GeoStrata

Geotechnical Investigation

Ballard Townhouse Development

Approximately 189 South 2500 East
Ballard, Utah

March 10, 2025

Prepared For:

Phase One Properties, LLC
Attention: Rob McNeel
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American Fork, Utah 84003

GeoStrata Job No. 1843-003

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TABLE OF CONTENTS

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APPENDICES

1.0 EXECUTIVE SUMMARY

This report presents the results of a geotechnical investigation conducted for the proposed 5.5-acre residential development to be constructed at approximately 189 South 2500 East in Ballard, Utah. The purposes of this investigation were to assess the nature and engineering properties of the subsurface soils at the site and to provide recommendations for general site grading and the design and construction of foundations, slab-on-grades, and exterior concrete flatwork, 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 through the advancement of 6 exploratory test pits at strategic locations across the proposed development. The test pits extended to a depth of 8 to 9 feet below existing site grade. Based on our observations and geologic literature review, the subject site was overlain by 1 foot of sandy to silty topsoil containing occasional organic materials. Underlying the topsoil, we encountered deposits mapped as consisting of Holocene to Upper Pleistocene-aged alluvial and colluvial deposits. Groundwater was not encountered in any of the test pits advanced as part of this investigation.

The proposed structures may be supported on foundation systems consisting of conventional strip and/or spread footings. Strip and spread footings should be a minimum of 20 and 36 inches wide, respectively, and shallow exterior footings should be at least 36-inches below final grade for frost protection and confinement. Conventional strip and spread footings, founded entirely on a minimum of 18-inches of properly placed and compacted structural fill that extends to uniform, undisturbed native soil or undisturbed bedrock, or structural fill may be proportioned for a **maximum net allowable bearing capacity of 1,600 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.

A laboratory obtained a CBR value of 5.0 for near-surface soils was utilized in the pavement design. Based on assumed traffic loads, a pavement section of 3 inches of asphalt over 10 inches of untreated base course is recommended for the proposed roadways.

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.

IMPORTANT INFORMATION ABOUT THIS GEOTECHNICAL-ENGIEERING REPORT:

Do not rely on the executive summary. The executive summary omits several details, any one of which could be crucial. Read and refer to the report in full. Do not rely on this report if this report was prepared for a different client, different project, different purpose, different site, and/or before important events occurred at the site or adjacent to it. All recommendations in this report are confirmation dependent. A two-page document prepared by GBA explains these items with greater detail is found in Appendix D (Plates D-1 and D-2).

2.0 INTRODUCTION

2.1 PURPOSE AND SCOPE OF WORK

This report presents the results of a geotechnical investigation conducted for the proposed 5.5-acre residential development to be developed at approximately 189 South 2500 East in Ballard, Utah. The purposes of this investigation were to provide estimates of the nature and engineering properties of the subsurface soils at the site and to provide recommendations for general site grading and the design and construction of foundations, slab-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 February 6, 2025, and your signed authorization.

The recommendations contained in this report are subject to the limitations presented in the "Limitations" section of this report (<u>Section 7.1</u>).

2.2 PROJECT DESCRIPTION

The subject property is located at approximately 189 South 2500 East in Ballard, Utah (See Plate A-1, *Site Vicinity Map*). Construction plans were not available at the time this report was prepared; however, our understanding of the proposed development is based on information provided by the Client as well as contained in a conceptual site plan showing the proposed outline of the development. Based on this information, we understand that the development is to consist of one to two-story wood framed structures of townhomes with basements (if feasible) founded on conventional strip or spread footings. We anticipate footing loads on the order of 2 to 3 kips per lineal foot and column loads of up to 50 kips. The development will also include paved parking and driving areas, landscaped areas and a stormwater detention basin.

3.0 METHODS OF STUDY

3.1 FIELD INVESTIGATION

As part of this investigation, subsurface soil conditions were explored by excavating six (6) exploratory test pits at the site extending to depths ranging from 8 to 9 feet below the site grade as it existed at the time of our investigation. The approximate locations of the explorations are shown on the *Exploration Location Map*, Plate A-2 in Appendix A. Exploration points were selected to provide a representative cross section of the subsurface soil 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 through B-6 in Appendix B. A *Key to USCS Soil Symbols and Terminology* is presented on Plate B-7.

The test pits were advanced using a Construction King 580SK Turbo backhoe. Disturbed subgrade samples of the native soils were retrieved from the test pits through use of resealable bags and buckets, whereas relatively undisturbed samples were obtained through collecting block samples. 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) members of our geotechnical staff and reviewed by the Geotechnical Engineer.

3.2 LABORATORY INVESTIGATION

Geotechnical laboratory tests were conducted on selected 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)
- Percent of Fines by Washing (ASTM D1140)
- Atterberg Limits Test (ASTM D4318)
- 1-D Collapse/Swell Potential Test (ASTM D4546)
- 1-D Consolidation of Soil Test (ASTM D2435)
- Density-Moisture Relationship Test (Proctor Test) (ASTM D698)
- California Bearing Ratio Test (CBR) (ASTM D1883)

- Water-soluble sulfate concentration test
- Soil Resistivity and pH testing

The results of laboratory tests are presented on the test pit logs in Appendix B (Plates B-1 to B-6), the Lab Summary Report (Plate C-1), and on the test result plates presented in Appendix C (Plates C-2 through 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

The subject property is located at an elevation of approximately 5,025 to 5,030 feet above mean sea level (MSL) measured utilizing Google Earth elevation data. The topography of the site slopes down towards the south, having a total site topographic relief of approximately 5 feet. The majority of the subject property currently exists as undeveloped lots in a relatively natural state. A ditch of approximately 2 feet in depth is present along the southern portion of the property that extends to the eastern and western borders of the site. The site is covered in moderate amounts of vegetation consisting of low grass and brush, as well as occasional trees, particularly on the western side of the property. The subject site is bound to the north by an existing commercial development, to the west by 2500 East, a paved 2-lane roadway, and to the south and east by undeveloped lots.

4.2 SUBSURFACE CONDITIONS

As previously discussed, the subsurface soil conditions were explored at the site by advancing six (6) test pits at representative locations across the subject property. The test pits extended to a depth of 8 to 9 feet below the existing site grade as well as one test hole advanced to a depth of 3 feet below the site grade for infiltration testing. Subsurface soil conditions were logged using the United Soils Classification System (USCS) at the time of the investigation and are included on the Test Pit Logs in Appendix B (Plates B-1 through B-6). 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 subject site was overlain by approximately 1-foot of sandy and silty topsoil containing occasional organic materials. Underlying the topsoil, we encountered deposits mapped by Sprinkel (2007) as consisting of Quaternary-aged alluvial and colluvial deposits. The mapping completed by Sprinkel describes these deposits as follows;

"Unconsolidated mud, silt, sand, and gravel (pebble to cobble clasts) deposited by streams, sheet wash and slope creep, bedded to nonstratified, moderately sorted to unsorted with angular to subrounded clasts, locally derived from bedrock units or other unconsolidated deposits…"

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These deposits persisted to the full depth of the explorations completed (8 to 9 feet). Although not encountered during our field investigation, the possibility exists for bedrock materials to be encountered at depths greater than those explored. Nearby exposures of the underling bedrock deposits are mapped as being located on properties ¾ of a mile to the northwest and are mapped on neighboring properties as consisting of the Eocene-aged Brennan Basin member of the Duchesne River Formation (map symbol Tdb). The mapping completed by Sprinkel describes these deposits as follows;

"Light- to medium-red, and yellowish-gray, fine- to medium-grained lithic sandstone and siltstone with minor amounts of mudstone and conglomerate, contains well developed paleosols.."

Descriptions of the soil units encountered are provided below:

<u>Topsoil:</u> Where observed, these deposits consist of moist, brown, SILT with sand (ML) and to a lesser degree, Silty SAND (SM). This unit also has an organic appearance and texture, with roots throughout. Topsoil was encountered in each of the test pits excavated as part of this investigation and is expected to overlie the majority of the site.

<u>Holocene to Upper Pleistocene Younger Alluvial and Colluvial Deposits:</u> Where observed, these deposits generally consisted of interbedded fine-grained and coarse-grained sediments. The coarse-grained sediments encountered at the subject site consisted of medium dense to very dense, moist, brown Silty SAND (SM) and Clayey SAND (SC). The sandy soils were generally fine- to medium-grained, and the fine-grained matrix of these soils were generally non-plastic. The fine-grained portion of the subsurface soils encountered as part of this investigation consisted of stiff to medium stiff, moist, brown to light brown Lean CLAY with sand (CL). These fine-grained sediments typically had low to no plasticity.

The stratification lines shown on the enclosed Test Pit logs represent the approximate boundary between soil types (Plates B-1 to B-6). 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

Groundwater was not encountered in any of the test pits advanced as part of this investigation. 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 raise several feet seasonally depending on the time of year. Groundwater is not expected to impact this development.

4.2.3 Collapse Potential

Collapse (often referred to as "hydro-collapse") is a phenomena whereby undisturbed soils exhibit volumetric strain and consolidation upon wetting under increased loading conditions. Collapsible soils can cause differential settling of structures and roadways. Collapsible soils do not necessarily preclude development and can be mitigated by over-excavating porous, potentially collapsible soils and replacing with engineered fill and by controlling surface drainage and runoff. For some structures that are particularly sensitive to differential settlement, or in areas where collapsible soils are identified at great depth, a deep foundation system should be considered.

Soils that have potential to collapse under increased loading and moisture conditions are typically characterized by a pinhole structure and relatively low unit weights. In general, potentially collapsible soils are observed in fine-grained soils that include clay and silt, although collapsible soils may include sandy soils. Results of our laboratory testing indicated that the near-surface sandy soils have a low to medium potential to collapse upon wetting and loading, with collapse measurements from 0.16 to 2.08 percent under a load of 1,500 psf. As a result, it is anticipated that the native fine-grain soils encountered at or below footing elevation will display moisture-sensitivity characteristics. We recommend all foundations be over-exacted by 18-inches and be replaced by properly placed and compacted structural fill (See Section 6.2.4)

4.2.4 Infiltration Testing Results

At the request of the client, GeoStrata completed infiltration testing for the design of the proposed stormwater detention basin. The infiltration test was conducted in test pit TP-6 at a depth of 3 feet below the existing site grade. The infiltration test hole was hand augured and filled with clean water to a water head height of 12-inches. The water head height was maintained at 12-inches during the pre-soaking phase of the test. The native soil condition at this depth consisted of medium stiff, moist, and brown Lean CLAY with sand (CL). Once full saturation of the native soil was achieved, the drop in water height was measured over time until a normalized infiltration rate was observed. The approximate location of the test pit can be found on Plate A-2, *Exploration Location Map*. It should be noted that testing was performed using clean water. Sediment collected from runoff may reduce the performance of the drain resulting in the observed field infiltration rate being slower than the measured infiltration rate. If possible, sediment should be settled/filtered out of the flow prior to entering the designed drainage area. The results of the infiltration test can be found on the table below.

Ballard Townhouse Development Ballard, Utah Location: TP-6 @ 3' Soil Type: Lean CLAY with sand (CL) Hole Depth = 12 inches, Hole Diameter = 4 inches				
Depth (ft)	**Time Difference (minutes)**	**Depth Difference (inches)**	**Infiltration Rate**	
			(min/in)	**(in/hour)**
3	25	Presoak	N/A	N/A
3	5	¾	6.7	9
3	5	¾	6.7	9
3	5	⅝	10	6
3	5	½	8	7.5
3	5	½	10	6
3	5	½	10	6
3	5	½	10	6
3	5	½	10	6
		Final Reading	**10**	**6**

5.0 GEOLOGIC CONDITIONS

5.1 GEOLOGIC SETTING

The site is located in Ballard, Utah at an elevation of approximately 5,025 to 5,030 feet above mean sea level within the western portion of the Uinta Basin. The Uinta Basin can be classified as a structural, depositional, or a topographic basin, and has an area of approximately 7,000 square miles. The basin is bounded on the north by the Uinta Mountains, on the west by the Wasatch Range, on the south by the Roan Cliffs, and on the east by the Douglas Creek Arch. Structurally, the Uinta Basin is a sharply asymmetric feature that that was produced by the Laramide Orogeny, and during the Eocene, large amounts of sediments from adjacent topographically high areas were deposited in various types of lacustrine and fluvial environments. These sediments which are assigned to the Wasatch, Green River, and Unita Formations, are perhaps more than 15,000 feet thick near the center of the basin (Cashion, 1967).

The near surface geology of the subject site is dominated by sediments, which were deposited within the last 10,000 years by alluvial processes weathering the relatively soft Eocene-aged Duchesne River Formation (Sprinkel, 2007). Surface sediments at the site are mapped as consisting of mixed alluvial and colluvial deposits overlaying relatively shallow bedrock deposits.

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, Hecker, 1993). The site is located approximately 61 miles east of the nearest mapped portion of the Strawberry Fault. The Strawberry Fault is a normal fault zone located along the eastern side of Strawberry Valley in the Wasatch hinterlands. This fault zone is thought to have experienced two to three events in the last 15,000 to 30,000 years, the most recent in the middle Holocene. The site is also located approximately 59 miles southeast of the nearest mapped portion of the Bear River Fault Zone. The Bear River Fault Zone is a complex Holocene normal fault zone in the Bear River drainage in Wyoming and Utah. These generally north-trenching faults are located on the west flank of the Uinta Mountains in Utah and are thought to have been last active approximately 5,000 years ago. Each of the faults listed above show evidence of

Holocene-aged movement and is therefore 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, 2018).

Spectral responses for the Risk-Targeted Maximum Considered Earthquake (MCER) are shown in the table below. These values generally correspond to a one percent probability of structure collapse in 50 years for a “firm rock” site. To account for site effects, site coefficients which vary with the magnitude of spectral acceleration are used. Based on geologic mapping completed for the subject site as well as on our field explorations advanced to 9-feet, it is our opinion that this location is best described as a Site Class D The spectral accelerations are calculated based on the site’s approximate latitude and longitude of 40.2993° and -109.9514˚ respectively and the Seismic Design Maps web-based application at https://seismicmaps.org/.

Description	**Value**
Site Class	D
S_s - MCE_R ground motion (period – 0.2s)	0.303
S_1 - MCE_R ground motion (period – 1.0s)	0.086
F_a - Site amplification factor at 1.0s	1.557
F_v - Site amplification factor at 1.0s	2.4
PGA - MCE_G peak ground acceleration	0.175
PGA_M – Site modified peak ground acceleration	0.254

It should be noted that our investigation did not include a site-specific ground motion hazard analysis, and a Site Class D has been assigned utilizing available geologic mapping and based on our observations made of the subject property. The seismic parameters presented herein may be used for design of the proposed structures provided that structural design allows for the ground motion hazard analysis exception in ASCE 7-16 Section 11.4.8. Alternatively, GeoStrata may be contacted to complete a ground motion hazard analysis in accordance with ASCE 7-16 Chapter 21.

5.3 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.

Liquefaction potential mapping has not been completed for the subject area. However, based on the relatively low anticipated seismic accelerations and significant fine-grained component of the near-surface soils, and as discussed in Section 4.2.2 of this report, groundwater was not encountered in any of the explorations completed as part of our investigation (a maximum depth of 9 feet), it is our opinion that the potential for liquefaction-induced settlement to impact the proposed development is very low.

6.0 ENGINEERING CONCLUSIONS AND RECOMMENDATIONS

6.1 GENERAL CONCLUSIONS

Supporting data upon which the following recommendations are based has 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.

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, general site grading is recommended to provide proper support for foundations, exterior concrete flatwork, and concrete slab-on-grade. Site grading is also recommended to provide proper drainage and moisture control on the subject property and to aid in preventing movements and differential settlement of foundations because of variations in subgrade moisture conditions.

6.2.1 General Site Preparation and Grading

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

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6.2.2 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 are classified as Type C soils. Deeper excavations, if required, should be constructed with side slopes no steeper than one and one- and one-half horizontal to one vertical (1.5H:1V). Wet conditions should be anticipated side slopes will likely need to be further flattened to maintain slope stability. Alternatively, shoring or trench boxes may be used to improve safe working 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.

6.2.3 Soft Soil Stabilization

Although unlikely, soft or pumping soils may be exposed in excavations at the site. It is recommended that all subgrade surfaces beneath proposed structures, pavements, and flat work concrete should be proof rolled with 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 Mirafi RS280i or prior approved equivalent. The filter fabric should consist of a Mirafi 140N, or equivalent as approved by the Geotechnical Engineer.

6.2.4 Structural Fill and Compaction

All fill placed for the support of structures, concrete flatwork or pavements should consist of structural fill. Structural fill may consist of native granular soils. Onsite native fine-grained soils may likewise be utilized as structural fill, although the contractor should be aware that the native silt soils may be very difficult to moisture condition and compact. The contractor should have confidence that the anticipated method of compaction will be suitable for the type of structural fill used as the fine-grained soils may be difficult to moisture condition and compact to the specified density. All structural fill should be free of vegetation, debris or frozen material, and should contain no inert materials larger than 4 inches nominal size. Alternatively, an imported structural fill meeting the specifications below may be used.

Imported structural fill should consist of a relatively well-graded granular soil with a maximum of 50 percent passing the No. 4 sieve and a maximum fines content (minus No.200 mesh sieve) of 25 percent. Fill material potion finer than the No. 40 sieve should have a liquid limit (LL) less than 35 and a plasticity index (PI) less than 25. The contractor should anticipate testing all soils used as structural fill frequently to assess the maximum dry density, fines content, and moisture content, etc.

Grain Size	Percent Passing
4-inch	100
2-inch	85 to 100
No. 4	15 to 50
No. 200	< 25
Liquid Limit (LL)	<35
Plasticity Index (PI)	<15

All structural fill soils should be approved by the Geotechnical Engineer prior to placement. Earth materials not meeting the aforementioned criteria may be suitable for use as structural fill; however, such material should be evaluated on a case-by-case basis and should be approved by the Geotechnical Engineer prior to use. These requirements for structural fill meet the needs of the site; however, regulating entities including special service districts, cities etc. may require the use of a predefined structural fill for use in their utility corridors/trenches. The contractor should be aware of the special requirements of structural fill by these regulating entities.

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 should be compacted to at least 95% of the maximum dry density, as determined by ASTM D-1557. The moisture content should be at or slightly above the optimum moisture content 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 and pavements, should be within 3% of the optimum moisture content when placed and compacted to at least 95% of the maximum dry density 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 optimum moisture content when placed and compacted to at least 95% of the maximum dry density as determined by ASTM D-1557. All other trenches, in landscape areas, should be backfilled and compacted to at least 90% of the maximum dry density (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 foundations for the proposed structures may consist of conventional strip and/or spread footings. Strip and spread footings should be a minimum of 20 and 36 inches wide, respectively, and shallow exterior footings should be embedded at least 36 inches below final grade for frost protection and confinement. Interior shallow footings not susceptible to frost conditions should be embedded at least 18 inches for confinement.

6.3.1 Installation and Bearing Material

The foundations for the proposed structures may consist of conventional strip and/or spread footings founded directly on a minimum of 18-inches of structural fill. It is recommended that GeoStrata inspect the bottom of the foundation excavation prior to the placement of steel or concrete to identify the competent native earth materials as well as any unsuitable soils. exposed in the footing excavations. Foundation elements should likewise not be founded on undocumented fill soils or directly on “combination soils”, i.e., partially on fine-grained soils and partially on coarse-grained soils. If combination soils are encountered then the excavation should be over-excavated a minimum of 12-inches, and then brought back up to design grade using properly placed and compacted structural fill. Structural fill should meet material recommendations and be placed and compacted as recommended in Section 6.2.4.

6.3.2 Bearing Pressure

Conventional strip and spread footings founded as described above may be proportioned for a maximum net allowable bearing capacity of **1,600 pounds per square foot (psf).** The recommended net allowable bearing pressure refers to the total dead load and can be increased by 1/3 to include the sum of all loads including wind and seismic.

6.3.3 Settlement

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.

6.3.4 Frost Depth

All exterior footings are to be constructed at least 36 inches below the ground surface for frost protection and confinement. This includes walk-out areas and may require fill to be placed around buildings. Interior footings not susceptible to frost conditions should be embedded at least 18 inches for confinement. If foundations are constructed through the winter months, all soils on which footings will bear shall be protected from freezing.

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6.3.5 Construction Observation

A geotechnical engineer shall periodically monitor excavations prior to installation of footings. Inspection of soil before placement of structural fill or concrete is required to detect any field conditions not encountered in the investigation which would alter the recommendations of this report. All structural fill material shall be tested under the direction of a geotechnical engineer for material and compaction requirements. Although not anticipated, if potentially collapsible soils are encountered, Lot specific swell-collapse testing should be completed at the time of the foundation excavation in order to observe whether collapsible or swelling soils underlie the proposed residences.

6.3.6 Foundation Drainage

As stated in Section 4.2.2 of this report, groundwater was not encountered in any of the test pits excavated as part of our field investigation. If groundwater is encountered as part of the foundation excavations, it is recommended that all final floor slab elevations be maintained a minimum of 36 inches above the groundwater elevation as established at the time of foundation excavation through the advancement of a test pit outside of the footprint of the structure. This test pit should be allowed to sit open for a minimum of 24 hours prior to inspection for groundwater conditions and should persist to a minimum depth of 36 inches below the elevation of the basement slab.

6.4 CONCRETE SLAB-ON-GRADE CONSTRUCTION

Concrete slabs-on-grade should be constructed over at least 4 inches of compacted gravel overlying native soils or structural fill. 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. 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.

6.5 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 soils. In determining the frictional resistance against concrete, a coefficient of friction of 0.43 should be used for coarse-grained native soil and structural fill against concrete.

Ultimate lateral earth pressures from native coarse-grained material acting against buried walls and structures for long term condition 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[1]	0.30	37
At-rest[2]	0.50	63
Passive[1]	6.11	763
Seismic Active[3]	0.34	43
Seismic Passive[4]	-0.91	-113

1. Based on Coulomb's equation
2. Based on Jaky
3. Based on Lew et al. (2010)
4. Based on Mononobe-Okabe Equation

These coefficients and densities assume level, granular 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.

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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.

6.6 MOISTURE PROTECTION AND SURFACE DRAINAGE

In our field investigation and laboratory testing program, collapsible soil was observed and measured. Every effort should be made to minimize the saturation of the native soils by applying the following recommendations. Moisture should not be allowed to infiltrate the soil in the vicinity of the foundations. We recommend the following mitigation measures be implemented at the building location.

- All foundations shall be over-exavated by a minimum of 18-inches and replaced with properly compacted structural fill.
- The ground surface within 10 feet of the entire perimeter of the building should slope a minimum of five percent away from the structure.
- Roof runoff devices (rain gutters) should be installed to direct all runoff a minimum of 10 feet away from the structure and preferably day-lighted to the curb where it can be transferred to the storm drain system. Rain gutters discharging roof runoff adjacent to or within the near vicinity of the structure may result in excessive differential settlement.
- We do not recommend storm drain collection sumps be used as part of this development. However, if necessary, sumps should not be located adjacent to foundations or within roadway pavements due to the presence of potentially collapsible soils.
- We recommend irrigation around foundations be minimized by selective landscaping and that irrigation valves be constructed at least 5 feet away from foundations.
- Jetting (injecting water beneath the surface) to compact backfill against foundation soils may result in excessive settlement beneath the building and is not allowed.

- Backfill against foundations walls should consist of on-site native fine-grained soils and should be placed in lifts and compacted to 90% modified proctor to create a moisture barrier.

Failure to comply with these recommendations could result in excessive total and differential settlements causing structural damage or below grade flooding.

6.7 PAVEMENT SECTION

For pavement design, the following CBR laboratory test result was obtained:

Test Pit	Depth (ft)	Soil Type	CBR (%)
TP-2	2	SM	5.0

We have elected to use the laboratory results for CBR value of 5.0 as part of our pavement section design. No traffic information was available at the time this report was prepared; therefore, GeoStrata has assumed traffic counts for the local and private roads and parking areas. We assumed that vehicle traffic along the local and private roadways will consist of approximately 200 passenger car trips per day, 2 small trucks per day, and 1 large trucks per day with a 20-year design life. Based on these assumptions, our analysis uses 41,000 ESAL's for a 20-year design life of the pavement. Asphalt has been assumed to be a high stability plant mix or Superpave mix with a minimum CBR of 70. The untreated base course material (road base or UTBC) composed of crushed stone with a minimum CBR of 30.

Local and Private Roadways Pavement Sections

Pavement Materials	Recommended Minimum Thickness (in)	
	Pavement 1	Typical City Minimums
Asphaltic Concrete	3	3
Untreated Base Course	10	6
Granular Borrow/ Engineered Fill	0	0

The pavement section thicknesses above assume that there is no mixing over time between the road base and the softer native layers below. In order to prevent mixing or fines migration, and thereby prolong the life of the pavement section, we recommend that the owner give

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consideration to placing a non-woven filter fabric between the native soils and the road base. We recommend that a Propex Geotex® NW-401, NW-601, or a GeoStrata-approved equivalent be used.

If traffic conditions vary significantly from our stated assumptions, GeoStrata should be contacted so we can modify our pavement design parameters accordingly. Specifically, if the traffic counts are significantly higher or lower, we should be contacted to review the pavement sections as necessary. The pavement sections thicknesses above assumes that the majority of construction traffic including cement trucks, cranes, loaded haulers, etc. has ceased. If a significant volume of construction traffic occurs after the pavement section has been constructed, the owner should anticipate maintenance or a decrease in the design life of the pavement area.

The pavement sections discussed above meet our minimum recommendations for pavement design. It should be noted that more stringent pavement section requirements may be enforced by Roosevelt City, Duchesne County, or other governing agency.

6.8 SOIL CORROSION

One (1) representative soil sample was tested for soil chemical reactivity. Chemical reactivity tests were performed to determine soil pH, resistivity, and concentrations of water-soluble sulfate ions. Results from these tests are summarized in the table below.

Test Pit Number	Depth (ft)	Sulfate (ppm)	Resistivity (Ω-cm)	Soil pH
TP-2	8	1,470	380	8.64

Test results indicate that the soluble sulfate concentrations of 1,470 ppm. Based on the American Concrete Institute (ACI) Building Code, these concentrations represent “moderate” degree of sulfate attack on concrete structures. It is recommended that a Type II Portland Cement Concrete (PCC) be used for concrete elements in contact with the onsite soils or properly placed and compacted granular structural fill.

Laboratory soil resistivity has a direct impact on the degree of corrosion in underground steel structures. A decrease in resistivity relates to an increase in corrosion activity and therefore dictates that protective treatment is to be used. Results from the laboratory resistivity tests indicate a resistivity of 380 ohm-cm. Based on the resistivity test results, the onsite soils are considered to be “extremely corrosive” to ferrous metals if saturated in the field.

Results of the ion hydrogen concentration (pH) tests were 8.64. Concentrations greater than 5 and less than 10 are less likely to contribute to corrosion attack on subsurface steel structures.

Anticipated underground steel structures (i.e., pipes, exposed steel) should be protected against corrosion and Type I/II Portland Cement Concrete is recommended for the site. We also recommend that a corrosion engineer review the results of our laboratory testing presented in the table above and provide additional recommendations for protection of steel and concrete as needed.

These recommendations are for the native soils at the site. We recommend that additional corrosion testing be performed on the import soils used in the mass grading of the site.

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 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, we 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 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.

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 us 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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APPENDIX A

Legend

Approximate Site Boundary

900 0 900 1,800 2,700 3,600 ft

1:15,000

N

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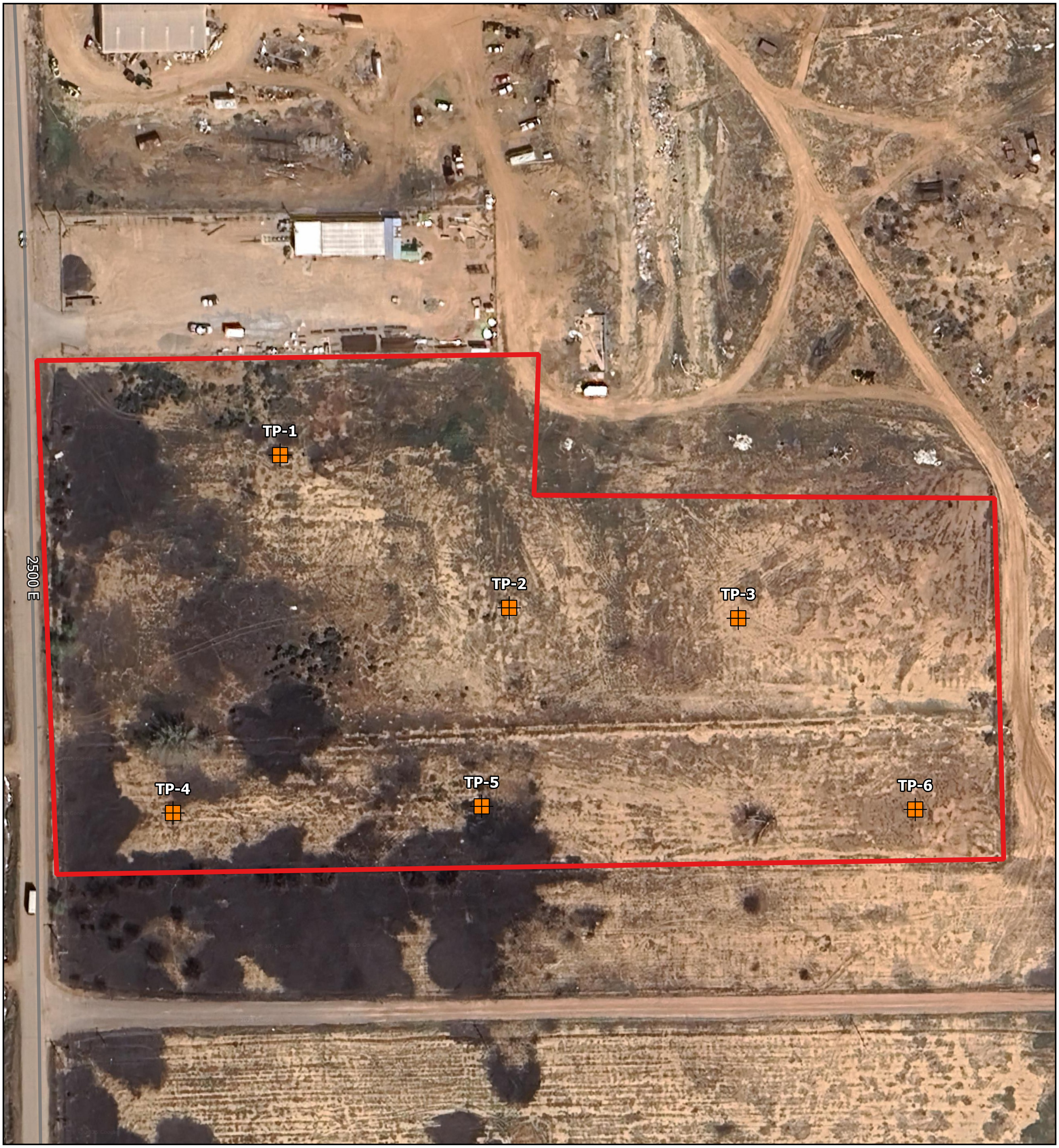
Phase One Properties, LLC
Ballard Townhouse Development
Ballard, Utah
Project Number: 1843-003

Site Vicinity Map

Plate A-1



Legend

Approximate Site Boundary

Approximate Test Pit Locations

70 0 70 140 210 280 ft

1:1,500

N

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Phase One Properties, LLC
Ballard Townhouse Development
Ballard, Utah
Project Number: 1843-003

Exploration Location Map

Plate A-2

APPENDIX B

DATE	
STARTED:	2/18/25
COMPLETED:	2/18/25
BACKFILLED:	2/18/25

Phase One Properties, LLC
Ballard Townhouse Development
Ballard, Utah
Project Number 1843-003

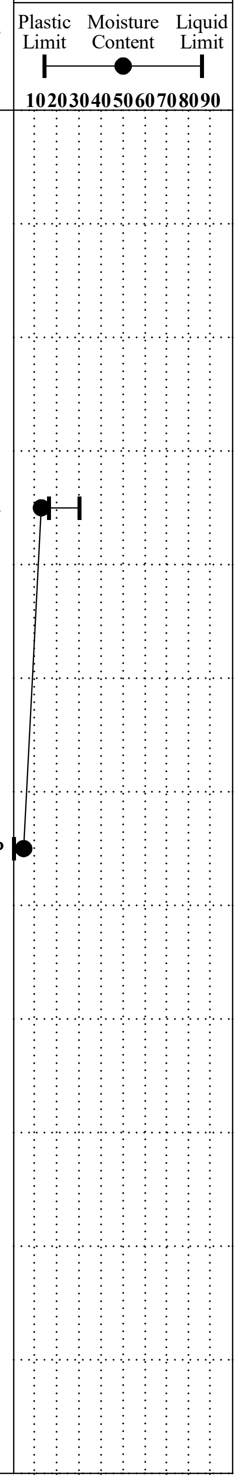
GeoStrata Rep: Nyle Sampson
Rig Type: 580SK Turbo

TEST PIT NO:
TP-1
Sheet 1 of 1

LOCATION
LATITUDE 40.2998 LONGITUDE -109.9530 ELEVATION 5,030-ft
Elevation Estimated Using Google Earth

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; SILT with sand - moist, brown, sand is medium- to fine-grained, organics throughout					
					CL	Lean CLAY with sand - medium stiff, moist, brown, sand is medium- to fine- grained, pinholes throughout					
1							91.4	12.6	84.7	30	14
					SM	Silty SAND - medium dense, moist, brown, sand is medium- to fine-grained					
	5										
2							102.1	4.5	34.7	NP	NP
						- no groundwater encountered					
						Bottom of Test Pit @ 9 Feet					
3	10										

Moisture Content and Atterberg Limits



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

WATER LEVEL
- MEASURED
- ESTIMATED

NOTES:

GeoStrata

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Plate
B - 1

2020 LOG OF TEST PIT - PLATE (B) 2020 GINT UPDATE TEMPLATE.GPJ GEOSTRATA.GDT 3/6/25

DATE		
STARTED:	2/18/25	
COMPLETED:	2/18/25	
BACKFILLED:	2/18/25	

Phase One Properties, LLC
Ballard Townhouse Development
Ballard, Utah
Project Number 1843-003

GeoStrata Rep: Nyle Sampson
Rig Type: 580SK Turbo

TEST PIT NO:
TP-2
Sheet 1 of 1

LOCATION
LATITUDE 40.2994 LONGITUDE -109.9522 ELEVATION 5,028-ft
Elevation Estimated Using Google Earth

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; SILT with sand - moist, brown, sand is medium- to fine-grained, organics throughout					
					SM	Silty SAND - medium dense, moist, brown, sand is medium- to fine-grained					
		Grab							40.0	NP	NP
1											
	5										
2											
		Grab						4.7	24.0	NP	NP
						- no groundwater encountered Bottom of Test Pit @ 9 Feet					
3	10										

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

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

WATER LEVEL
- MEASURED
- ESTIMATED

NOTES:

Plate
B - 2

DATE			
STARTED:	2/18/25	Phase One Properties, LLC Ballard Townhouse Development Ballard, Utah Project Number 1843-003	GeoStrata Rep: Nyle Sampson Rig Type: 580SK Turbo
COMPLETED:	2/18/25		TEST PIT NO: TP-3 Sheet 1 of 1
BACKFILLED:	2/18/25		

LOCATION

LATITUDE 40.2993 LONGITUDE -109.9514 ELEVATION 5,026-ft

Elevation Estimated Using Google Earth

DEPTH (FEET)	SAMPLES	WATER LEVEL	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index
0				TOPSOIL; SILT with sand - moist, brown, sand is medium- to fine-grained, organics throughout					
			SM	Silty SAND - medium dense, moist, brown, sand is medium- to fine-grained					
5	Grab sample				104.0	8.3	39.3	NP	NP
				- no groundwater encountered Bottom of Test Pit @ 9 Feet					

Moisture Content and Atterberg Limits

Plastic Limit — Moisture Content — Liquid Limit

10 20 30 40 50 60 70 80 90

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

WATER LEVEL
- MEASURED
- ESTIMATED

NOTES:

Plate B - 3

DATE		
STARTED:	2/18/25	
COMPLETED:	2/18/25	
BACKFILLED:	2/18/25	

Phase One Properties, LLC
Ballard Townhouse Development
Ballard, Utah
Project Number 1843-003

GeoStrata Rep: Nyle Sampson
Rig Type: 580SK Turbo

TEST PIT NO: **TP-4**
Sheet 1 of 1

LOCATION
LATITUDE 40.2988 LONGITUDE -109.9534 ELEVATION 5,027-ft
Elevation Estimated Using Google Earth

MATERIAL DESCRIPTION

DEPTH (FEET)	SAMPLES	WATER LEVEL	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index
0				TOPSOIL; SILT with sand - moist, brown, sand is medium- to fine-grained, organics throughout					
			CL	Lean CLAY - medium stiff, moist, brown					
~4.5	Grab sample				103.0	20.3	98.2	31	14
9				- no groundwater encountered Bottom of Test Pit @ 9 Feet					

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

DEPTH: METERS 0, 1, 2, 3; FEET 0, 5, 10

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

WATER LEVEL
- MEASURED
- ESTIMATED

NOTES:

GeoStrata

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Plate
B - 4

DATE	
STARTED:	2/18/25
COMPLETED:	2/18/25
BACKFILLED:	2/18/25

Phase One Properties, LLC
Ballard Townhouse Development
Ballard, Utah
Project Number 1843-003

GeoStrata Rep: Nyle Sampson
Rig Type: 580SK Turbo

TEST PIT NO:
TP-5
Sheet 1 of 1

LOCATION
LATITUDE 40.2988 LONGITUDE -109.9523 ELEVATION 5,027-ft
Elevation Estimated Using Google Earth

DEPTH (FEET)	SAMPLES	WATER LEVEL	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index
0				TOPSOIL; SILT with sand - moist, brown, sand is medium- to fine-grained, organics throughout					
			CL	Lean CLAY - medium stiff, moist, brown					
	Grab				100.5	10.3	91.2	25	10
8				- no groundwater encountered 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

METERS: 0, 1, 2, 3
FEET: 0, 5, 10

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

WATER LEVEL
- MEASURED
- ESTIMATED

NOTES:

Plate
B - 5

DATE		
STARTED:	2/18/25	
COMPLETED:	2/18/25	
BACKFILLED:	2/18/25	

Phase One Properties, LLC
Ballard Townhouse Development
Ballard, Utah
Project Number 1843-003

GeoStrata Rep: Nyle Sampson
Rig Type: 580SK Turbo

TEST PIT NO: **TP-6**
Sheet 1 of 1

LOCATION
LATITUDE 40.2988 LONGITUDE -109.9508 ELEVATION 5,026-ft
Elevation Estimated Using Google Earth

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; Silty SAND - moist, brown, sand is medium- to fine- grained, organics throughout						
					CL	Lean CLAY with sand - medium stiff, moist, brown, sand is medium- to fine- grained						
						- @ 3-feet, infiltration test performed						
1		Grab sample					114.8	14.1	79.2	23	10	
	5				SC	Clayey SAND - medium dense, moist, brown, sand is medium- to fine- grained, some chunks of cemented sand						
2		Grab sample										
						- no groundwater encountered						
						Bottom of Test Pit @ 9 Feet						
3	10											

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

WATER LEVEL
- MEASURED
- ESTIMATED

NOTES:

Plate
B - 6

DESCRIPTION OF SYMBOLS

Sample Type

Disturbed or Bag Sample

3” OD “California” Style Split Barrel Sampler

2” OD Split Spoon Sampler

3” OD Thin-Walled Shelby Tube Sampler

2.5” O.D./ 2” I.D. Sampler

Water Level

Water Level After a Specific Period of Time

Water Initially Encountered

Exploration Type

Boring

Test Pit

Location and Elevation

Unless otherwise noted, Latitude and Longitude are approximately determined using a hand-held GPS device. The accuracy of such devices is variable. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

Classification of Soils for (Unified Soil Classification System)

UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D 2487)

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 GRAVEL WITH <5% FINES	Cu≥4 and 1≤Cc≤3	GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
			Cu<4 and/ or 1>Cc>3	GP	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
		GRAVELS WITH 5% TO 12% FINES	Cu≥4 and 1≤Cc≤3	GW-GM	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE FINES
				GW-GC	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE CLAY FINES
			Cu<4 and/ or 1>Cc>3	GP-GM	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE FINES
				GP-GC	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE CLAY FINES
		GRAVELS WITH > 12% FINES		GM	SILTY GRAVELS, GRAVEL-SILT-SAND MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
				GC-GM	CLAYEY GRAVELS, GRAVEL-SAND-CLAY-SILT MIXTURES
	SANDS (More than half of coarse fraction is smaller than the #4 sieve)	CLEAN SANDS WITH <5% FINES	Cu≥6 and 1≤Cc≤3	SW	WELL-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES
			Cu<6 and/ or 1>Cc>3	SP	POORLY GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES
		SANDS WITH 5% TO 12% FINES	Cu≥6 and 1≤Cc≤3	SW-SM	WELL-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE FINES
				SW-SC	WELL-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE CLAY FINES
			Cu<6 and/ or 1>Cc>3	SP-SM	POORLY GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE FINES
				SP-SC	POORLY GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE CLAY FINES
		SANDS WITH > 12% FINES		SM	SILTY SANDS, SAND-GRAVEL-SILT MIXTURES
				SC	CLAYEY SANDS, SAND-GRAVEL-CLAY MIXTURES
				SC-SM	CLAYEY SANDS, SAND-SILT-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 AND VERY FINE SANDS, SILTY OR CLAYEY FINE SANDS, SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				CL-ML	INORGANIC CLAYS-SILTS OF LOW 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

Terms Describing Consistence or Condition

STRENGTH TERMS	RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance		CONSISTENCY OF FINE-GRAINED SOILS (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance		
	Descriptive Term (Density)	Standard Penetration or N-Value Blows/Ft.	Descriptive Term (Consistency)	Unconfined Compressive Strength Qu, (psf)	Standard Penetration or N-Value Blows/Ft.
	Very Loose	0 - 3	Very Soft	less than 500	0 - 1
	Loose	4 - 9	Soft	500 to 1,000	2 - 4
	Medium Dense	10 - 29	Medium Stiff	1,000 to 2,000	4 - 8
	Dense	30 - 50	Stiff	2,000 to 4,000	8 - 15
	Very Dense	> 50	Very Stiff	4,000 to 8,000	15 - 30
			Hard	> 8,000	> 30

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 is below water table

CEMENTATION

DESCRIPTION	FIELD TEST
Weakly	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

Angularity

DESCRIPTION	CRITERIA
Angular	Particles have sharp edges and relatively plane sides with unpolished surfaces.
Subangular	Particles are similar to angular description but have rounded edges.
Subrounded	Particles have nearly plane sides but have well-rounded corners and edges.
Rounded	Particles have smoothly curved sides and no edges.

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Soil Symbols Description Key

Phase Once Properties, LLC
Ballard Townhouse Development
Ballard, Utah
Project Number: 1843-003

Plate B-7

APPENDIX C

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		Consolidation			Collapse (%)	Swell (%)	CBR (%)	Sulfate Content (ppm)	Chloride Content (ppm)	Resistivity (Ω-cm)	pH
							Gravel (%)	Sand (%)	Fines (%)	LL	PI	Cc	Cr	OCR							
TP-1	3	CL	12.6	91.4			0	15.3	84.7	30	14	-	-	-	1.95	-					
TP-1	6	SM	4.5	102.1			0	65.3	34.7	NP	NP	-	-	-	1.76	-					
TP-2	2	SM			10	126	0.0	60.0	40.0	NP	NP					0.11	5.0				
TP-2	8	SM	4.7				1.0	75.0	24.0	NP	NP							1,470	173	380	8.64
TP-3	5	SM	8.3	104			0	60.7	39.3	NP	NP	-	-	-	2.08	-					
TP-4	4	CL	20.3	103			0	1.8	98.2	31	14	0.08	0.016	2	-	-					
TP-5	7	CL	10.3	100.5			0	8.8	91.2	25	10	-	-	-	0.16	-					
TP-6	3	CL	14.1	114.8			0	20.8	79.2	23	10	0.065	0.007	5	-	-					

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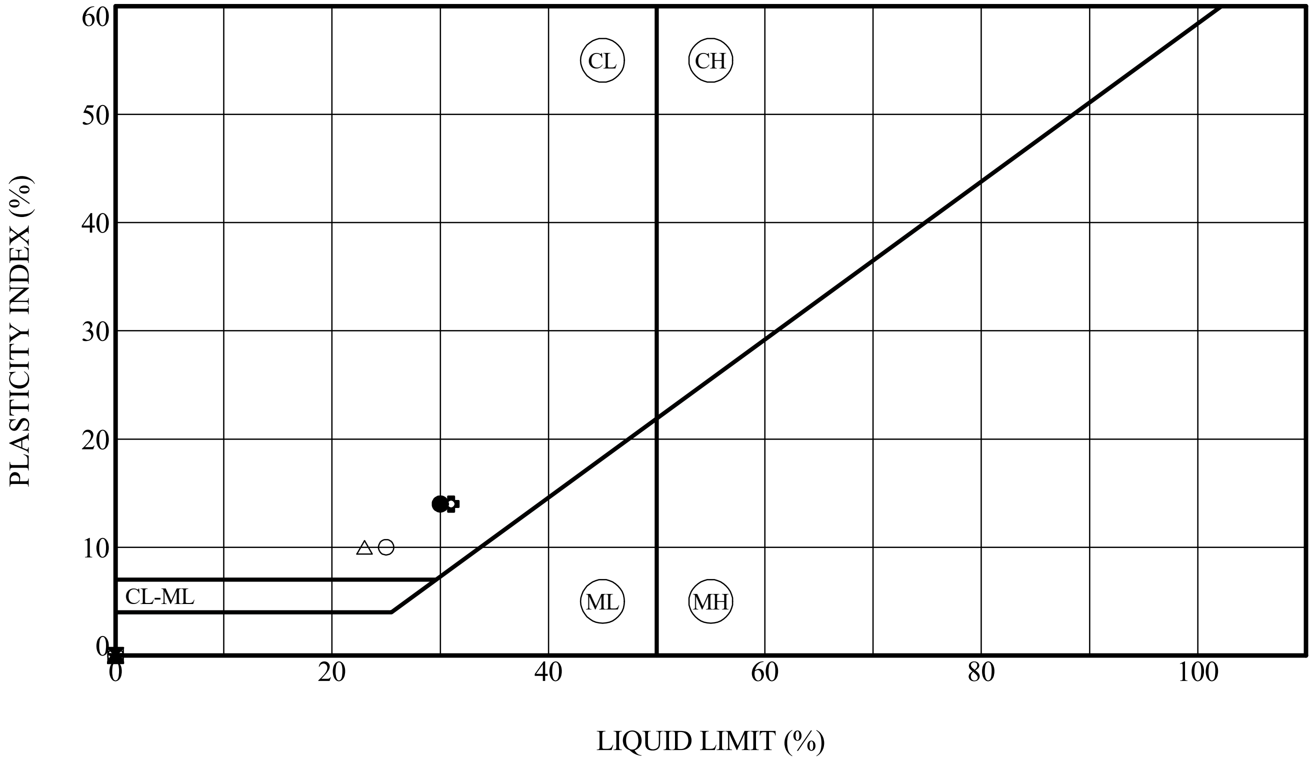
Lab Summary Report

Phase Once Properties, LLC
Ballard Townhouse Development
Ballard, Utah
Project Number: 1843-003

Plate C - 1



	Sample Location	Depth (ft)	LL (%)	PL (%)	PI (%)	Fines (%)	Classification
●	**TP-1**	**3.0**	**30**	**16**	**14**	**84.7**	**Lean CLAY with sand**
⊠	**TP-1**	**6.0**	**NP**	**NP**	**NP**	**34.7**	**Silty SAND**
▲	**TP-2**	**2.0**	**NP**	**NP**	**NP**	**40.0**	**Silty SAND**
★	**TP-2**	**8.0**	**NP**	**NP**	**NP**	**24.0**	**Silty SAND**
⊙	**TP-3**	**5.0**	**NP**	**NP**	**NP**	**39.3**	**Silty SAND**
✿	**TP-4**	**4.0**	**31**	**17**	**14**	**98.2**	**Lean CLAY**
○	**TP-5**	**7.0**	**25**	**15**	**10**	**91.2**	**Lean CLAY**
△	**TP-6**	**3.0**	**23**	**13**	**10**	**79.2**	**Lean CLAY with sand**

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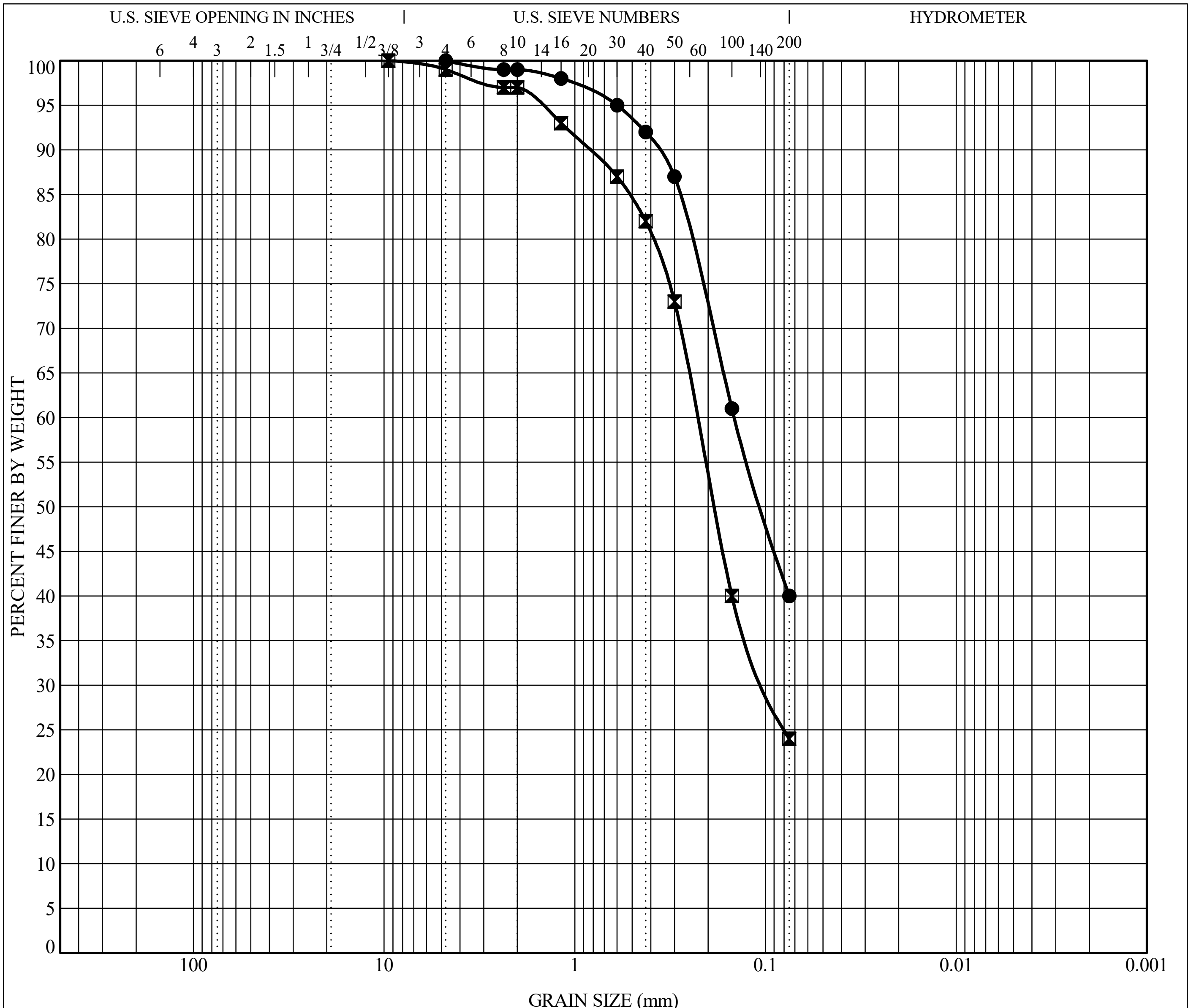
ATTERBERG LIMITS' RESULTS - ASTM D 4318

Phase One Properties, LLC
Ballard Townhouse Development
Ballard, Utah
Project Number: 1843-003

Plate

C - 2

C_ATTERBERG 2020 GINT UPDATE TEMPLATE.GPJ GEOSTRATA.GDT 3/6/25



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Sample Location	Depth	Classification	LL	PL	PI	Cc	Cu
●	**TP-2**	**2.0**	**Silty SAND**	**NP**	**NP**	**NP**		
⊠	**TP-2**	**8.0**	**Silty SAND**	**NP**	**NP**	**NP**		

	Sample Loctaion	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**TP-2**	**2.0**	**4.75**	**0.145**			**0.0**	**60.0**	**40.0**	
⊠	**TP-2**	**8.0**	**9.5**	**0.228**	**0.097**		**1.0**	**75.0**	**24.0**	

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GRAIN SIZE DISTRIBUTION - ASTM D422

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Ballard Townhouse Development
Ballard, Utah
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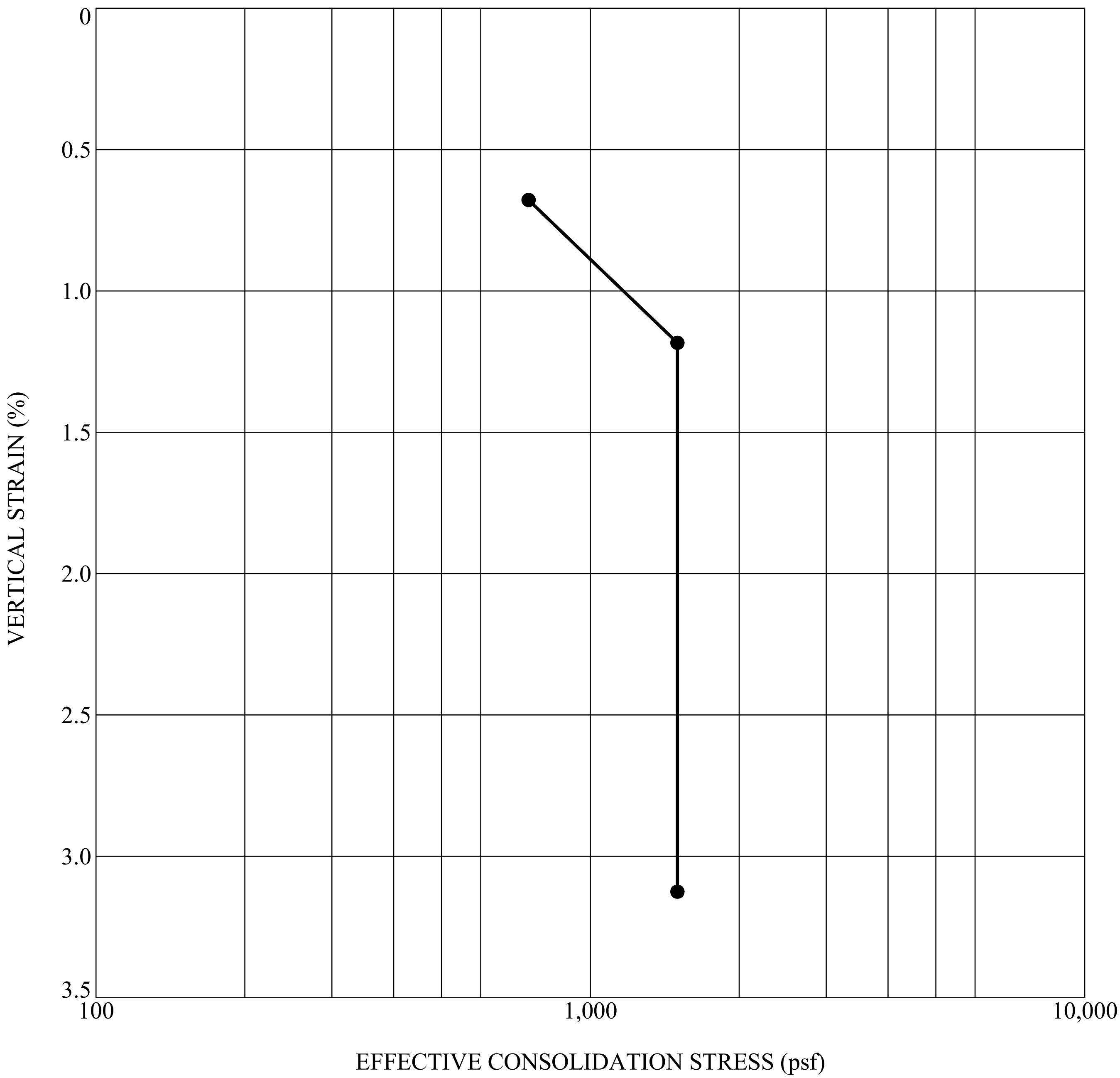
Plate

C - 3

C_GSD 2020 GINT UPDATE TEMPLATE.GPJ GEOSTRATA.GDT 3/6/25



	Sample Location	Depth (ft)	Classification	γ_d (pcf)	MC (%)	Inundation Load (psf)	Swell (%)	Collapse (%)
●	**TP-1**	**3.0**	**Lean CLAY with sand**	**91**	**14**	**1500**	**-**	**1.95**

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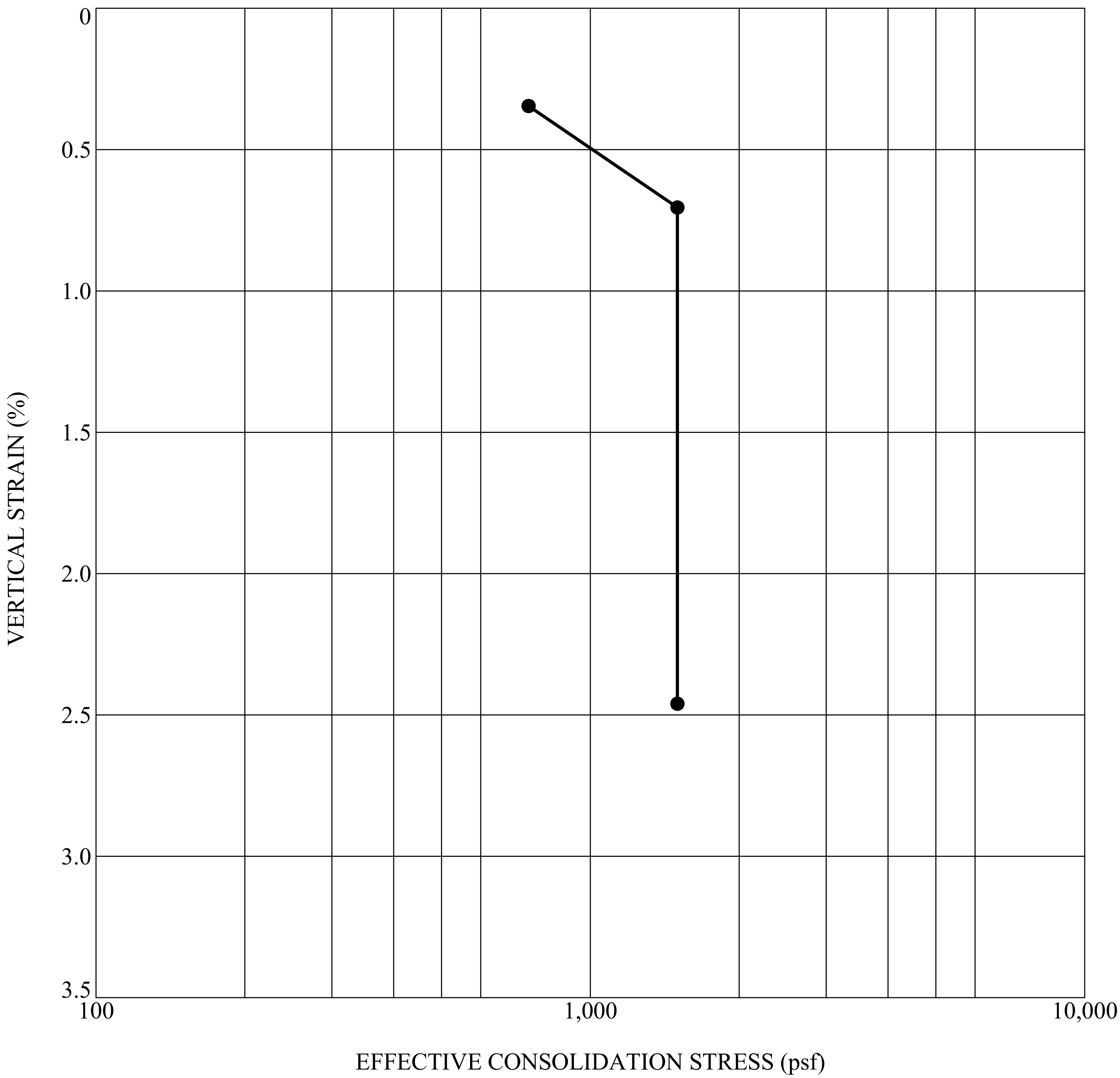
1-D SWELL/COLLAPSE TEST

Phase One Properties, LLC
Ballard Townhouse Development
Ballard, Utah
Project Number: 1843-003

Plate
C - 4

C_SWELL/COLLAPSE 2020 GINT UPDATE TEMPLATE.GPJ GEOSTRATA.GDT 3/11/25



	Sample Location	Depth (ft)	Classification	γ_d (pcf)	MC (%)	Inundation Load (psf)	Swell (%)	Collapse (%)
●	**TP-1**	**6.0**	**Silty SAND**	**102**	**5**	**1500**	**-**	**1.76**

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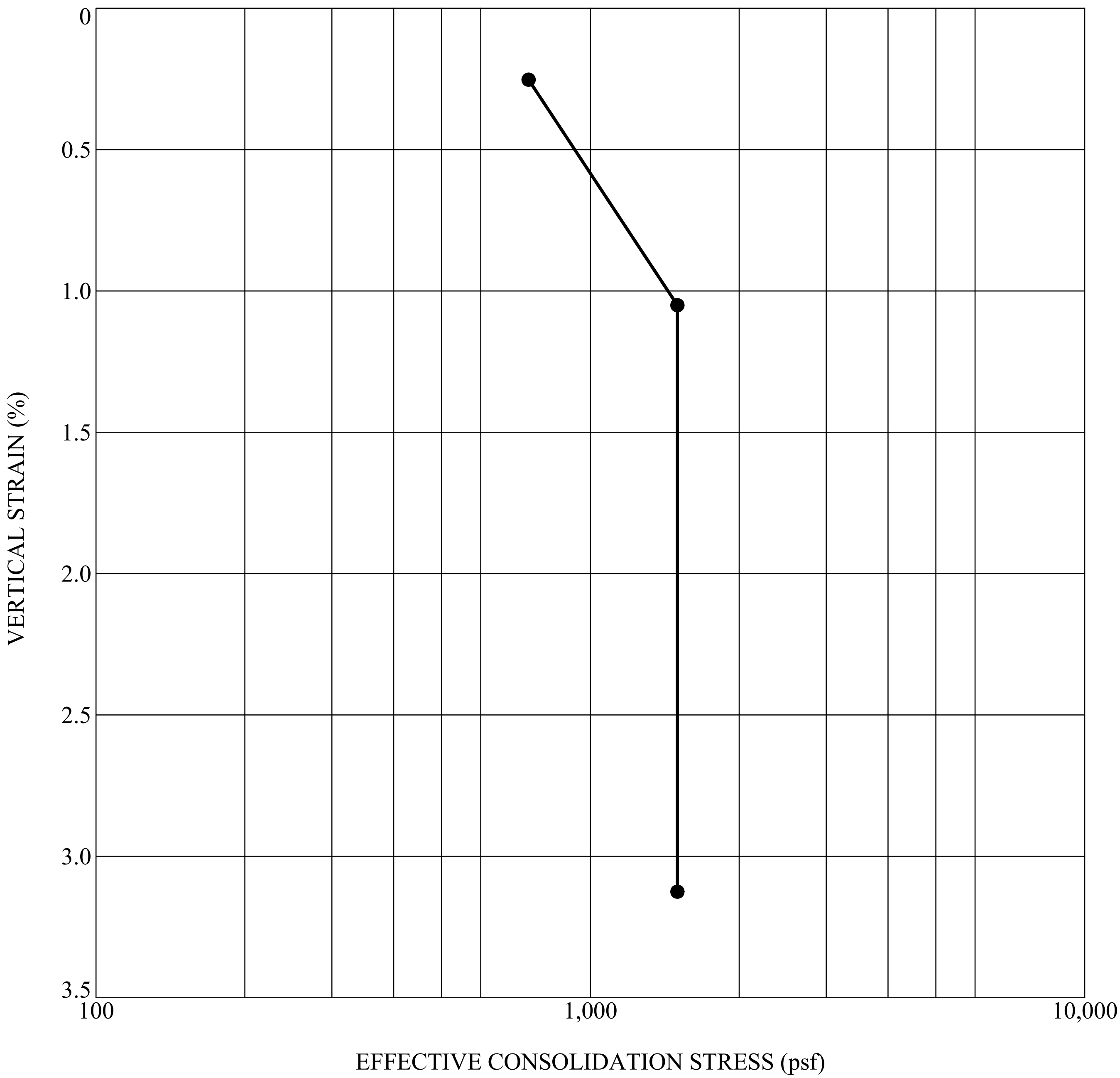
1-D SWELL/COLLAPSE TEST

Phase One Properties, LLC
Ballard Townhouse Development
Ballard, Utah
Project Number: 1843-003

Plate
C - 5

C_SWELL/COLLAPSE 2020 GINT UPDATE TEMPLATE.GPJ GEOSTRATA.GDT 3/11/25



	Sample Location	Depth (ft)	Classification	γ_d (pcf)	MC (%)	Inundation Load (psf)	Swell (%)	Collapse (%)
●	**TP-3**	**5.0**	**Silty SAND**	**104**	**10**	**1500**	**-**	**2.08**

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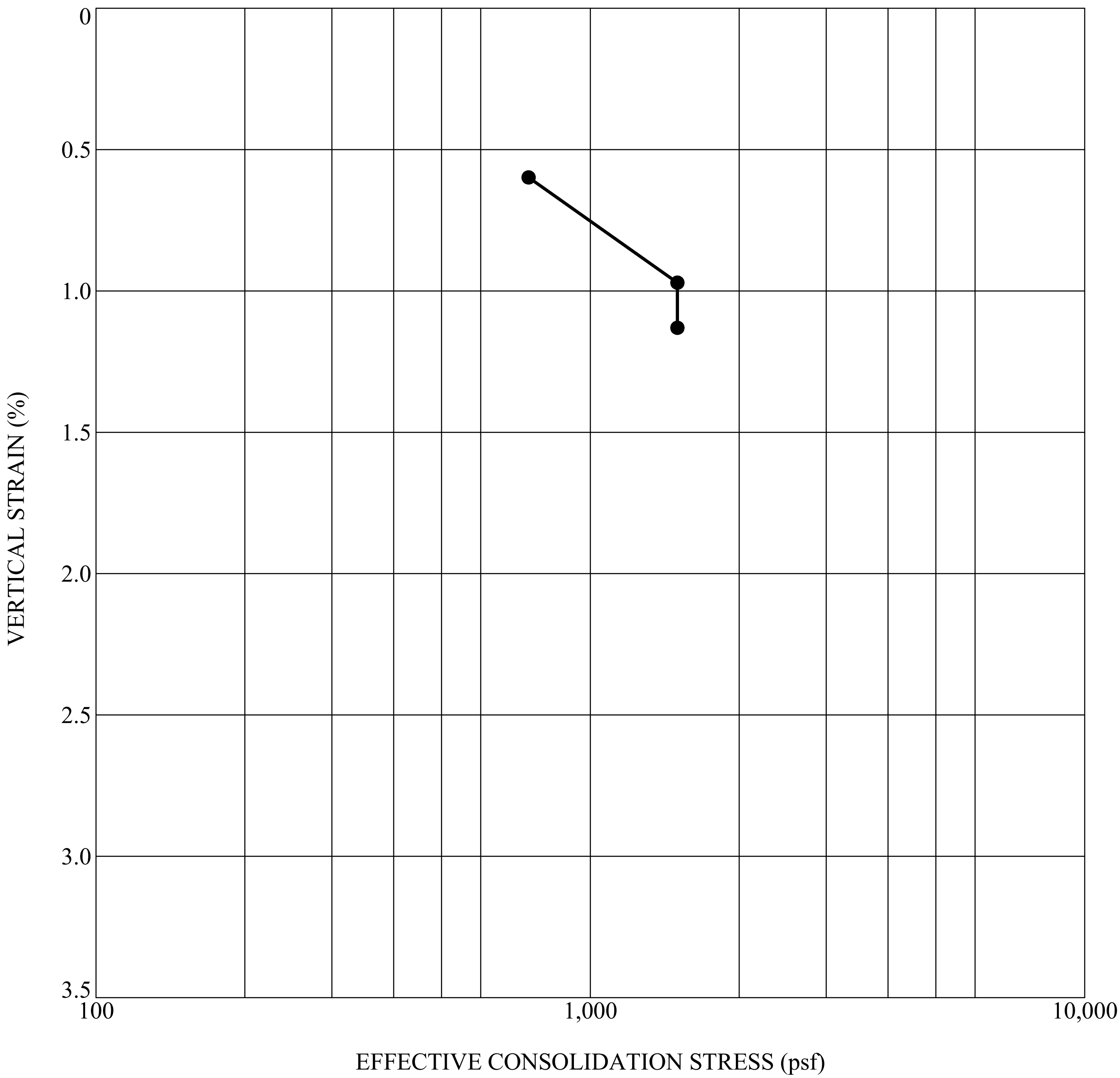
1-D SWELL/COLLAPSE TEST

Phase One Properties, LLC
Ballard Townhouse Development
Ballard, Utah
Project Number: 1843-003

Plate
C - 6



	Sample Location	Depth (ft)	Classification	γ_d (pcf)	MC (%)	Inundation Load (psf)	Swell (%)	Collapse (%)
●	**TP-5**	**7.0**	**Lean CLAY**	**100**	**11**	**1500**	**-**	**0.16**

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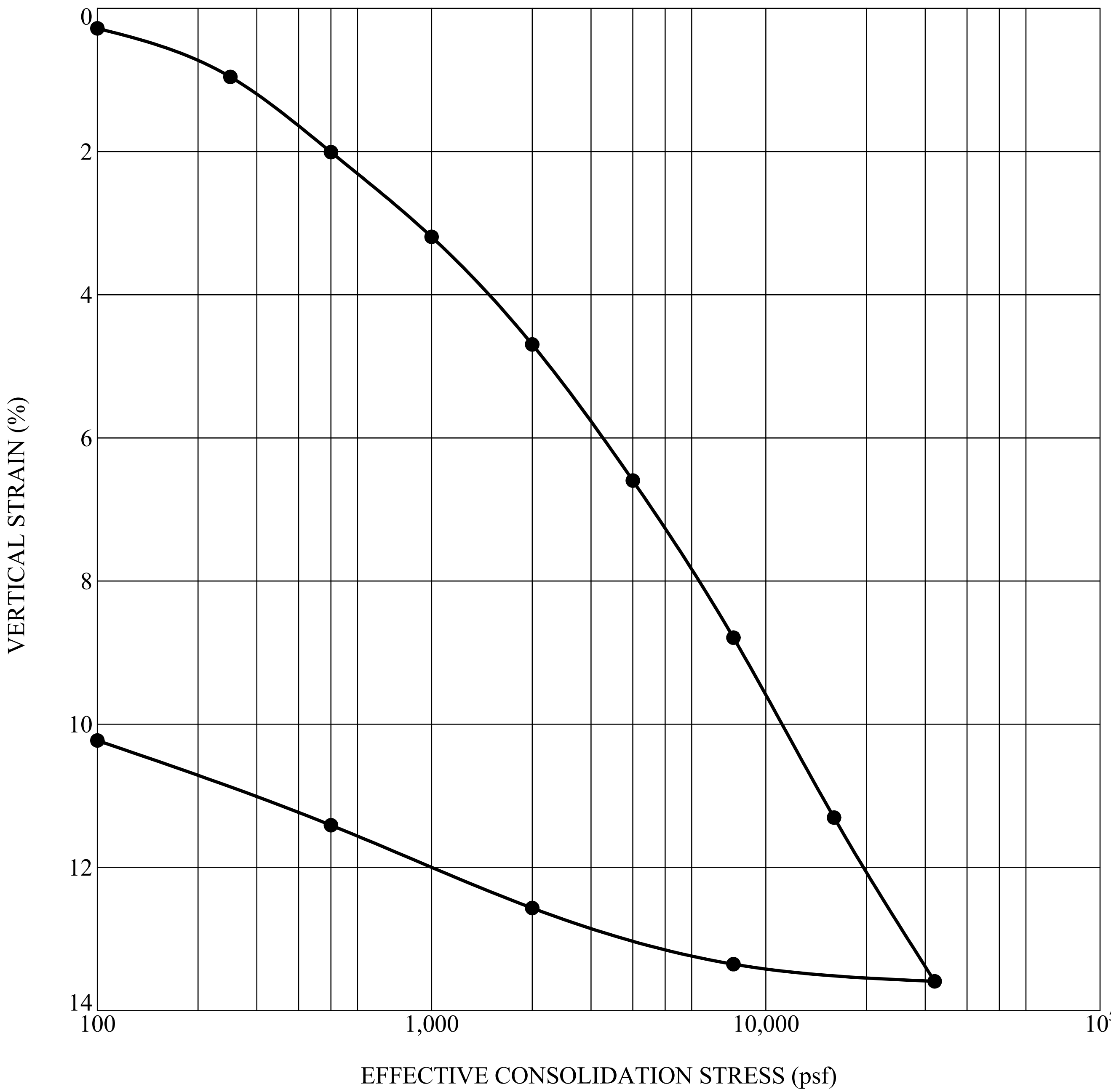
1-D SWELL/COLLAPSE TEST

Phase One Properties, LLC
Ballard Townhouse Development
Ballard, Utah
Project Number: 1843-003

Plate
C - 7



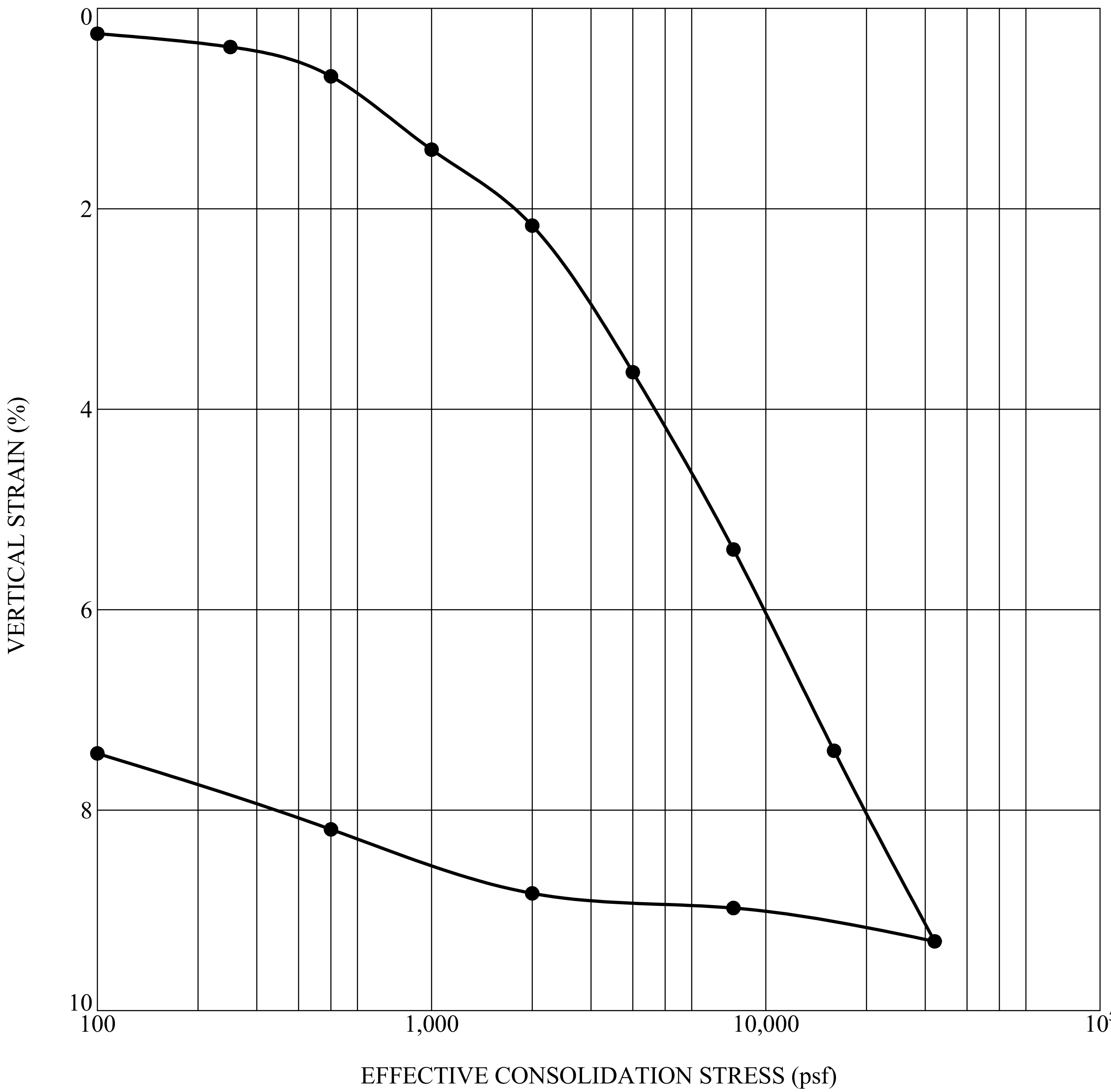
	Sample Location	Depth (ft)	Classification	γ_d (pcf)	MC (%)	C'_c	C'_r	OCR
●	**TP-4**	**4.0**	**Lean CLAY**	**103**	**21**	**0.080**	**0.016**	**2.0**

1-D CONSOLIDATION TEST - ASTM D 2435

Phase One Properties, LLC
Ballard Townhouse Development
Ballard, Utah
Project Number: 1843-003

Plate

C - 8



	Sample Location	Depth (ft)	Classification	γ_d (pcf)	MC (%)	C'_c	C'_r	OCR
●	**TP-6**	**3.0**	**Lean CLAY with sand**	**115**	**15**	**0.065**	**0.007**	**5.0**

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1-D CONSOLIDATION TEST - ASTM D 2435

Phase One Properties, LLC
Ballard Townhouse Development
Ballard, Utah
Project Number: 1843-003

Plate
C - 9

C_CONSOL 2020 GINT UPDATE TEMPLATE.GPJ GEOSTRATA.GDT 3/12/25

Source of Material: TP-2 2.0 ft.

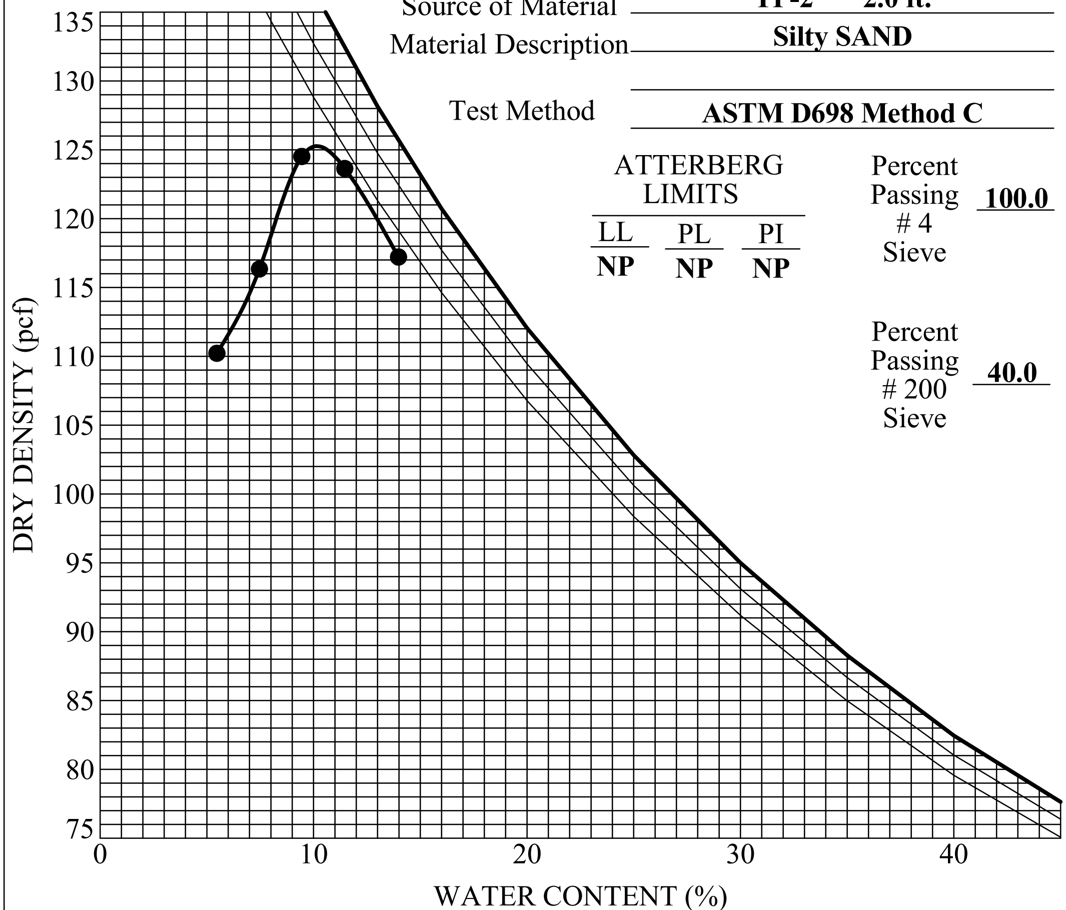
Material Description: Silty SAND

Test Method: ASTM D698 Method C

ATTERBERG LIMITS		
LL	PL	PI
NP	NP	NP

Percent Passing # 4 Sieve: 100.0

Percent Passing # 200 Sieve: 40.0



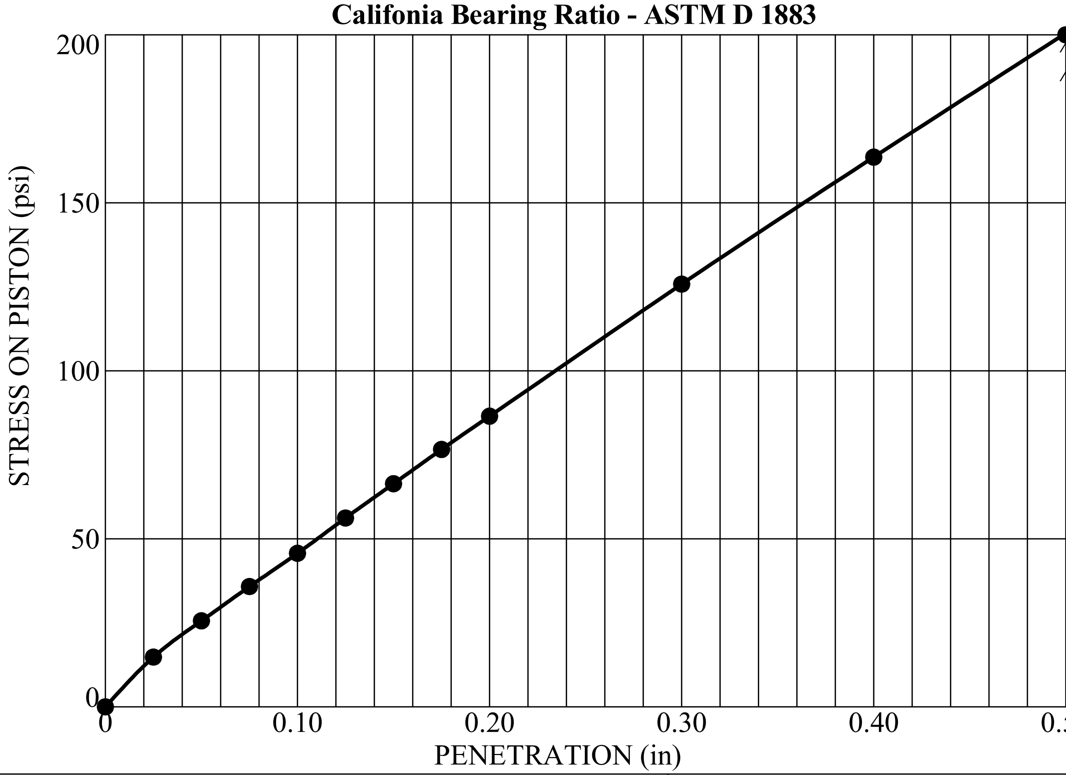
TEST RESULTS

Maximum Dry Density	126.0 (pcf)
Optimum Water Content	10.0 (%)
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	125.5 (pcf)
Relative Compaction	100 (%)
Surcharge	51 (psf)
% Standard CBR	5.00
Swell	0.11 (%)

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COMPACTION AND CBR TEST

Phase One Properties, LLC
Ballard Townhouse Development
Ballard, Utah
Project Number: 1843-003

Plate
C - 10

C_COMPACTION SPLIT 2020 GINT UPDATE TEMPLATE.GPJ GEOSTRATA.GDT 3/12/25

APPENDIX D

Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, you can benefit from a lowered exposure to problems associated with subsurface conditions at project sites and development of them that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed herein, contact your GBA-member geotechnical engineer. Active engagement in GBA exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Understand the Geotechnical-Engineering Services Provided for this Report

Geotechnical-engineering services typically include the planning, collection, interpretation, and analysis of exploratory data from widely spaced borings and/or test pits. Field data are combined with results from laboratory tests of soil and rock samples obtained from field exploration (if applicable), observations made during site reconnaissance, and historical information to form one or more models of the expected subsurface conditions beneath the site. Local geology and alterations of the site surface and subsurface by previous and proposed construction are also important considerations. Geotechnical engineers apply their engineering training, experience, and judgment to adapt the requirements of the prospective project to the subsurface model(s). Estimates are made of the subsurface conditions that will likely be exposed during construction as well as the expected performance of foundations and other structures being planned and/or affected by construction activities.

The culmination of these geotechnical-engineering services is typically a geotechnical-engineering report providing the data obtained, a discussion of the subsurface model(s), the engineering and geologic engineering assessments and analyses made, and the recommendations developed to satisfy the given requirements of the project. These reports may be titled investigations, explorations, studies, assessments, or evaluations. Regardless of the title used, the geotechnical-engineering report is an engineering interpretation of the subsurface conditions within the context of the project and does not represent a close examination, systematic inquiry, or thorough investigation of all site and subsurface conditions.

Geotechnical-Engineering Services are Performed for Specific Purposes, Persons, and Projects, and At Specific Times

Geotechnical engineers structure their services to meet the specific needs, goals, and risk management preferences of their clients. A geotechnical-engineering study conducted for a given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client.

Likewise, geotechnical-engineering services are performed for a specific project and purpose. For example, it is unlikely that a geotechnical-engineering study for a refrigerated warehouse will be the same as one prepared for a parking garage; and a few borings drilled during a preliminary study to evaluate site feasibility will not be adequate to develop geotechnical design recommendations for the project.

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project or purpose;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, the reliability of a geotechnical-engineering report can be affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying the recommendations in it. A minor amount of additional testing or analysis after the passage of time – if any is required at all – could prevent major problems.

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read the report in its entirety. Do not rely on an executive summary. Do not read selective elements only. *Read and refer to the report in full.*

You Need to Inform Your Geotechnical Engineer About Change

Your geotechnical engineer considered unique, project-specific factors when developing the scope of study behind this report and developing the confirmation-dependent recommendations the report conveys. Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the elevation, configuration, location, orientation, function or weight of the proposed structure and the desired performance criteria;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project or site changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept*

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responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface using various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing is performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgement to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team through project completion to obtain informed guidance quickly, whenever needed.

This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, they are not final, because the geotechnical engineer who developed them relied heavily on judgement and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* exposed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a continuing member of the design team, to:

- confer with other design-team members;
- help develop specifications;
- review pertinent elements of other design professionals' plans and specifications; and
- be available whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction-phase observations.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for information purposes only.* To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. This happens in part because soil and rock on project sites are typically heterogeneous and not manufactured materials with well-defined engineering properties like steel and concrete. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually provide environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures.* If you have not obtained your own environmental information about the project site, ask your geotechnical consultant for a recommendation on how to find environmental risk-management guidance.

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, the engineer's services were not designed, conducted, or intended to prevent migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, ***proper implementation of the geotechnical engineer's recommendations will not of itself be sufficient to prevent moisture infiltration. Confront the risk of moisture infiltration*** by including building-envelope or mold specialists on the design team. ***Geotechnical engineers are not building-envelope or mold specialists.***

GEOPROFESSIONAL BUSINESS ASSOCIATION

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