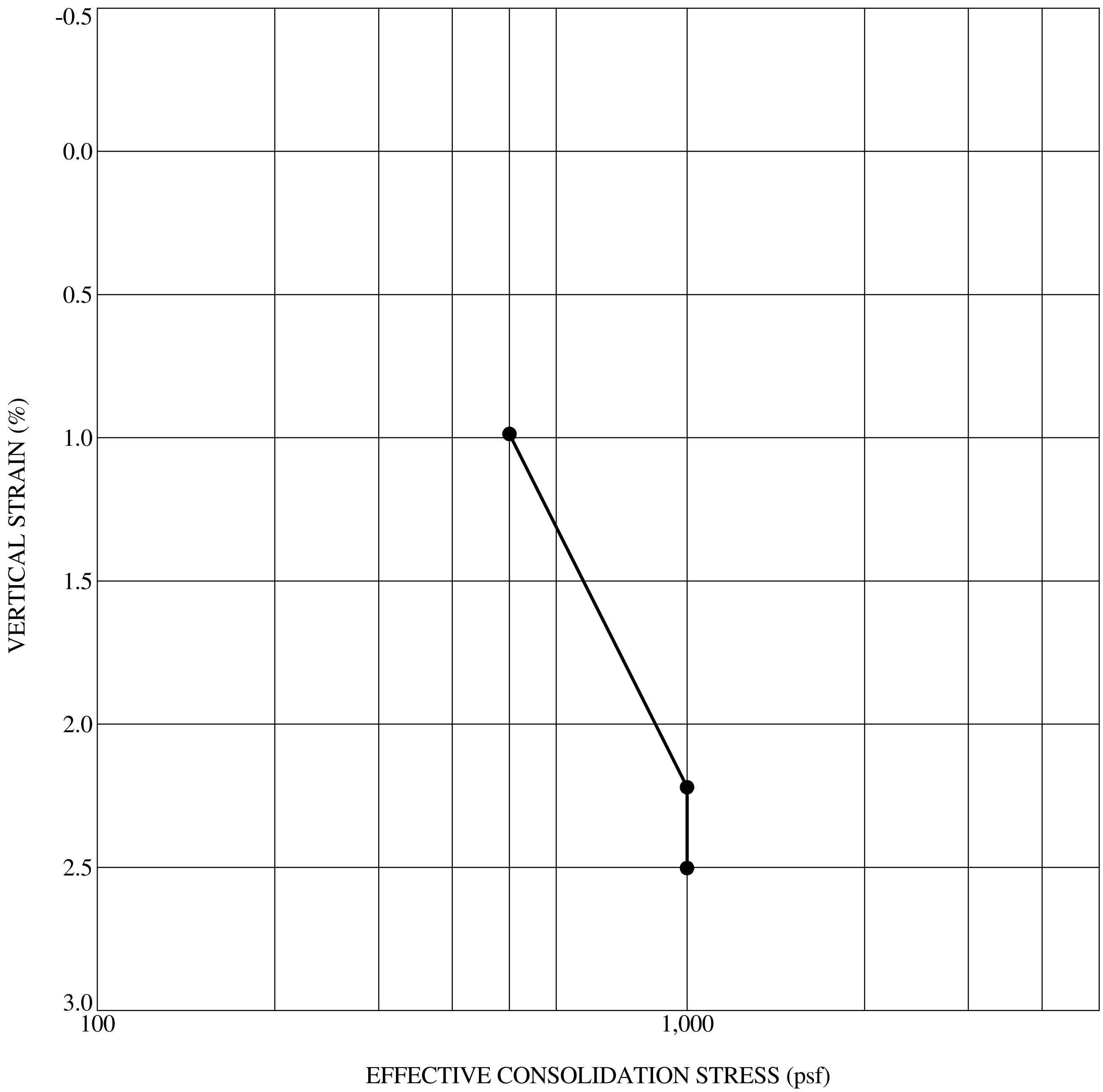
1-D SWELL/COLLAPSE TEST

Lewis Homes
The Ridge Development
Eden, UT
Project Number: 924-001

Plate

C - 7

C_SWELL/COLLAPSE TEST PIT LOGS.GPJ GEOSTRATA.GDT 12/3/13



	Sample Location	Depth (ft)	Classification	γ_d (pcf)	MC (%)	Inundation Load (psf)	Swell (%)	Collapse (%)
●	**TP-13**	**10.5**	**Fat CLAY with sand**	**66**	**42**	**1000**	**---**	**0.28**
⊠								
▲								
★								
⊙								

1-D SWELL/COLLAPSE TEST

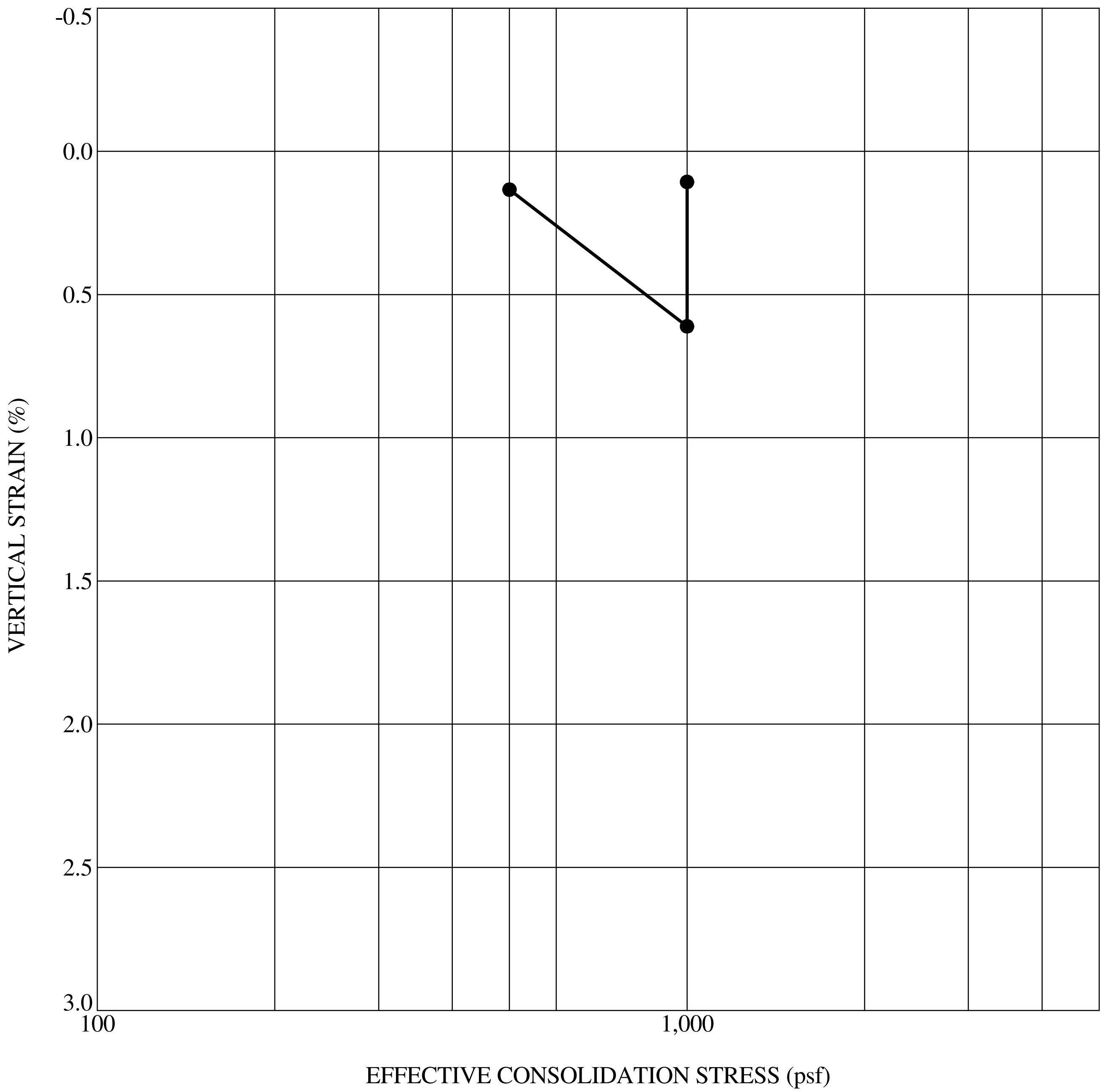
GeoStrata

Lewis Homes
The Ridge Development
Eden, UT
Project Number: 924-001

Plate

C - 8

C_SWELL/COLLAPSE TEST PIT LOGS.GPJ GEOSTRATA.GDT 12/3/13



	Sample Location	Depth (ft)	Classification	γ_d (pcf)	MC (%)	Inundation Load (psf)	Swell (%)	Collapse (%)
●	**TP-15**	**7.0**	**Lean CLAY**	**83**	**6**	**1000**	**0.50**	**---**
⊠								
▲								
★								
⊙								

GeoStrata

1-D SWELL/COLLAPSE TEST

Lewis Homes
The Ridge Development
Eden, UT
Project Number: 924-001

Plate

C - 9

Source of Material **TP-09 4.0 ft.**

Material Description **Elastic SILT with sand**

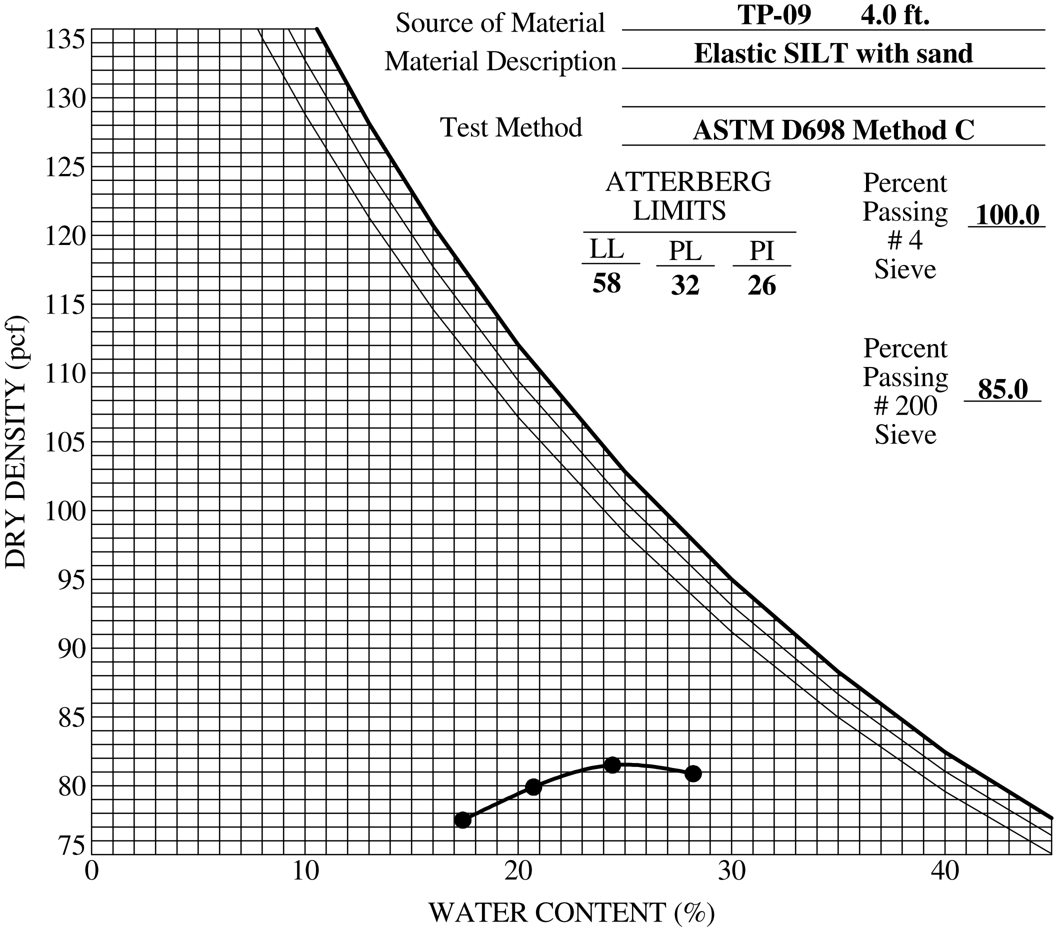
Test Method **ASTM D698 Method C**

ATTERBERG LIMITS

LL	PL	PI
58	**32**	**26**

Percent Passing # 4 Sieve **100.0**

Percent Passing # 200 Sieve **85.0**



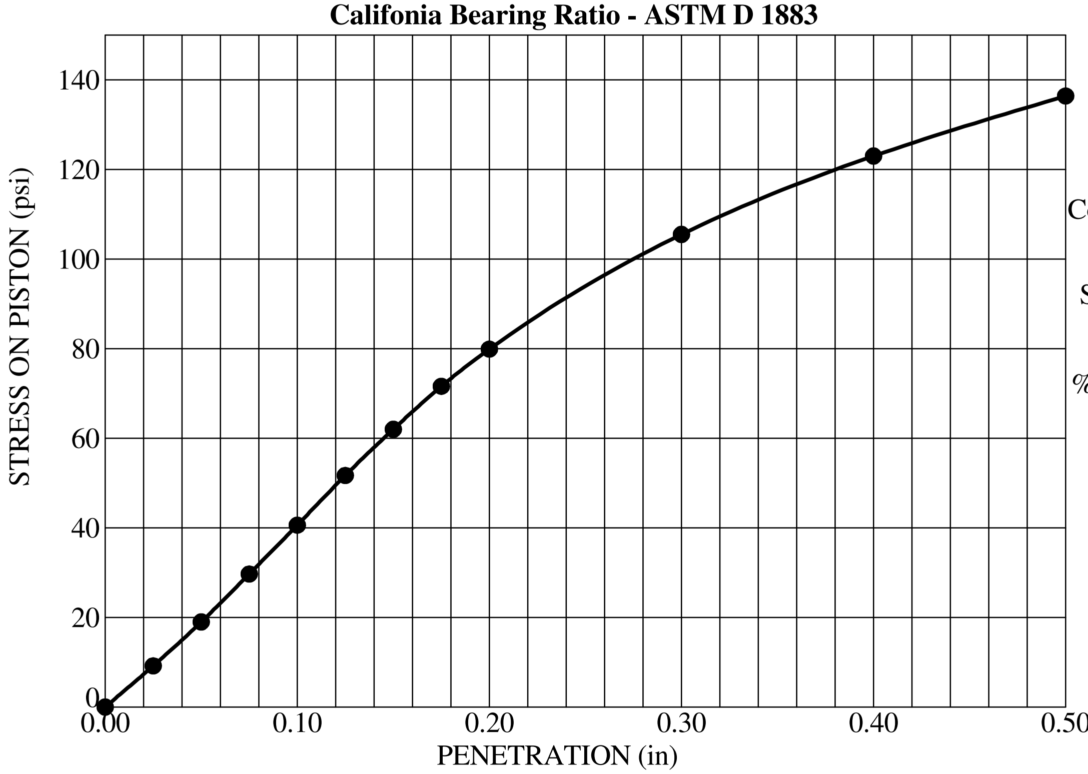
TEST RESULTS

Maximum Dry Density	**81.5**	**(pcf)**
Optimum Water Content	**25.0**	**(%)**
Percent Rock	**---**	**(%)**
Corrected Maximum Dry Density	**---**	**(pcf)**
Corrected Optimum Water Content	**---**	**(%)**

Curves of 100% Saturation for Specific Gravity Equal to:

2.60, 2.70, 2.80

Califonia Bearing Ratio - ASTM D 1883



Dry Density	**79.1**	**(pcf)**
Relative Compaction	**97**	**(%)**
Surcharge	**50**	**(psf)**
% Standard CBR	**4.30**	
Swell	**3.86**	**(%)**

COMPACTION AND CBR TEST

GeoStrata

Lewis Homes
The Ridge Development
Eden, UT
Project Number: 924-001

Plate
C - 10

Seismic Ground Motion Values: USGS, 2009; Dobry and others, 2000

Project: The Ridge Development
Geotechnical Investigation
Project No.: 924-001
Project Location: Eden
Date: Tuesday, December 3, 2013
Engineer: DJB

Site Coordinates:
Latitude: **41.3218** degrees
Longitude: **-111.8233** degrees

Exceedance Probability: **2** %
Exposure Time: **50** years
S_s = **1.039** From USGS 2002 Probabilistic Seismic
S_1 = **0.388** Hazard Maps for 2475-year Return Period

Site Soil Class: **C** (Very dense soil and soft rock)
F_a = 1.00
F_v = 1.42

Site Class	Values of Site Factor, F_a, for Short-Period Range of Spectral Acceleration				
	$S_S \leq 0.25$	$S_S = 0.5$	$S_S = 0.75$	$S_S = 1.0$	$S_S \geq 1.25$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	*	*	*	*	*

(*)Site-specific geotechnical investigation and dynamic site response analyses shall be performed

Site Class	Values of Site Factor, F_v, for Long-Period Range of Spectral Acceleration				
	$S_1 \leq 0.1$	$S_1 = 0.2$	$S_1 = 0.3$	$S_1 = 0.4$	$S_1 \geq 0.5$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.7	1.6	1.5	1.4	1.3
D	2.4	2.0	1.8	1.6	1.5
E	3.5	3.2	2.8	2.4	2.4
F	*	*	*	*	*

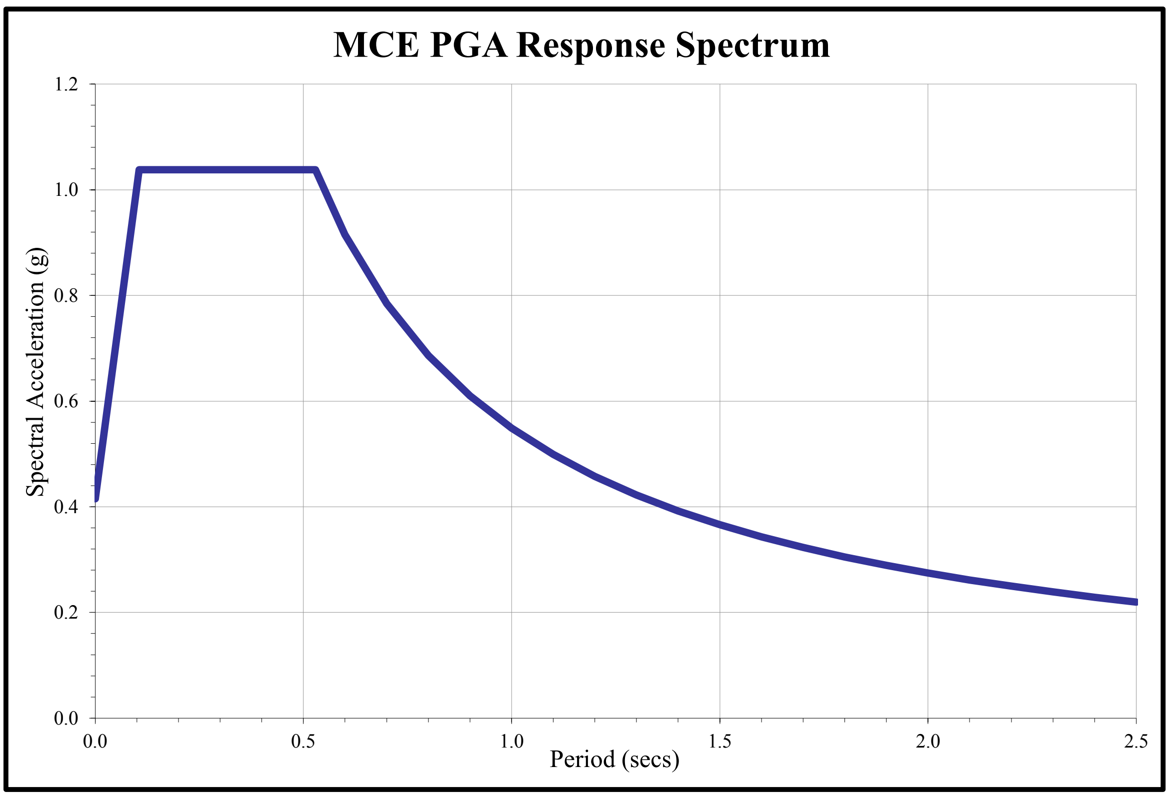
(*)Site-specific geotechnical investigation and dynamic site response analyses shall be performed

Adjusted for Site Conditions:
$S_{MS} = F_a \times S_S$ = (1.00 x 1.04) = 1.04 g
$S_{M1} = F_v \times S_1$ = (1.42 x 0.39) = 0.55 g

MCE PGA = 0.4 x S_{MS} = (0.4 x 1.04) = **0.42 g**
MCE $T_0 = 0.2 \times (S_{M1}/S_{MS})$ = (0.2 x [0.55/1.04]) = 0.11 secs
MCE $T_S = (S_{M1}/S_{MS})$ = (0.55/1.04) = 0.53 secs

Response Time Step, ΔT = **0.1**

Period (sec)	MCE Spectral Acceleration (g)
0.00	0.42
0.11	1.04
0.53	1.04
0.60	0.92
0.70	0.78
0.80	0.69
0.90	0.61
1.00	0.55
1.10	0.50
1.20	0.46
1.30	0.42
1.40	0.39
1.50	0.37
1.60	0.34
1.70	0.32
1.80	0.31
1.90	0.29
2.00	0.27
2.10	0.26
2.20	0.25
2.30	0.24
2.40	0.23
2.50	0.22



D-1

SUMMARY OF GEOLOGIC HAZARDS

The Ridge Development **Project Number 924-001**

Hazard	Hazard Rating*				Further Study Recommended**
	Not Assessed	Probable	Possible	Unlikely	
Earthquake					
Ground Shaking		X			See Geotechnical Report
Surface Faulting				X	
Tectonic Subsidence				X	
Liquefaction				X	See Geotechnical Report
Slope Stability				X	
Flooding (Including Seiche)				X	See Geotechnical Report
Slope Failure					
Rock Fall				X	
Landslide				X	See Geotechnical Report
Debris Flow				X	
Avalanche	X				
Problem Soils					
Collapsible				X	
Soluble				X	
Expansive				X	
Organic				X	
Piping				X	
Non-Engineered Fill				X	
Erosion				X	
Wind Blown Sand				X	
Mine Subsidence				X	
Shallow Bedrock		X			See Geotechnical Report
Shallow Groundwater		X			See Geotechnical Report
Flooding					
Streams			X		See Geotechnical Report
Alluvial Fans				X	
Lakes				X	See Geotechnical Report
Dam Failure				X	
Canals/Ditches				X	
Radon	X				

* Hazard Rating :
Not assessed - report does not consider this hazard and no inference is made as to the presence or absence of the hazard at the site
Probable -Evidence is strong that the hazard exists and mitigation measures should be taken
Possible - hazard may exist, but the evidence is equivocal, based only on theoretical studies, or was not observed and furthes study is necessary as noted
Unlikely - no evidence was found to indicate that the hazard is present, hazard not known or suspected to be present

Further Study :
E - geotechnical/engineering, H - hydrologic, A - Avalanche, G - Additional detailed geologic hazard study out of the scope of this study