



**REPORT
GEOTECHNICAL STUDY
LOT 5 BIG SKY ESTATES
2337 PANORAMA CIRCLE
NEAR LIBERTY, WEBER COUNTY, UTAH**

Submitted To:

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Submitted By:

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Mr. and Mrs. Dave and Gayle Mariani
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Re: Report
Geotechnical Study
Lot 5 Big Sky Estates
2337 Panorama Circle
Near Liberty, Weber County, Utah
(41.3012° N; 111.8535° W)

1. INTRODUCTION

1.1 GENERAL

This report presents the results of our geotechnical study performed for Lot 5 Big Sky Estates located at 2337 Panorama Circle near Liberty in Weber County, Utah. The general location of the site with respect to major roadways, as of 2014, is presented on Figure 1, Vicinity Map. A more detailed layout of the site showing the proposed improvements is presented on Figure 2, Site Plan. The locations of the test pits excavated and boring drilled in conjunction with this study are also presented on Figure 2.

1.2 OBJECTIVES AND SCOPE

The objectives and scope of our study were planned in discussions between Mr. and Mrs. Dave and Gayle Mariani and Mr. Andrew Harris of GSH Geotechnical, Inc. (GSH).

In general, the objectives of this study were to:

1. Define and evaluate the subsurface soil and groundwater conditions across the site.
2. Provide appropriate foundation, earthwork, and slope stability recommendations as well as geoseismic information to be utilized in the design and construction of the proposed home.

In accomplishing these objectives, our scope has included the following:

1. A field program consisting of the excavating, logging, and sampling of 3 test pits and 1 boring.
2. A laboratory testing program.
3. An office program consisting of the correlation of available data, engineering analyses, and the preparation of this summary report.

1.3 AUTHORIZATION

Authorization was provided by returning a signed copy of our Professional Services Agreement No. 16-0235N dated February 14, 2016.

1.4 PROFESSIONAL STATEMENTS

Supporting data upon which our recommendations are based are presented in subsequent sections of this report. Recommendations presented herein are governed by the physical properties of the soils encountered in the exploration test pits/boring, projected groundwater conditions, and the layout and design data discussed in Section 2, Proposed Construction, of this report. If subsurface conditions other than those described in this report are encountered and/or if design and layout changes are implemented, GSH must be informed so that our recommendations can be reviewed and amended, if necessary.

Our professional services have been performed, our findings developed, and our recommendations prepared in accordance with generally accepted engineering principles and practices in this area at this time.

2. PROPOSED CONSTRUCTION

The proposed project consists of constructing a single-family residence on Lot 5 Big Sky Estates near Liberty in Weber County, Utah. Construction will likely consist of reinforced concrete footings and basement/crawlspace foundation walls supporting 1 to 2 wood-framed levels above grade. Projected maximum column and wall loads are on the order of 10 to 25 kips and 1 to 3 kips per lineal foot, respectively.

Site development will require a moderate amount of earthwork in the form of site grading. We estimate in general that maximum cuts and fills to achieve design grades will be on the order of 2 to 8 feet. Larger cuts and fills may be required in isolated areas.

3. INVESTIGATIONS

3.1 FIELD PROGRAM

In order to define and evaluate the subsurface soil and groundwater conditions at the site, 1 boring was drilled to a depth of about 29.0 feet below existing grade. The boring was drilled using a truck-mounted drill rig equipped with hollow-stem augers, mud rotary, and coring. Additionally, 3 test pits were excavated to depths of about 7.0 to 11.0 feet below existing grade. The test pits were excavated using a track-mounted excavator. Test pit and boring locations are presented on Figure 2.

The field portion of our study was under the direct control and continual supervision of an experienced member of our geotechnical staff. During the course of the excavating and drilling operations, a continuous log of the subsurface soil conditions encountered was maintained. In addition, samples of the typical soils encountered were obtained and placed in sealed bags and plastic containers for subsequent laboratory testing and examination. The soils were classified in the field based upon visual and textural examination. These classifications have been supplemented by subsequent inspection and testing in our laboratory. Detailed graphical representation of the subsurface conditions encountered is presented on Figure 3A, Boring Log, and on Figures 4A through 4C, Test Pit Log. Soils were classified in accordance with the nomenclature described on Figure 5, Key to Boring Log (USCS) and on Figure 6, Key to Test Pit Log (USCS).

A 3.0-inch outside diameter, 2.42-inch inside diameter drive sampler (Dames & Moore) and a 2.0-inch outside diameter, 1.38-inch inside diameter drive sampler (SPT) were utilized in the subsurface soil sampling at select locations within the boring. The blow counts recorded on the boring logs were those required to drive the sampler 12 inches with a 140-pound hammer dropping 30 inches.

A 2.42-inch inside diameter thin-wall drive sampler was utilized in the subsurface sampling of the test pits at the site.

Following completion of drilling and excavation operations, one and one-quarter-inch diameter slotted PVC pipe was installed in boring B-1 and test pit TP-2 in order to provide a means of monitoring the groundwater fluctuations. The boring was backfilled with auger cuttings. Following completion of excavating and logging, each test pit was backfilled. Although an effort was made to compact the backfill with the trackhoe, backfill was not placed in uniform lifts and compacted to a specific density. Consequently, the backfill soils must be considered as non-engineered and settlement of the backfill with time is likely to occur.

3.2 LABORATORY TESTING

3.2.1 General

In order to provide data necessary for our engineering analyses, a laboratory testing program was performed. The program included moisture, density, Atterberg limits, partial gradations, consolidation, direct shear, and residual direct shear tests. The following paragraphs describe the tests and summarize the test data.

3.2.2 Moisture and Density

To provide index parameters and to correlate other test data, moisture and density tests were performed on selected samples. The results of these tests are presented on the boring log, Figure 3A, and on the test pit logs, Figure 4A through 4C.

3.2.3 Atterberg Limit Tests

To aid in classifying the soils, Atterberg limit tests were performed on samples of the fine-grained cohesive soils. Results of the test are tabulated on the following table:

Boring/ Test Pit No.	Depth (feet)	Liquid Limit (percent)	Plastic Limit (percent)	Plasticity Index (percent)	Soil Classification
B-1	2.5	25	17	8	SC
B-1	10.0	21	11	10	GC
B-1	19.0	33	22	11	SC
TP-2	2.5	Non-Plastic	Non-Plastic	Non-Plastic	SM
TP-3	3.0	72	38	34	MH

3.2.4 Partial Gradation Tests

To aid in classifying the granular soils, partial gradation tests were performed. Results of the tests are tabulated below:

Boring/ Test Pit No.	Depth (feet)	Percent Passing No. 200 Sieve	Soil Classification
B-1	2.5	28	SC
B-1	10.0	14	GC
B-1	19.0	23	SC
TP-1	4.0	30	SC
TP-2	2.5	25	SM
TP-3	3.0	74	MH

3.2.5 Consolidation Tests

To provide data necessary for our settlement analyses, consolidation tests were performed on each of 2 representative samples of the fine grained soils encountered at the site. Based upon data obtained from the consolidation tests, the silty clay/clayey silt soils are moderately over-consolidated and will exhibit moderate strength and compressibility characteristics under the anticipated loadings. Detailed results of the test are maintained within our files and can be transmitted, at the client's request.

3.2.6 Laboratory Direct Shear Test

To determine the shear strength of the soils encountered at the site, a laboratory direct shear test was performed on a sample of the site soils. The results of the test are tabulated below:

Test Pit/Boring No.	Depth (feet)	Soil Type	In-Situ Moisture Content (percent)	Dry Density (pcf)	Internal Friction Angle (degrees)	Apparent Cohesion (psf)
TP-1	4.0	SC	27	79	28	605
TP-3	6.0	MH	28	74	28	350

3.2.7 Laboratory Residual Direct Shear Test

To determine the residual shear strength of the soils encountered at the site, a laboratory residual direct shear test was performed on a sample of the site soils. The results of the test are tabulated on below:

Test Pit/Boring No.	Depth (feet)	Soil Type	In-Situ Moisture Content (percent)	Dry Density (pcf)	Internal Friction Angle (degrees)	Apparent Cohesion (psf)
TP-1	4.0	SC	27	79	16	275

4. SITE CONDITIONS

4.1 GEOLOGIC SETTING

A geologic hazards reconnaissance study¹ dated June 9, 2016 was prepared for the subject property by Western Geologic, LLC, and a copy of that report is included in the attached Appendix.

4.2 SURFACE

The subject property is a vacant, irregularly-shaped lot located at 2337 Panorama Circle near Liberty in Weber County, Utah. The topography of the site slopes downward to the west/southwest at grades of about 10H:1V (Horizontal:Vertical) to about 4H:1V (Horizontal:Vertical) with an overall change in elevation of about 145 feet across the site. Vegetation at the site consists primarily of native weeds, grasses, brush, and numerous mature trees, particularly over the slope area. The site is bordered on the north by residential development, on the west and south by undeveloped property, and on the east by Panorama Road followed by residential development.

4.3 SUBSURFACE SOIL

Subsurface conditions encountered at the test pit and boring locations varied slightly across the site. Topsoil and disturbed soils were observed in the upper 3 to 12 inches at the test pit and boring locations. Non-engineered fill extending about 1.0 foot below existing site grades was encountered at boring B-1. In test pit TP-3 and boring B-1, natural soils were observed beneath the non-engineered fill and topsoil/disturbed soils to the full depth penetrated, about 7.0 to 29.0 feet below surrounding grades and consisted of silty clay with varying fine to coarse sand content, fine sandy silt, fine to coarse sand with varying amounts of silt, weathered bedrock (weathered sandstone/claystone/siltstone), and occasional mixture of these soils. In test pits TP-1

¹ "Report, Geologic Hazards Evaluation, Lot 5 Big Sky Estates No.1, 2337 North Panorama Circle, Liberty, Weber County, Utah," Western Geologic, LLC, June 9, 2016.

and TP-2, mass movement soil deposits were encountered below the topsoil and disturbed soils extending to the full depth explored of about 10.0 to 11.0 feet below surrounding site grades. The mass movement deposits were comprised of a mixture of silty sand, clayey silt, silty clay, and degraded/weathered sandstone/siltstone.

The natural granular soils encountered were medium dense to very dense, slightly moist to moist, reddish-brown to brown to gray in color, and will generally exhibit moderately high strength and low compressibility characteristics under the anticipated vertical loading.

The natural silt/clay soils encountered were medium stiff to hard, slightly moist to moist, brown to gray in color, and will generally exhibit moderate strength and compressibility characteristics under the anticipated vertical loading.

For a more detailed description of the subsurface soils encountered, please refer to Figure 3A, Boring Log, and Figures 4A through 4C, Test Pit Log. The lines designating the interface between soil types on the test pit and boring logs generally represent approximate boundaries. In-situ, the transition between soil types may be gradual.

4.4 GROUNDWATER

Groundwater was not encountered in the test pits or boring at the time of our field exploration; however, water resulting from recent precipitation was observed seeping into the test pits at about 2 to 4 feet below existing site grades. Seasonal and longer-term groundwater fluctuations of 1 to 2 feet shall be anticipated. The highest seasonal levels will generally occur during the late spring and summer months. Landscape irrigation on this and surrounding areas may also create additional seasonal groundwater fluctuations. The limitations of landscape irrigation at the site are discussed further in Section 5.9, Site Irrigation, and measures to reduce infiltration of surface water at the site are discussed further in Section 5.8, Subdrains. The contractor must be prepared to dewater excavations as needed.

5. DISCUSSIONS AND RECOMMENDATIONS

5.1 SUMMARY OF FINDINGS

The results of our analyses indicate that the proposed structure may be supported upon conventional spread and/or continuous wall foundations established upon a minimum of 2 feet of granular structural fill extending to suitable natural soils. Under no circumstance should the proposed structure or associated structural fill be placed directly on mass movement/landslide deposits noted at the site. Mass movement/landslide deposits must be removed in their entirety from beneath the proposed home and extending a minimum of 10 feet outside the home area.

The most significant geotechnical aspects of the site are:

1. The surficial non-engineered fills encountered at boring B-1;
2. The proximity of the proposed structure to mass movement soil deposits; and

3. Maintaining stability of the slope at the property.

Mass movement/landslide deposits must be removed in their entirety from beneath the proposed home and extending a minimum of 10 feet outside the home area. If this is not feasible, GSH must be contacted to provide additional recommendations for foundation support.

A subdrain system must be installed upslope of the home and near the head of the mass movement deposit soils below the home to reduce the potential for surface water infiltration, as discussed further within this report.

The on-site soils are not appropriate to be used as structural site grading fill, however, they may be used as general grading fill in landscape areas.

A geotechnical engineer from GSH will need to verify that all mass movement deposit soils, fill material (if encountered) and topsoil/disturbed soils have been completely removed and suitable natural soils encountered prior to the placement of structural site grading fills, floor slabs, foundations, or rigid pavements.

In the following sections, detailed discussions pertaining to earthwork, foundations, lateral pressure and resistance, floor slabs, slope stability, and the geoseismic setting of the site are provided.

5.2 EARTHWORK

5.2.1 Site Preparation

Initial site preparation will consist of the removal of surface vegetation, topsoil, and other deleterious materials from beneath an area extending out at least 3 feet from the perimeter of the proposed building, pavements, and exterior flatwork areas.

Additional site preparation will consist of the removal of existing non-engineered fills (if encountered) from an area extending out at least 3 feet from the perimeter of residential structures and 1 foot beyond rigid pavements. Mass movement/landslide deposits must be removed in their entirety from beneath the proposed home and extending a minimum of 10 feet outside the home area.

Non-engineered fills/disturbed soil may remain in asphalt pavement and sidewalk areas as long as they are free of deleterious materials and properly prepared. Below rigid pavements non-engineered fills/disturbed soils must be removed. Additionally, the surface of any existing engineered fills must be prepared prior to placing additional site grading fills.

Proper preparation shall consist of scarifying, moisture conditioning, and re-compacting the upper 12 inches to the requirements for structural fill. As an option to proper preparation and recompaction, the upper 12 inches of non-engineered fill (where encountered) may be removed and replaced with granular subbase over unfrozen proofrolled subgrade. Even with proper

preparation, pavements established overlying non-engineered fills may encounter some long-term movements unless the non-engineered fills are completely removed.

It must be noted that from a handling and compaction standpoint, onsite soils containing high amounts of fines (silts and clays) are inherently more difficult to rework and are very sensitive to changes in moisture content requiring very close moisture control during placement and compaction. This will be very difficult, if not impossible, during wet and cold periods of the year. Additionally, the onsite soils are likely above optimum moisture content for compacting at present and would require some drying prior to recompacting.

Subsequent to stripping and prior to the placement of structural site grading fill, pavements, driveway, and parking slabs on grade, the prepared subgrade must be proofrolled by passing moderate-weight rubber tire-mounted construction equipment over the surface at least twice. If excessively soft or loose soils are encountered, they must be removed to a maximum depth of 2 feet and replaced with structural fill. Beneath footings, all loose and disturbed soils must be totally removed. Fill soils must be handled as described above.

Surface vegetation, debris, and other deleterious materials shall generally be removed from the site. Topsoil, although unsuitable for utilization as structural fill, may be stockpiled for subsequent landscaping purposes.

A representative of GSH must verify that suitable natural soils and/or proper preparation of existing fills have been encountered/met prior to placing site grading fills, footings, slabs, and pavements.

5.2.2 Excavations

For granular (cohesionless) soils, construction excavations above the water table, not exceeding 4 feet, shall be no steeper than one-half horizontal to one vertical (0.5H:1V). For excavations up to 10 feet, in granular soils and above the water table, the slopes shall be no steeper than one horizontal to one vertical (1H:1V). Excavations encountering saturated cohesionless soils will be very difficult and will require very flat sideslopes and/or shoring, bracing and dewatering. Excavations deeper than 10 feet are not anticipated at the site.

Temporary excavations up to 10 feet deep in fine-grained cohesive soils (if encountered), above or below the water table, may be constructed with sideslopes no steeper than one-half horizontal to one vertical (0.5H:1V).

To reduce disturbance of the natural soils during excavation, it is recommended that smooth edge buckets/blades be utilized.

All excavations must be inspected periodically by qualified personnel. If any signs of instability or excessive sloughing are noted, immediate remedial action must be initiated.

5.2.3 Structural Fill

Structural fill will be required as site grading fill, as backfill over foundations and utilities, and possibly as replacement fill beneath some footings. All structural fill must be free of sod, rubbish, construction debris, frozen soil, and other deleterious materials.

Structural site grading fill is defined as fill placed over fairly large open areas to raise the overall site grade. The maximum particle size within structural site grading fill should generally not exceed 4 inches; although, occasional particles up to 6 to 8 inches may be incorporated provided that they do not result in “honeycombing” or preclude the obtainment of the desired degree of compaction. In confined areas, the maximum particle size should generally be restricted to 2.5 inches.

Only granular soils are recommended in confined areas such as utility trenches, below footings, etc. Generally, we recommend that all imported granular structural fill consist of a well-graded mixture of sands and gravels with no more than 20 percent fines (material passing the No. 200 sieve) and less than 30 percent retained on the 3/4 inch sieve. The plasticity index of import fine-grained soil shall not exceed 18 percent.

To stabilize soft subgrade conditions or where structural fill is required to be placed closer than 1.0 foot above the water table at the time of construction, a mixture of coarse gravels and cobbles and/or 1.5- to 2.0-inch gravel (stabilizing fill) should be utilized. It may also help to utilize a stabilization fabric, such as Mirafi 600X or equivalent, placed on the native ground if 1.5- to 2.0-inch gravel is used as stabilizing fill.

On-site soils are not recommended as structural fill but may be used as non-structural grading fill in landscape areas. Non-structural site grading fill is defined as all fill material not designated as structural fill and may consist of any cohesive or granular soils not containing excessive amounts of degradable material.

5.2.4 Fill Placement and Compaction

All structural fill shall be placed in lifts not exceeding 8 inches in loose thickness. Structural fills shall be compacted in accordance with the percent of the maximum dry density as determined by the ASTM² D-1557 (AASHTO³ T-180) compaction criteria in accordance with the table on the following page.

² American Society for Testing and Materials

³ American Association of State Highway and Transportation Officials

Location	Total Fill Thickness (feet)	Minimum Percentage of Maximum Dry Density
Beneath an area extending at least 5 feet beyond the perimeter of the structure	0 to 10	95
Site Grading Fills outside area defined above	0 to 5	90
Site Grading Fills outside area defined above	5 to 10	95
Trench Backfill	--	96
Pavement granular base/subbase	--	96

Structural fills greater than 10 feet thick are not anticipated at the site.

Subsequent to stripping and prior to the placement of structural site grading fill, the subgrade shall be prepared as discussed in Section 5.2.1, Site Preparation, of this report. In confined areas, subgrade preparation shall consist of the removal of all loose or disturbed soils.

If utilized for stabilizing fill, coarse gravel and cobble mixtures should be end-dumped, spread to a maximum loose lift thickness of 15 inches, and compacted by dropping a backhoe bucket onto the surface continuously at least twice. As an alternative, the fill may be compacted by passing moderately heavy construction equipment or large self-propelled compaction equipment at least twice. Subsequent fill material placed over the coarse gravels and cobbles shall be adequately compacted so that the “fines” are “worked into” the voids in the underlying coarser gravels and cobbles.

5.2.5 Utility Trenches

All utility trench backfill material below structurally loaded facilities (flatwork, floor slabs, roads, etc.) shall be placed at the same density requirements established for structural fill. If the surface of the backfill becomes disturbed during the course of construction, the backfill shall be proofrolled and/or properly compacted prior to the construction of any exterior flatwork over a backfilled trench. Proofrolling may be performed by passing moderately loaded rubber tire-mounted construction equipment uniformly over the surface at least twice. If excessively loose or soft areas are encountered during proofrolling, they must be removed (to a maximum depth of 2 feet below design finish grade) and replaced with structural fill.

Most utility companies and City-County governments are now requiring that Type A-1-a/A-1-b (AASHTO Designation – basically granular soils with limited fines) soils be used as backfill over utilities. These organizations are also requiring that in public roadways the backfill over major utilities be compacted over the full depth of fill to at least 96 percent of the maximum dry

density as determined by the AASHTO T-180 (ASTM D-1557) method of compaction. We recommend that as the major utilities continue onto the site that these compaction specifications are followed.

Natural or imported silt/clay soils are not recommended for use as trench backfill, particularly in structurally loaded areas.

5.3 SLOPE STABILITY

5.3.1 Parameters

The properties of the soils at this site were estimated using the results of our laboratory testing, published correlations, and our experience with similar soils. Accordingly, we estimated the following parameters for use in the stability analyses:

Material	Internal Friction Angle (degrees)	Apparent Cohesion (psf)	Saturated Unit Weight (pcf)
Colluvium	28	250	115
Bedrock	29	400	120
Landslide	16	200	115

For the seismic analysis, a peak horizontal ground acceleration of 0.292 using IBC 2012 guidelines and adjusted for Site Class effects (for Site Class D soils) was obtained for site (grid) locations of 41.3012 degrees latitude (north) and 111.8535 degrees longitude (west). To model sustained accelerations at the site, one-half of this value is typically used. Accordingly, a value of 0.146 was used as the pseudostatic coefficient in the seismic analyses.

5.3.2 Stability Analyses

We evaluated the global stability of the existing slope using the computer program *SLIDE*. This program uses a limit equilibrium (Simplified Bishop) method for calculating factors of safety against sliding on an assumed failure surface and evaluates numerous potential failure surfaces, with the most critical failure surface identified as the one yielding the lowest factor of safety of those evaluated. We analyzed the following configuration based on cross-sections provided in the referenced geologic study (see geological study in appendix for cross-section information and location):

- Slopes between 10H:1V (Horizontal:Vertical) to 4H:1V (Horizontal:Vertical) with an overall change in elevation of about 145 feet across the site. To simulate the load imposed on the slope by the proposed home, a load of 1,500 psf was modeled over the proposed building area. In addition, a phreatic surface was included in our analyses to

account for potential seasonal perched water and effluent water from the proposed on-site septic system.

Typically, the required minimum factors of safety are 1.5 for static conditions and 1.0 for seismic (pseudostatic) conditions. The results of our analyses indicate that the existing slope configurations analyzed will meet both these requirements provided our recommendations are followed (see Figures 7 and 8).

Slope movements or even failure can occur if the slope soils are undermined or become saturated. Groundwater was not encountered during the course of our field investigation; however saturation of the slope soils can adversely affect the stability of the slope. Measures must be implemented to reduce the potential for saturation of the soils at the site. Surface drainage at the bottom and top of the slope should be directed to prevent ponding at the toe or crest of the slope, and a cut-off drain on the slope above the home and at the head of the landslide deposit below the home is recommended to reduce the potential for infiltration of surface water at the site, as discussed further in Section 5.8, Subdrains. Landscape irrigation on this and surrounding areas may also create additional seasonal groundwater fluctuations. The limitations of landscape irrigation at the site are discussed further in Section 5.9, Site Irrigation. The property owner and the owner's representatives should be made aware of the risks should these or other conditions occur that could saturate or erode/undermine the slope soils.

Changes to the grading at the site and any retaining walls must be properly engineered to maintain stability of the slopes. GSH must review the final grading plans for the project prior to initiation of any construction.

5.4 SPREAD AND CONTINUOUS WALL FOUNDATIONS

5.4.1 Design Data

The proposed structure may be supported upon conventional spread and continuous wall foundations established upon a minimum of 2 feet of structural fill extending to suitable natural soils. For design, the following parameters are provided:

Minimum Recommended Depth of Embedment for Frost Protection	- 30 inches
Minimum Recommended Depth of Embedment for Non-frost Conditions	- 15 inches
Recommended Minimum Width for Continuous Wall Footings	- 16 inches
Minimum Recommended Width for Isolated Spread Footings	- 24 inches

Recommended Net Bearing Pressure
for Real Load Conditions

- 1,500 pounds
per square foot

Bearing Pressure Increase
for Seismic Loading

- 50 percent

The term “net bearing pressure” refers to the pressure imposed by the portion of the structure located above lowest adjacent final grade. Therefore, the weight of the footing and backfill to lowest adjacent final grade need not be considered. Real loads are defined as the total of all dead plus frequently applied live loads. Total load includes all dead and live loads, including seismic and wind.

5.4.2 Installation

Footings shall not be installed upon mass movement soil deposits, soft or disturbed soils, non-engineered fill, construction debris, frozen soil, or within ponded water. If the granular structural fill upon which the footings are to be established becomes disturbed, it shall be recompacted to the requirements for structural fill or be removed and replaced with structural fill.

The width of structural fill, where placed below footings, shall extend laterally at least 6 inches beyond the edges of the footings in all directions for each foot of fill thickness beneath the footings. For example, if the width of the footing is 2 feet and the thickness of the structural fill beneath the footing is 2.0 feet, the width of the structural fill at the base of the footing excavation would be a total of 4.0 feet, centered below the footing.

5.4.3 Settlements

Maximum settlements of foundations designed and installed in accordance with recommendations presented herein and supporting maximum anticipated loads as discussed in Section 2, Proposed Construction, are anticipated to be 1 inch or less.

Approximately 40 percent of the quoted settlement should occur during construction.

5.5 LATERAL RESISTANCE

Lateral loads imposed upon foundations due to wind or seismic forces may be resisted by the development of passive earth pressures and friction between the base of the foundations and the supporting soils. In determining frictional resistance, a coefficient of 0.40 should be utilized for foundations placed over granular structural fill. Passive resistance provided by properly placed and compacted granular structural fill above the water table may be considered equivalent to a fluid with a density of 300 pounds per cubic foot. Below the water table, this granular soil should be considered equivalent to a fluid with a density of 150 pounds per cubic foot.

A combination of passive earth resistance and friction may be utilized provided that the friction component of the total is divided by 1.5.

5.6 LATERAL PRESSURES

The lateral pressure parameters, as presented within this section, are for backfills which will consist of drained granular soil placed and compacted in accordance with the recommendations presented herein. The lateral pressures imposed upon subgrade facilities will, therefore, be basically dependent upon the relative rigidity and movement of the backfilled structure. For active walls, such as retaining walls which can move outward (away from the backfill), granular backfill may be considered equivalent to a fluid with a density of 35 pounds per cubic foot in computing lateral pressures. For more rigid walls (moderately yielding), generally not exceeding 8 feet in height, granular backfill may be considered equivalent to a fluid with a density of 45 pounds per cubic foot. The above values assume that the surface of the soils slope behind the wall is no steeper than 4 horizontal to 1 vertical and that the granular fill within 3 feet of the wall will be compacted with hand-operated compacting equipment.

For seismic loading, a uniform pressure shall be added. The uniform pressures based on different wall heights are provided in the following table:

Wall Height (feet)	Seismic Loading Active Case (psf)	Seismic Loading Moderately Yielding (psf)
4	25	55
6	40	85
8	55	115

5.7 FLOOR SLABS

Floor slabs may be established upon a minimum of 2 feet of structural fill extending to suitable natural soils. Under no circumstances shall floor slabs be established over mass movement deposit soils, non-engineered fills, loose or disturbed soils, sod, rubbish, construction debris, other deleterious materials, frozen soils, or within ponded water. In order to provide a capillary break and facilitate curing of the concrete, it is recommended that floor slabs be directly underlain by 4 inches of “free-draining” fill, such as “pea” gravel or three-quarters- to one-inch minus clean gap-graded gravel.

Settlement of lightly loaded floor slabs (average uniform pressure of 100 to 150 pounds per square foot or less) is anticipated to be less than 1/4 inch.

The tops of all floor slabs in habitable areas must be established at least 4 feet above the highest anticipated normal water level or 1.5 feet above the maximum groundwater level controlled by land drains.

5.8 SUBDRAINS

5.8.1 General

We recommend that the perimeter foundation subdrains and a cutoff drain above the home and near the head of the mass movement deposit soils be installed as indicated below.

5.8.2 Foundation Subdrains

Foundation subdrains should consist of a 4-inch diameter perforated or slotted plastic or PVC pipe enclosed in clean gravel. The invert of a subdrain should be at least 2 feet below the top of the lowest adjacent floor slab. The gravel portion of the drain should extend 2 inches laterally and below the perforated pipe and at least 1 foot above the top of the lowest adjacent floor slab. The gravel zone must be installed immediately adjacent to the perimeter footings and the foundation walls. To reduce the possibility of plugging, the gravel must be wrapped with a geotextile, such as Mirafi 140N or equivalent. Above the subdrain, a minimum 4-inch-wide zone of “free-draining” sand/gravel should be placed adjacent to the foundation walls and extend to within 2 feet of final grade. The upper 2 feet of soils should consist of a compacted clayey cap to reduce surface water infiltration into the drain. As an alternative to the zone of permeable sand/gravel, a prefabricated “drainage board,” such as Miradrain or equivalent, may be placed adjacent to the exterior below-grade walls. Prior to the installation of the footing subdrain, the below-grade walls should be dampproofed. The slope of the subdrain should be at least 0.3 percent. The gravel placed around the drain pipe should be clean 0.75-inch to 1.0-inch minus gap-graded gravel and/or “pea” gravel. The foundation subdrains can be discharged into the area subdrains, storm drains, or other suitable down-gradient location.

We recommend final site grading slope away from the structures at a minimum 2 percent for hard surfaces (pavement) and 5 percent for soil surfaces within the first 10 feet from the structures.

5.8.3 Cutoff Drain

To reduce potential infiltration of surface water and groundwater into the subsurface soils at the site, a cutoff drain should be installed upslope of the home and near the head of the mass movement deposit soils below the home. Final location of the required cutoff drains must be reviewed by GSH prior to construction. The drain should consist of a perforated 4-inch minimum diameter pipe wrapped in fabric and placed near the bottom of a minimum 24 inch wide trench excavated to a depth of at least 15 feet below existing grade or to competent bedrock and lined in filter fabric. The pipe should daylight at one or both ends of the drain and discharge to an appropriate drainage device or area. Clean gravel up to 2 inches in maximum size, with less than 10 percent passing the No. 4 sieve and less than 5 percent passing the No. 200 sieve, should be placed around the drain pipe. A fabric, such as Mirafi 140N or equivalent, should be placed between the clean gravel and the adjacent soils. A zone of clean gravel wrapped in fabric at least 24 inches wide should also extend above the drain, to within 2 feet of the ground surface, with

fabric placed over the top of the gravel. The upper 2 feet of soils should consist of a compacted clayey cap to reduce surface water infiltration into the drain.

5.9 SITE IRRIGATION

Proper site drainage is important to maintaining slope stability at the site. Saturation of soils at the site may result in slope movement or failure. Therefore, we recommend that no irrigation lines should be placed on the slope. Landscaping at the site should be planned to utilize drought resistant plants that require minimal watering. Plants or lawn may be placed on the slope, with plants watered using direct drip systems targeted only for each plant, and any lawn areas watered using sprinklers placed in a manner such that watering is a minimum of 30 feet back from the crest of the slope. Overwatering should be strictly avoided. The surface of the site should be graded to prevent the accumulation or ponding of surface water at the site. The property owner and the owner's representatives should be made aware of the risks should these or other conditions occur that could saturate or erode/undermine the slope soils.

To reduce the potential for saturation of the site soils, overwatering at the site should be strictly avoided. Watering at the site should be limited to a maximum equivalent rainfall of 0.5 inches per week. Irrigation at the site should be strictly avoided during periods of natural precipitation.

5.10 GEOSEISMIC SETTING

5.10.1 General

Utah municipalities have adopted the International Building Code (IBC) 2012. The IBC 2012 code determines the seismic hazard for a site based upon 2008 mapping of bedrock accelerations prepared by the United States Geologic Survey (USGS) and the soil site class. The USGS values are presented on maps incorporated into the IBC code and are also available based on latitude and longitude coordinates (grid points).

The structure must be designed in accordance with the procedure presented in Section 1613, Earthquake Loads, of the IBC 2012 edition.

5.10.2 Faulting

Based upon our review of available literature, no active faults are known to pass through the site. The nearest active fault is the Wasatch Fault Zone Weber Section, approximately 4.0 miles west of the site.

5.10.3 Soil Class

For dynamic structural analysis, the Site Class D – Stiff Soil Profile as defined in Chapter 20 of ASCE 7 (per Section 1613.3.2, Site Class Definitions, of IBC 2012) can be utilized.

5.10.4 Ground Motions

The IBC 2012 code is based on 2008 USGS mapping, which provides values of short and long period accelerations for the Site Class B boundary for the Maximum Considered Earthquake (MCE). This Site Class B boundary represents average bedrock values for the Western United States and must be corrected for local soil conditions. The following table summarizes the peak ground and short and long period accelerations for the MCE event and incorporates the appropriate soil amplification factor for a Site Class D soil profile. Based on the site latitude and longitude (41.3012 degrees north and -111.8535 degrees west, respectively), the values for this site are tabulated below:

Spectral Acceleration Value, T	Site Class B		Site Class D	
	Boundary		[adjusted for site	Design
	[mapped values]	Site	class effects]	Values
	(% g)	Coefficient	(% g)	(% g)
Peak Ground Acceleration	39.7	$F_a = 1.103$	43.8	29.2
0.2 Seconds (Short Period Acceleration)	$S_s = 99.2$	$F_a = 1.103$	$S_{MS} = 109.4$	$S_{DS} = 72.9$
1.0 Second (Long Period Acceleration)	$S_1 = 34.8$	$F_v = 1.704$	$S_{M1} = 59.3$	$S_{D1} = 39.5$

5.10.5 Liquefaction

The site is located in an area that has been identified by the Utah Geologic Survey as having “very low” liquefaction potential. Liquefaction is defined as the condition when saturated, loose, finer-grained sand-type soils lose their support capabilities because of excessive pore water pressure which develops during a seismic event. Clay soils, even if saturated, will generally not liquefy.

Liquefaction of the site soils is not anticipated during the design seismic event due to the unsaturated nature of the site soils.

5.11 SITE OBSERVATIONS


As stated previously, prior to placement of foundations, floor slabs, pavements, and site grading fills, a geotechnical engineer from GSH must verify that all mass movement deposit soils, non-engineered fill materials, topsoil, and disturbed soils have been removed and/or properly prepared and suitable subgrade conditions encountered. Additionally, GSH must observe fill placement and verify in-place moisture content and density of fill materials placed at the site.


5.12 CLOSURE

If you have any questions or would like to discuss these items further, please feel free to contact us at (801) 393-2012.

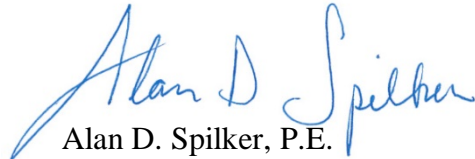
Respectfully submitted,

GSH Geotechnical, Inc.


Andrew M. Harris, P.E.
State of Utah No. 740456
Senior Geotechnical Engineer

A circular professional engineer seal for Andrew Michael Harris, State of Utah, License No. 7420456. The seal includes the text "LICENSED PROFESSIONAL ENGINEER" and "STATE OF UTAH".

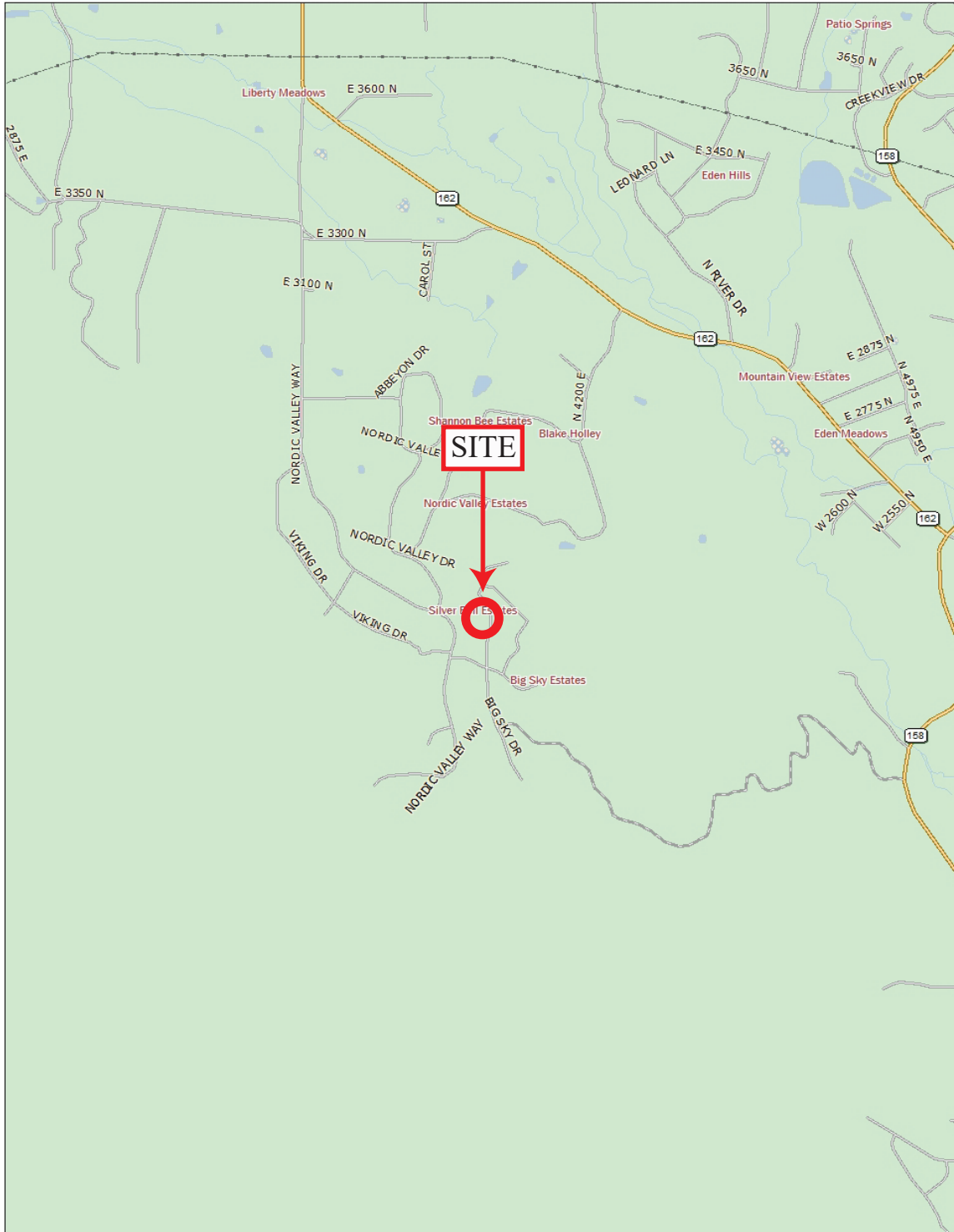
Reviewed by:


Alan D. Spilker, P.E.
State of Utah No. 334228
Senior Geotechnical Engineer

AMH/ADS:mmh

Encl. Figure 1, Vicinity Map
Figure 2, Site Plan
Figures 3A Boring Log
Figures 4A through 4C, Test Pit Logs
Figure 5, Key to Boring Log (USCS)
Figure 6, Key to Test Pit Log (USCS)
Figures 7 and 8, Stability Results
Appendix, Geologic Hazards Reconnaissance Study

Addressee (email)



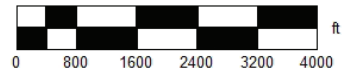
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MN (11.5° E)



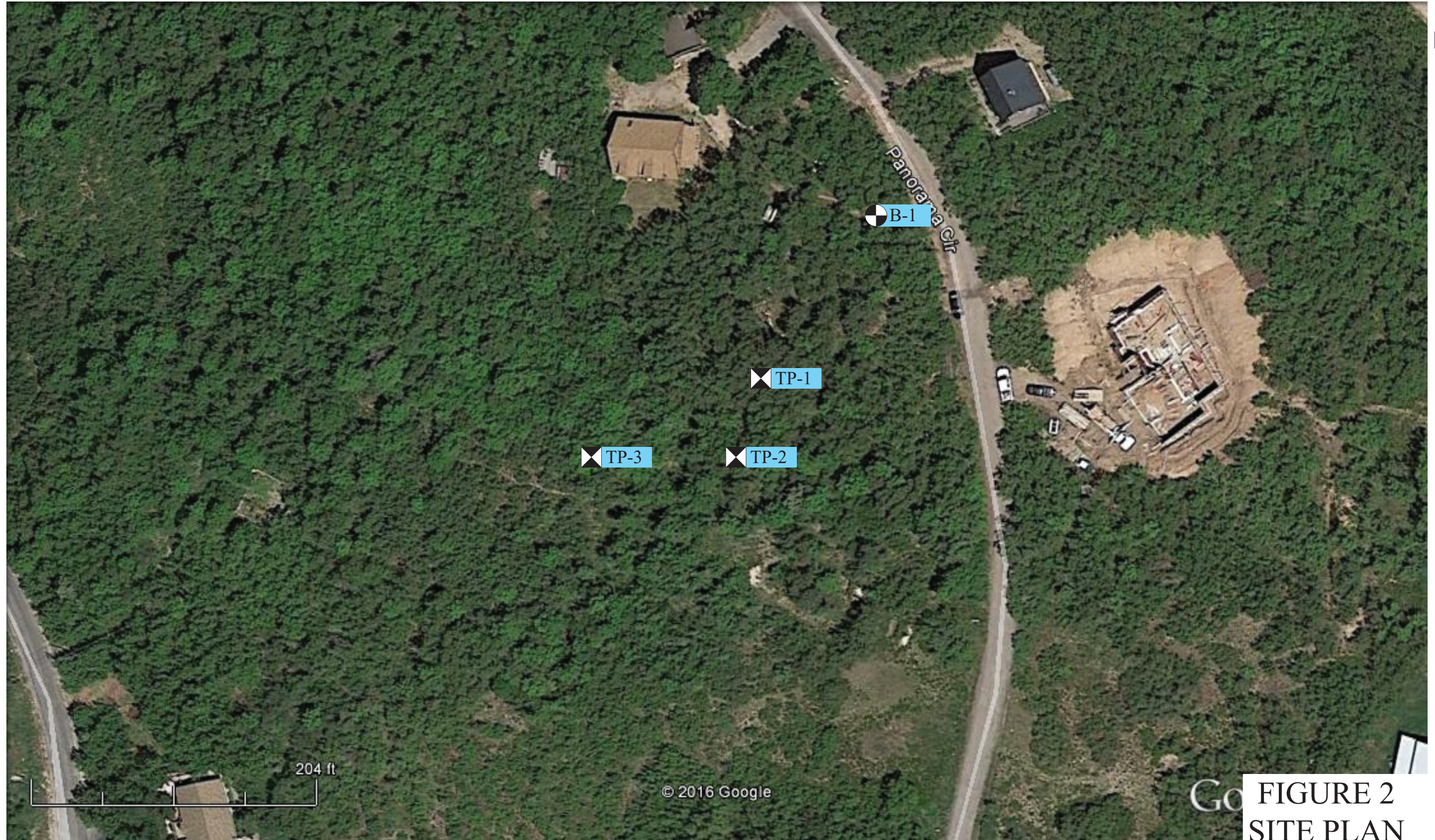
Data Zoom 13-0

FIGURE 1

VICINITY MAP



REFERENCE:
DELORME STREET ATLAS



Go **FIGURE 2**
SITE PLAN
 **GSH**

REFERENCE:
ADAPTED FROM AERIAL PHOTOGRAPH
DOWNLOADED FROM GOOGLE EARTH
IMAGERY DATE: JUNE 16, 2015



GSH

BORING LOG

Page: 1 of 2

BORING: B-1

CLIENT: Dave and Gayle Mariani

PROJECT NUMBER: 2104-01N-16

PROJECT: Lot 5 Big Sky Estates

DATE STARTED: 4/27/16

DATE FINISHED: 4/29/16

LOCATION: 2337 Oanorama Circle, Near Liberty, Weber County, Utah

GSH FIELD REP.: CM/RG

DRILLING METHOD/EQUIPMENT: 3-3/4" ID Hollow-Stem Auger

HAMMER: Automatic

WEIGHT: 140 lbs

DROP: 30"

GROUNDWATER DEPTH: Not Encountered (4/29/16)

ELEVATION: ---

WATER LEVEL	U S C S	DESCRIPTION	DEPTH (FT.)	BLOW COUNT	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
		Ground Surface	0								slightly moist medium dense
	SM/ SC	SILTY/CLAYEY FINE TO COARSE SAND, FILL with some fine gravel; major roots (topsoil) to 12"; brown									
	FILL SC	CLAYEY FINE TO COARSE SAND with some fine gravel; brown		41		8		28	25	8	
			5	67		8	127				dense
		grades light gray		50/4"							very dense
	GC	CLAYEY FINE GRAVEL with fine to coarse sand; reddish-brown to gray	10	54		10		14	21	10	slightly moist dense
	SC	CLAYEY FINE TO COARSE SAND reddish-brown		50/2"							moist very dense
			15	50/12"		15		23	33	11	
	BR	SILTSTONE/SANDSTONE BEDROCK highly fractured; highly weathered; brownish-gray	20								
			25								

See Subsurface Conditions section in the report for additional information.

FIGURE 3A



GSH

BORING LOG

Page: 2 of 2

BORING: B-1

CLIENT: Dave and Gayle Mariani

PROJECT NUMBER: 2104-01N-16

PROJECT: Lot 5 Big Sky Estates

DATE STARTED: 4/27/16

DATE FINISHED: 4/29/16

WATER LEVEL	U S C S	DESCRIPTION	DEPTH (FT.)	BLOW COUNT	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
			25								
		End of Exploration at 29.0' No groundwater encountered at time of drilling Installed 1.25" diameter slotted PVC pipe to 19.0'	30								
			35								
			40								
			45								
			50								

See Subsurface Conditions section in the report for additional information.

FIGURE 3A
(continued)



GSH

TEST PIT LOG

Page: 1 of 1

TEST PIT: TP-1

CLIENT: Dave and Gayle Mariani

PROJECT NUMBER: 2104-01N-16

PROJECT: Lot 5 Big Sky Estates

DATE STARTED: 4/29/16

DATE FINISHED: 4/29/16

LOCATION: 2337 Oanorama Circle, Near Liberty, Weber County, Utah

GSH FIELD REP.: HRW

EXCAVATING METHOD/EQUIPMENT: JCB 214S - Backhoe

GROUNDWATER DEPTH: Not Encountered (4/29/16)

ELEVATION: ---

WATER LEVEL	U S C S	DESCRIPTION	DEPTH (FT.)	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
		Ground Surface	0							moist medium stiff
	CL	SILTY CLAY with some fine sand; major roots (topsoil) to 6"; brown								
	SC	CLAYEY FINE TO COARSE SAND brown	5		19		30			moist medium dense
			10							dense
		End of Exploration at 11.0' No significant sidewall caving No groundwater encountered at time of excavation	15							
			20							
			25							

See Subsurface Conditions section in the report for additional information.

FIGURE 4A



GSH

TEST PIT LOG

Page: 1 of 1

TEST PIT: TP-2

CLIENT: Dave and Gayle Mariani

PROJECT NUMBER: 2104-01N-16

PROJECT: Lot 5 Big Sky Estates

DATE STARTED: 4/29/16

DATE FINISHED: 4/29/16

LOCATION: 2337 Oanorama Circle, Near Liberty, Weber County, Utah

GSH FIELD REP.: HRW

EXCAVATING METHOD/EQUIPMENT: JCB 214S - Backhoe

GROUNDWATER DEPTH: Not Encountered (4/29/16)

ELEVATION: ---

WATER LEVEL	U S C S	DESCRIPTION	DEPTH (FT.)	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
		Ground Surface	0							
	CL	SILTY CLAY with some fine sand; major roots (topsoil) to 8"; brown								moist very stiff
	SM/ ML	WEATHERED SILTSTONE/FINE SANDSTONE light gray					25	NP	NP	slightly moist hard
			5							
		grades claystone								
			10							
		End of Exploration at 10.0' No significant sidewall caving No groundwater encountered at time of excavation								
			15							
			20							
			25							

See Subsurface Conditions section in the report for additional information.

FIGURE 4B



GSH

TEST PIT LOG

Page: 1 of 1

TEST PIT: TP-3

CLIENT: Dave and Gayle Mariani

PROJECT NUMBER: 2104-01N-16

PROJECT: Lot 5 Big Sky Estates

DATE STARTED: 4/29/16

DATE FINISHED: 4/29/16

LOCATION: 2337 Oanorama Circle, Near Liberty, Weber County, Utah

GSH FIELD REP.: HRW

EXCAVATING METHOD/EQUIPMENT: JCB 214S - Backhoe

GROUNDWATER DEPTH: Not Encountered (4/29/16)

ELEVATION: ---

WATER LEVEL	U S C S	DESCRIPTION	DEPTH (FT.)	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
		Ground Surface	0							moist stiff
	CL	SILTY CLAY with some fine sand; major roots (topsoil) to 8"; brown								
	MH	SILSTONE BEDROCK light gray				74	72	34		very stiff slightly moist hard
		End of Exploration at 7.0' No significant sidewall caving No groundwater encountered at time of excavation								
			10							
			15							
			20							
			25							

See Subsurface Conditions section in the report for additional information.

FIGURE 4C

CLIENT: Dave and Gayle Mariani
 PROJECT: Lot 5 Big Sky Estates
 PROJECT NUMBER: 2104-01N-16

KEY TO BORING LOG

WATER LEVEL	USCS	DESCRIPTION	DEPTH (FT.)	BLOW COUNT	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
-------------	------	-------------	-------------	------------	---------------	--------------	-------------------	---------------	------------------	------------------	---------

① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩ ⑪ ⑫

COLUMN DESCRIPTIONS

- ① **Water Level:** Depth to measured groundwater table. See symbol below.
- ② **USCS:** (Unified Soil Classification System) Description of soils encountered; typical symbols are explained below.
- ③ **Description:** Description of material encountered; may include color, moisture, grain size, density/consistency,
- ④ **Depth (ft.):** Depth in feet below the ground surface.
- ⑤ **Blow Count:** Number of blows to advance sampler 12" beyond first 6", using a 140-lb hammer with 30" drop.
- ⑥ **Sample Symbol:** Type of soil sample collected at depth interval shown; sampler symbols are explained below.
- ⑦ **Moisture (%):** Water content of soil sample measured in laboratory; expressed as percentage of dryweight of
- ⑧ **Dry Density (pcf):** The density of a soil measured in laboratory; expressed in pounds per cubic foot.
- ⑨ **% Passing 200:** Fines content of soils sample passing a No. 200 sieve; expressed as a percentage.
- ⑩ **Liquid Limit (%):** Water content at which a soil changes from plastic to liquid behavior.
- ⑪ **Plasticity Index (%):** Range of water content at which a soil exhibits plastic properties.
- ⑫ **Remarks:** Comments and observations regarding drilling or sampling made by driller or field personnel. May include other field and laboratory test results using the following abbreviations:

CEMENTATION:	MODIFIERS:	MOISTURE CONTENT (FIELD TEST):
Weakly: Crumbles or breaks with handling or slight finger pressure.	Trace <5%	Dry: Absence of moisture, dusty, dry to the touch.
Moderately: Crumbles or breaks with considerable finger pressure.	Some 5-12%	Moist: Damp but no visible water.
Strongly: Will not crumble or break with finger pressure.	With > 12%	Saturated: Visible water, usually soil below water table.

Descriptions and stratum lines are interpretive; field descriptions may have been modified to reflect lab test results. Descriptions on the logs apply only at the specific boring locations and at the time the borings were advanced; they are not warranted to be representative of subsurface conditions at other locations or times.

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)	MAJOR DIVISIONS		USCS SYMBOLS	TYPICAL DESCRIPTIONS
	COARSE-GRAINED SOILS More than 50% of material is larger than No. 200 sieve size.	GRAVELS More than 50% of coarse fraction retained on No. 4 sieve.	CLEAN GRAVELS (little or no fines)	GW
GRAVELS WITH FINES (appreciable amount of fines)			GP	Poorly-Graded Gravels, Gravel-Sand Mixtures, Little or No Fines
			GM	Silty Gravels, Gravel-Sand-Silt Mixtures
SANDS More than 50% of coarse fraction passing through No. 4 sieve.			CLEAN SANDS (little or no fines)	SW
		SANDS WITH FINES (appreciable amount of fines)	SP	Poorly-Graded Sands, Gravelly Sands, Little or No Fines
FINE-GRAINED SOILS More than 50% of material is smaller than No. 200 sieve size.			SILTS AND CLAYS Liquid Limit less than 50%	SM
	SC	Clayey Sands, Sand-Clay Mixtures		
	ML	Inorganic Silts and Very Fine Sands, Rock Flour, Silty or Clayey Fine Sands or Clayey Silts with Slight Plasticity		
	SILTS AND CLAYS Liquid Limit greater than 50%	CL	Inorganic Clays of Low to Medium Plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean Clays	
		OL	Organic Silts and Organic Silty Clays of Low Plasticity	
		MH	Inorganic Silts, Micaceous or Diatomaceous Fine Sand or Silty Soils	
HIGHLY ORGANIC SOILS	SILTS AND CLAYS Liquid Limit greater than 50%	CH	Inorganic Clays of High Plasticity, Fat Clays	
		OH	Organic Silts and Organic Clays of Medium to High Plasticity	
		PT	Peat, Humus, Swamp Soils with High Organic Contents	

STRATIFICATION:	
DESCRIPTION	THICKNESS
Seam	up to 1/8"
Layer	1/8" to 12"
Occasional: One or less per 6" of thickness	
Numerous; More than one per 6" of thickness	

TYPICAL SAMPLER GRAPHIC SYMBOLS

- Bulk/Bag Sample
- Standard Penetration Split Spoon Sampler
- Rock Core
- No Recovery
- 3.25" OD, 2.42" ID D&M Sampler
- 3.0" OD, 2.42" ID D&M Sampler
- California Sampler
- Thin Wall

WATER SYMBOL

- Water Level

Note: Dual Symbols are used to indicate borderline soil classifications.

FIGURE 5



CLIENT: Dave and Gayle Mariani
 PROJECT: Lot 5 Big Sky Estates
 PROJECT NUMBER: 2104-01N-16

KEY TO TEST PIT LOG

WATER LEVEL	USCS	DESCRIPTION	DEPTH (FT.)	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
-------------	------	-------------	-------------	---------------	--------------	-------------------	---------------	------------------	------------------	---------

① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩ ⑪

COLUMN DESCRIPTIONS

- ① **Water Level:** Depth to measured groundwater table. See symbol below.
- ② **USCS:** (Unified Soil Classification System) Description of soils encountered; typical symbols are explained below.
- ③ **Description:** Description of material encountered; may include color, moisture, grain size, density/consistency,
- ④ **Depth (ft.):** Depth in feet below the ground surface.
- ⑤ **Sample Symbol:** Type of soil sample collected at depth interval shown; sampler symbols are explained below.
- ⑥ **Moisture (%):** Water content of soil sample measured in laboratory; expressed as percentage of dryweight of
- ⑦ **Dry Density (pcf):** The density of a soil measured in laboratory; expressed in pounds per cubic foot.
- ⑧ **% Passing 200:** Fines content of soils sample passing a No. 200 sieve; expressed as a percentage.
- ⑨ **Liquid Limit (%):** Water content at which a soil changes from plastic to liquid behavior.
- ⑩ **Plasticity Index (%):** Range of water content at which a soil exhibits plastic properties.
- ⑪ **Remarks:** Comments and observations regarding drilling or sampling made by driller or field personnel. May include other field and laboratory test results using the following abbreviations:

CEMENTATION:	MODIFIERS:	MOISTURE CONTENT (FIELD TEST):
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COARSE-GRAINED SOILS More than 50% of material is larger than No. 200 sieve size.	GRAVELS More than 50% of coarse fraction retained on No. 4 sieve.	CLEAN GRAVELS (little or no fines)	GW Well-Graded Gravels, Gravel-Sand Mixtures, Little or No Fines	
		GRAVELS WITH FINES (appreciable amount of fines)	GP Poorly-Graded Gravels, Gravel-Sand Mixtures, Little or No Fines	
		SANDS More than 50% of coarse fraction passing through No. 4 sieve.	CLEAN SANDS (little or no fines)	GM Silty Gravels, Gravel-Sand-Silt Mixtures
			SANDS WITH FINES (appreciable amount of fines)	GC Clayey Gravels, Gravel-Sand-Clay Mixtures
	FINE-GRAINED SOILS More than 50% of material is smaller than No. 200 sieve size.	SILTS AND CLAYS Liquid Limit less than 50%	ML	Inorganic Silts and Very Fine Sands, Rock Flour, Silty or Clayey Fine Sands or Clayey Silts with Slight Plasticity
			CL	Inorganic Clays of Low to Medium Plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean Clays
OL			Organic Silts and Organic Silty Clays of Low Plasticity	
SILTS AND CLAYS Liquid Limit greater than 50%		MH	Inorganic Silts, Micaceous or Diatomaceous Fine Sand or Silty Soils	
		CH	Inorganic Clays of High Plasticity, Fat Clays	
		OH	Organic Silts and Organic Clays of Medium to High Plasticity	
HIGHLY ORGANIC SOILS		PT	Peat, Humus, Swamp Soils with High Organic Contents	

STRATIFICATION:

DESCRIPTION	THICKNESS
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Layer	1/8" to 12"
Occasional: One or less per 6" of thickness	
Numerous; More than one per 6" of thickness	

TYPICAL SAMPLER GRAPHIC SYMBOLS

- Bulk/Bag Sample
- Standard Penetration Split Spoon Sampler
- Rock Core
- No Recovery
- 3.25" OD, 2.42" ID D&M Sampler
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- California Sampler
- Thin Wall

WATER SYMBOL

- Water Level

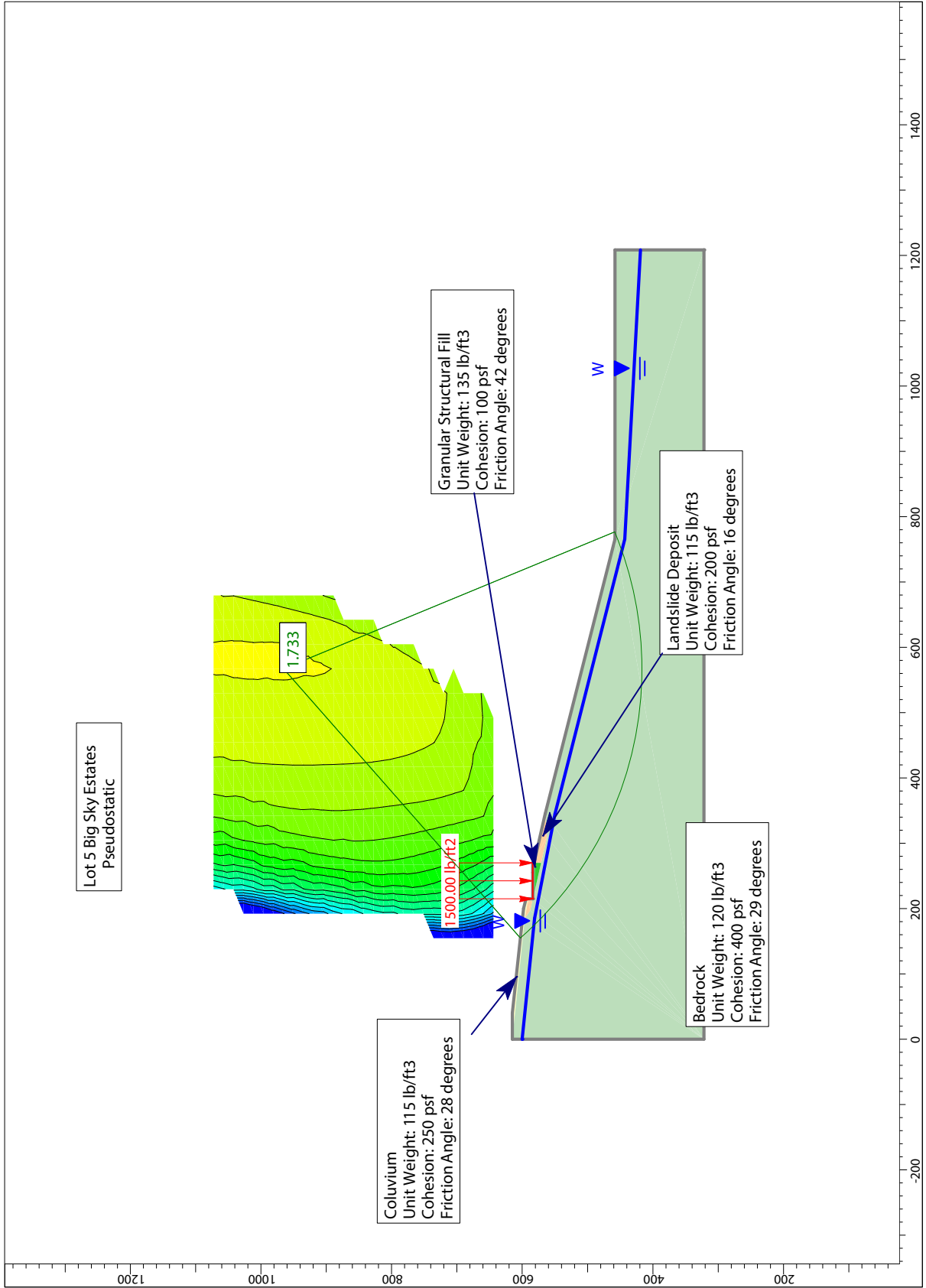
Note: Dual Symbols are used to indicate borderline soil classifications.

FIGURE 6



STABILITY RESULTS

LOT 5 BIG SKY ESTATES



STABILITY RESULTS

LOT 5 BIG SKY ESTATES

