Geotechnical Investigation
Green Hills Country Estates Lot 100
Weber County, Utah

May 2, 2018

Prepared by:

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Geotechnical Investigation
Green Hills Country Estates Lot 100
1330 North Maple Drive
Weber County, Utah
CG Project No.: 146-001

Prepared by:

Mark I. Christensen, P.E.
Principal

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May 2, 2018

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ATTACHED PLATES

1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE OF WORK

This report presents the results of a geotechnical investigation performed for the residential lot Green Hills Country Estates Lot 100, located at 1330 Maple Drive in Weber County, Utah. The general location of the project is indicated on the Project Vicinity Map, Plate 1. In general, the purposes of this investigation were to evaluate the subsurface conditions and the nature and engineering properties of the subsurface soils, and to provide recommendations for general site grading and for design and construction of floor slabs and foundations. This investigation included subsurface exploration, representative soil sampling, field and laboratory testing, engineering analysis, and preparation of this report. Prior to completion of our report, the Geologic Hazards Reconnaissance report for the property by Western GeoLogic, dated April 2, 2018, was reviewed to assist in our assessments.

The work performed for this report was authorized by Mr. Rhett Bonham and was conducted in accordance with the Christensen Geotechnical proposal dated April 11, 2018.

1.2 PROJECT DESCRIPTION

Based on conversations with Black Diamond Contracting, we understand that the proposed construction at the site is to consist of one single-family residence located in the western corner of the property. The proposed structure is to have a footprint on the order of 1,500 square feet and is to be one to two stories in height with a basement. Footings loads for the proposed structure are anticipated to be on the order of 3 to 4 klf for walls and 150 psf for floors. If structural loads are different from those anticipated, Christensen Geotechnical should be notified and allowed to reevaluate our recommendations.

2.0 METHODS OF STUDY

2.1 FIELD INVESTIGATION

The subsurface conditions at the site were explored by excavating two test pits at the location of the proposed house, one to a depth of 6 feet and one to a depth of 10 feet below existing site grade. The approximate test pit locations are shown on the Exploration Location Map, Plate 2. Logs of the subsurface conditions as encountered in the test pits were recorded at the time of excavation and are presented on the Test Pit Logs, Plates 3 and 4. A key to the symbols and terms used on the Test Pit Logs may be found on Plate 5.

Test pit excavation was accomplished with a mini excavator. Due to the subsurface conditions encountered, only disturbed samples were collected from the test pit sidewalls at the time of excavation. Samples were visually classified in the field and portions of each sample were packaged and transported to our laboratory for testing. Classifications for the individual soil units are shown on the attached Test Pit Logs.

2.2 LABORATORY TESTING

Of the soils collected during the field investigation, representative samples were selected for testing in the laboratory to evaluate the pertinent engineering properties. Laboratory tests included moisture content determinations, Atterberg limits determinations, and gradation analyses. A summary of our laboratory testing is presented in the table below:

Table No. 1: Laboratory Test Results

TEST HOLE NO.	DEPTH (ft.)	NATURAL DRY DENSITY (pcf)	NATURAL MOISTURE (%)	ATTERBERG LIMITS		GRAIN SIZE DISTRIBUTION (%)			SOIL TYPE
				LIQUID LIMIT	PLASTICITY INDEX	GRAVEL (+ #4)	SAND	SILT/ CLAY (- #200)	
TP-1	8		6.3	NP	NP	60.7	23.8	15.5	GM
TP-2	4		6.8	NP	NP	65.5	17.1	17.4	GM

The results of the laboratory tests are also presented on the Test Pit Logs (Plates 3 and 4), and more detailed laboratory results are presented on the laboratory testing plate (Plate 6).

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

3.0 GENERAL SITE CONDITIONS

3.1 SURFACE CONDITIONS

At the time of our investigation, the subject site was an undeveloped lot in an existing subdivision. The lot was located in Maple Canyon with Maple Creek crossing through the lot, flowing down to the southwest. Slopes above the creek varied from as steep as 3 to 1 to as little as 8 to 1 (horizontal to vertical). Vegetation at the site consisted of common native vegetation, including grasses, sage brush and dense pockets of oak brush. The lot was bordered by Maple Drive to the northwest, an existing house to the southwest and undeveloped land on all other sides.

3.2 SUBSURFACE CONDITIONS

3.2.1 Soils

Based on the two test pits completed for this investigation, the site is covered with 1 to 1½ feet of topsoil. Below the topsoil, subsurface soils consist of Silty GRAVEL with sand (GM) through the maximum depth explored (10 feet). Cobbles and boulders up to 2½ feet in diameter were encountered within the Silty GRAVEL with sand (GM).

3.2.2 Groundwater

Groundwater was not encountered within our test pits at the time of excavation. It should be understood that groundwater is likely below its seasonal high and may fluctuate in response to seasonal changes, precipitation, and irrigation.

4.0 SEISMIC CONSIDERATION

4.1 SEISMIC DESIGN CRITERIA

The State of Utah and Utah municipalities have adopted the 2015 International Building Code (IBC) for seismic design. The IBC seismic design is based on seismic hazard maps depicting probabilistic ground motions and spectral response; the maps, ground motions, and spectral response having been developed by the United States Geological Survey (USGS). Seismic design values, including the design spectral response, may be calculated for a specific site using the USGS Seismic Design Maps web-based application and the project site's approximate latitude and longitude and Site Class. Based on our field exploration, it is our opinion that this location is best described as a Site Class D which represents a "stiff soil" profile. The spectral acceleration values obtained from the USGS web-based application are shown below.

Table 2: IBC Seismic Response Spectrum Values

Site Location: Latitude = 41.2827° N Longitude = -111.7240° W			
Spectral Period (sec)	**Response Spectrum Spectral Acceleration (g)**		
0.2	S_S=0.776g	S_{MS}=0.923g	S_{DS}=0.615g
1.0	S_1= 0.257g	S_{M1}=0.485g	S_{D1}=0.324g

Using these values, the peak ground acceleration (PGA) is estimated to be 0.37g.

4.2 LIQUEFACTION

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

A review of the map "Special Study Areas, Wasatch Front and Nearby Areas, Utah" (Christenson et al., 2008), indicates that the subject site is located in an area designated as having a very low potential for liquefaction. Due to the soil conditions encountered at the site, we also assess the liquefaction potential to be very low through the depths explored.

5.0 ENGINEERING ANALYSIS AND RECOMMENDATIONS

5.1 GENERAL CONLUSIONS

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

5.2 EARTHWORK

5.2.1 General Site Preparation and Grading

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

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

5.2.2 Soft Soil Stabilization

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

5.2.3 Temporary Construction Excavations

Based on OSHA requirements and the soil conditions encountered during our field investigation, we anticipate that temporary construction excavations at the site that have vertical walls extending up to depths of 5 feet may be occupied without shoring; however, where groundwater or fill soils are encountered, flatter slopes may be required. Excavations which extend to more than 5 feet in depth should be sloped or shored in accordance with OSHA regulations for a type C soil. Stability of construction excavations is the contractor's responsibility. All excavations should be evaluated by qualified personnel prior to entry to assess the need for sloping or shoring.

5.2.4 Structural Fill and Compaction

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

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

5.3 FOUNDATIONS

Foundations for the planned structure may consist of conventional continuous and/or spread footings established on undisturbed native soil or structural fill extending down to undisturbed native soil. Footings for the proposed structure should be a minimum of 20 inches and 30 inches wide for continuous and spot footings, respectively. Exterior footings should be established at a minimum of 40 inches below the lowest adjacent grade to provide frost protection and confinement. Interior footings not subject to frost should be embedded a minimum of 18 inches for confinement.

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

5.4 ESTIMATED SETTLEMENT

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

5.5 LATERAL EARTH PRESSURES

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

Table No. 3: Lateral Earth Pressures

Condition	Lateral Pressure Coefficient	Equivalent Fluid Density (pcf)
Active Static	0.27	31
Active Seismic	0.11	13
At-Rest	0.43	49
Passive Static	3.69	424
Passive Seismic	-0.32	-36

We recommend that walls that are allowed little or no wall movement be designed using "at rest" conditions. Walls allowed to rotate at least 0.4 percent of the wall height may be designed with "active" pressures. The coefficients and densities presented above assume level backfill with no buildup of hydrostatic pressures. If anticipated, hydrostatic pressures and any surcharge loads should be added to the presented values. If sloping backfill is present, we recommend the geotechnical engineer be consulted to provide more accurate lateral pressure parameters once the design geometry is established.

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

Lateral building loads will be resisted by friction between the footings and the foundation soils and by passive pressure developed by backfill against the wall. For footings on native soils, we recommend an ultimate coefficient of friction of 0.45 be used. If passive resistance is used in conjunction with frictional resistance, the passive resistance should be reduced by ½. Passive earth pressure from soils subject to frost or heave should usually be neglected in design.

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

5.6 CONCRETE SLAB-ON-GRADE CONSTRUCTION

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

5.7 MOISTURE PROTECTION AND SURFACE DRAINAGE

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

1. The ground surface should be graded to drain away from the structures in all directions, with a minimum fall of 8 inches in the first 10 feet.
2. Roof runoff should be collected in rain gutters with downspouts designed to discharge well outside of the backfill limits.

3. Sprinkler heads should be aimed away from and placed at least 12 inches from foundation walls.
4. There should be adequate compaction of backfill around foundation walls, to a minimum of 90% density (ASTM D 1557). Water consolidation methods should not be used.

5.8 SUBSURFACE DRAINAGE

Due to the high elevation of the site and the location in an existing canyon, we recommend that all basement and retaining walls incorporate a foundation drain. The foundation drain should consist of a 4-inch-diameter slotted pipe placed at or below the bottom of footings and encased in at least 12 inches of free-draining gravel. The gravel should be extended up the foundation wall to within 2 feet of the final ground surface, and a filter fabric, such as Mirafi 140N, should separate the gravel from the native soils. The pipe should be graded to drain to the land drains, a storm drain or other free-gravity outfall unless provisions for pumped sumps are made. Gravel extending up the wall may be replaced by a fabricated drain panel such as Mirafi G 100N or equivalent.

5.9 SLOPE STABILITY

As recommended in the Western GeoLogic Geologic Hazards Reconnaissance, a slope stability assessment was performed in the area of the proposed house. Our assessment is based on the assumption that the proposed house will be located in the western corner of the lot. The profile used in our assessment was based on the North-South Profile presented on Figure 3D of the Western GeoLogic report. The slope stability assessment was performed using the Slide computer program and the modified Bishop's method of slices. For our analysis, we conservatively assumed that the Silty GRAVEL with sand has a strength consisting of an angle of internal friction of 35 degrees and a cohesion of 50 psf.

The slope was assessed under static and pseudo static conditions. The pseudo static condition is used to assess the slope during a seismic event. As indicated in Section 4.1, the peak ground acceleration at this site is estimated to be 0.37. As is common practice, half of this value was used in our pseudo static assessments. Minimum factors of safety of 1.5 and 1.0 for static and seismic conditions, respectively, were considered acceptable. Our analyses indicated that the area of the proposed structure has safety factors greater than 1.5 for the static and greater than 1.0 for the pseudo static conditions and is therefore considered suitable for the proposed construction.

6.0 LIMITATIONS

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

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

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

7.0 REFERENCES

Christenson, Gary E. and Shaw, Lucas M., 2008, "Liquefaction Special Study Areas, Wasatch Front and Nearby Areas, Utah," Utah Geological Survey, Supplement Map to Utah Circular 106.

Western GeoLogic, April 2, 2018, "Geologic Hazards Reconnaissance, Green Hills Country Estates Lot 100R, Huntsville, Weber County, Utah," unpublished consultant's report.

Base Photo: Utah AGRC

Drawing Not to Scale

N

Approximate Project Boundary

Christensen Geotechnical	Black Diamond Contracting Green Hills Country Estates Lot 100 Weber County, Utah Project No. 146-001 **Vicinity Map**	Plate 1

Drawing Not to Scale

Approximate Test Pit Location

N

Christensen Geotechnical	Black Diamond Contracting Green Hills Country Estates Lot 100 Weber County, Utah Project No. 146-001 **Exploration Location Map**	Plate 2

Date	
Started:	4/20/2018
Completed:	4/20/2018
Backfilled:	4/20/2018

TEST PIT LOG

Logged By: M Christensen
Equipment: Mini Trackhoe
Location: See Plate 2

Test Pit No.
TP-1
Sheet 1 of 1

Depth (feet)	Sample Type	Groundwater	Graphic Log	Group Symbol	Material Description	Dry Density (pcf)	Moisture Content (%)	Minus #200 (%)	Liquid Limit	Plastic Limit
0–1.5					Topsoil; Silty SAND - moist, dark brown					
1.5–10	Bulk/Bag (≈4.5 ft); Bulk/Bag (≈8 ft)			GM	Silty GRAVEL with sand - medium dense, moist, brown, with boulders up to 2½ feet in diameter		6.3	15.5		
10					Bottom of test pit at 10 feet					

Depth scale: 5, 10, 15

☒ Bulk/Bag Sample
▥ Undisturbed Sample
Stabllized Groundwater
Groundwater At Time of Excavation

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Black Diamond Contracting
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Plate
3

Date		TEST PIT LOG	Test Pit No.
Started:	4/20/2018	Logged By: M Christensen	TP-2
Completed:	4/20/2018	Equipment: Mini Trackhoe	
Backfilled:	4/20/2018	Location: See Plate 2	Sheet 1 of 1

Depth (feet)	Sample Type	Groundwater	Graphic Log	Group Symbol	Material Description	Dry Density (pcf)	Moisture Content (%)	Minus #200 (%)	Liquid Limit	Plastic Limit
					Topsoil; Silty SAND - moist, dark brown					
				GM	Silty GRAVEL with sand - medium dense, moist, brown, with boulders up to 2½ feet in diameter					
	☒						6.8	17.4		
5										
					Refusal at 6 feet on boulders					
10										
15										

☒ Bulk/Bag Sample
▥ Undisturbed Sample

▼ Stabllized Groundwater
▽ Groundwater At Time of Excavation

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RELATIVE DENSITY – COURSE GRAINED SOILS

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

CONSISTENCY – FINE GRAINED SOILS

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

CEMENTATION

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

MOISTURE

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

GRAIN SIZE

Description		Sieve Size	Grain Size (in)	Approximate Size
Boulders		>12"	>12"	Larger than basketball
Cobbles		3" – 12"	3" – 12"	Fist to basketball
Gravel	Coarse	3/4" - 3"	3/4" - 3"	Thumb to fist
	Fine	#4 – 3"	0.19 – 0.75	Pea to thumb
Sand	Coarse	#10 - #4	0.079 – 0.19	Rock salt to pea
	Medium	#40 - #10	0.017 – 0.079	Sugar to rock salt
	Fine	#200 - #40	0.0029 – 0.017	Flour to sugar
Silt/Clay		<#200	<0.0029	Flour sized or smaller

STRATAFICATION

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

MODIFIERS

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

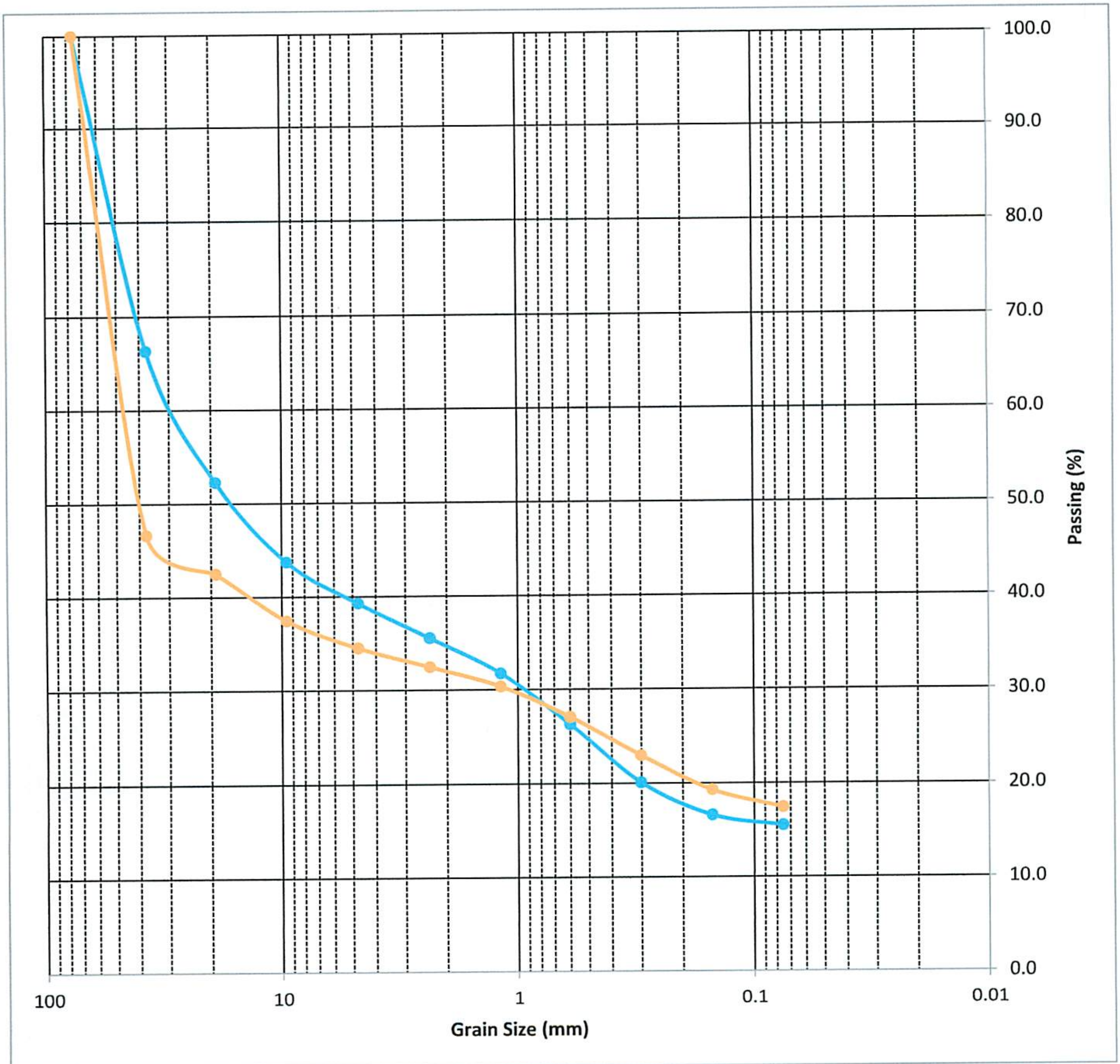
STRATIFICATION

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

NOTES

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

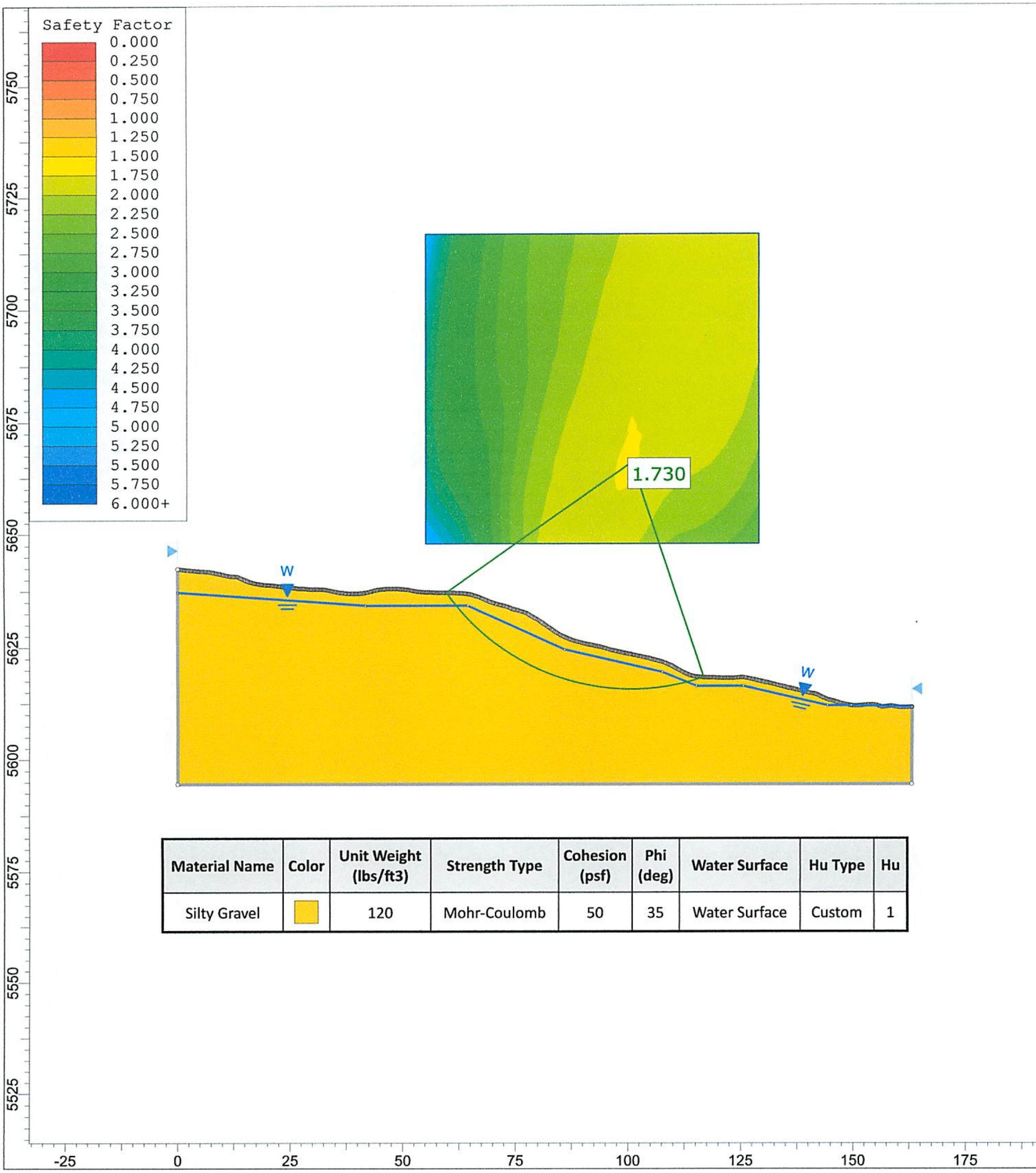
Grain Size Distribution



Samples tested did not include particles larger than 3 inches in diameter.

Location	Depth		Classification	% Gravel	% Sand	% Silt and Clay
TP-1	8	● (blue)	Silty GRAVEL with sand	60.7	23.8	15.5
TP-2	4	● (orange)	Silty GRAVEL with sand	65.5	17.1	17.4

Christensen Geotechnical	**Black Diamond Contracting** **Green Hills Country Estates Lot 100** **Weber County, Utah** **Project No.: 146-001**	**Plate** **6**



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Silty Gravel		120	Mohr-Coulomb	50	35	Water Surface	Custom	1

Global Stability - Static

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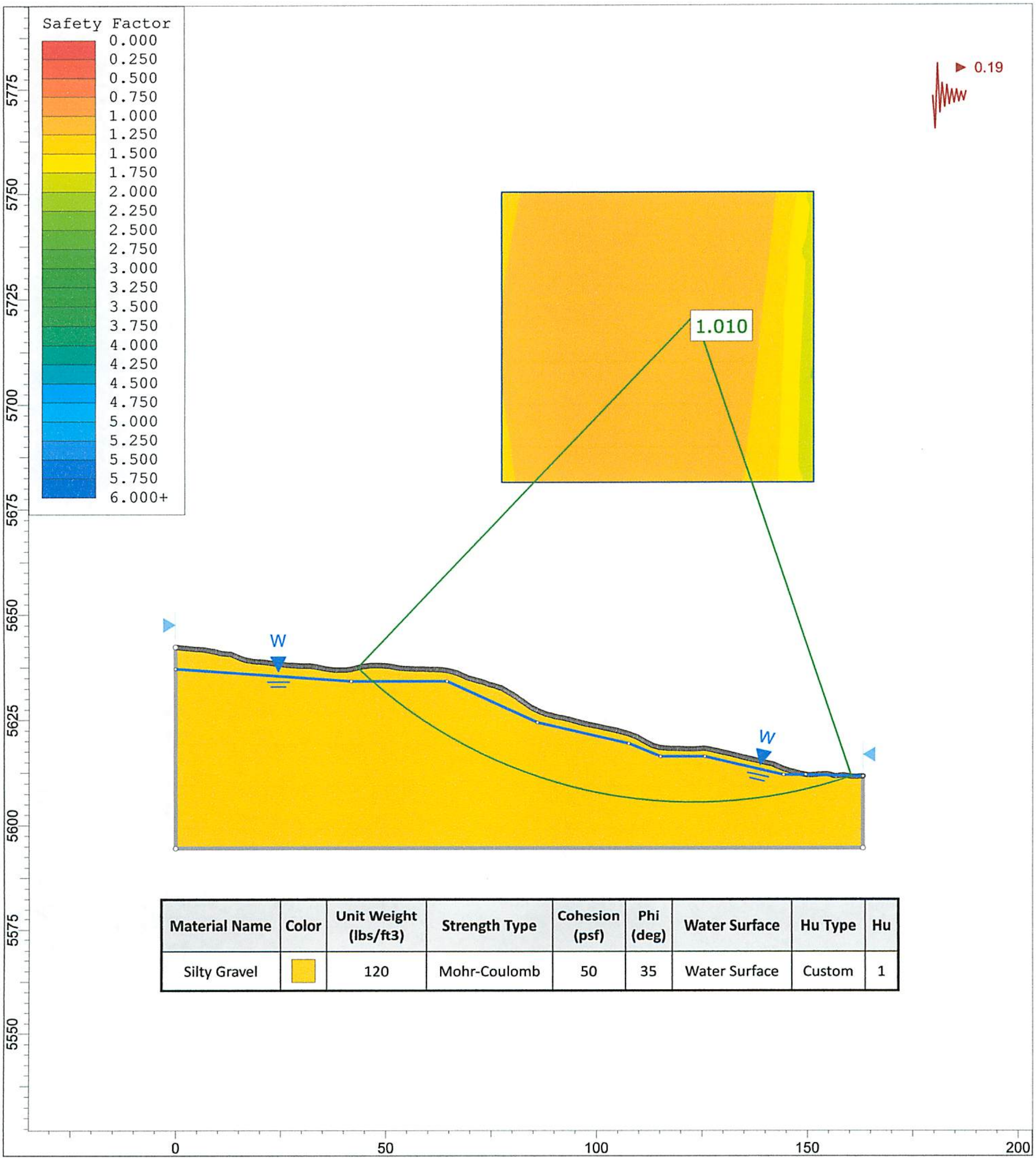
Plate 7



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Silty Gravel		120	Mohr-Coulomb	50	35	Water Surface	Custom	1

Global Stability - Pseudo Static

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Plate 8

Utah Geological Survey

<table>
<tr><td colspan="3">Project:
Review of a geotechnical and landslide-hazard report for the proposed Green Hill Country Estates Phase VI, Weber County, Utah</td><td>Requesting Agency:
Weber County Planning Commission</td></tr>
<tr><td>By:
Francis Ashland</td><td>Date:
7-2-96</td><td>County:
Weber</td><td rowspan="2">Job No:
96-19</td></tr>
<tr><td colspan="2">USGS Quadrangle:
Browns Hole (1368)</td><td>Number of attachments:
none</td></tr>
</table>

INTRODUCTION

At the request of Jim Gentry, Weber County Planning Commission, I reviewed geologic-hazard portions of a geotechnical and landslide-hazard report for the proposed Green Hill Country Estates Phase VI (Applied Geotechnical Engineering Consultants, Inc. [AGEC], 1996). The proposed subdivision is in the SE1/4 section 4 and the N1/2 section 9, T. 6 N., R. 2 E., Salt Lake Base Line and Meridian. The scope of work included a review of unpublished geotechnical data. I performed no field inspection of the property.

LANDSLIDES

The AGEC (1996) report indicates landsliding on the property of clay soils in road cuts with slopes exceeding 3.5:1 (horizontal:vertical). AGEC speculates four existing landslides were triggered by a reduction in strength when soils became wet during infiltration of runoff in spring 1995. In addition, AGEC infers that increases in slope angle due to road cuts may also have contributed to the failures. AGEC recommends lower final cut-slope angles for the soil types at the property and upslope surface drainage that I believe will reduce the likelihood of future landsliding. AGEC also recommends several options for stabilization of the four existing landslides (AGEC, figure 2) including excavation and replacement, regrading to flatter slopes, and regrading to present slope angles in combination with subsurface interceptor drains. I believe these recommendations are adequate to stabilize existing landslides as long as construction is carefully monitored. AGEC's assessment of the landslide hazard at the property is thorough, well documented, and supported by laboratory testing and field observations.

OTHER GEOLOGIC HAZARDS

The AGEC (1996) report lists or makes recommendations to reduce losses from other potential geologic hazards, including expansive soils, shallow ground water, and earthquake ground shaking. AGEC indicates local expansive clay soils on the property that swell upon wetting to nearly 3 percent while under a load of 1 ksf. Because consolidation tests were performed on only two samples, the extent of expansive soils and their maximum swell potential are not well known. AGEC recommends shallow spread footings on "natural undisturbed soil or... compacted strubtural fill." To reduce foundation heave, AGEC recommends measures to reduce the chance of wetting expansive soils near structures including site grading, installation of underdrains, and a precaution regarding irrigation. AGEC also recommends that a geotechnical engineer observe all footing excavations to identify whether expansive soils are present in the subgrade, and I strongly concur. However, AGEC provides no specific foundation recommendations in the event that expansive soils are present beneath footings. I believe that such lot-specific foundation recommendations should be provided wherever expansive soils are encountered in the foundation subgrade. AGEC indicates that, "ideally", expansive soils beneath floor slabs should be excavated and replaced with structural fill. In addition, AGEC recommends "positive joints" between floor slabs and bearing walls that allow the slab to heave independently, and a perimeter "positive drainage system." Although AGEC's foundation and floor slab recommendations may be adequate, my experience indicates that spread footings and slab-on-grade are not conservative designs for areas with expansive soils. Elsewhere in Utah, expansive soils exhibiting similar amounts of swell under a load of 1 ksf have caused building distress or heave. Also, although AGEC's grading, drainage, and irrigation recommendations would, if properly implemented, reduce the potential for damage to structures, they do not address the potential damage to roads, other paved areas, and buried utilities. Because of the complexity of AGEC's recommendations and the difficulties in implementation, I believe that some damage to structures as well as roads, utilities, and paved areas should be anticipated.

The AGEC (1996) report indicates no ground water in any excavation to a depth of 7 feet. However, because the excavations were made in November, ground-water levels may have been at or near a seasonal low and may not be representative of other times of the year. AGEC indicates shallow perched ground-water conditions are possible during times of runoff or snowmelt and recommends an underdrain system that, if implemented, should be adequate to deal with post-construction shallow ground water. For construction during the late winter or spring, shallow ground water may be encountered during homesite excavation.

AGEC recommends building to seismic zone 3 standards to help reduce losses from ground shaking in a moderate to strong earthquake, and I concur.

SUMMARY

AGEC's assessment of landsliding at the property is thorough and well documented, and I concur with its conclusions and recommendations related to this hazard. AGEC's surface grading, drainage, irrigation, and "positive-joint" system recommendations are reasonable to reduce problems from expansive soils but assuring that they are followed will be difficult. AGEC's recommendation to observe footing excavations to identify expansive soils is adequate, provided lot-specific foundation recommendations are given wherever expansive soils are found in the foundation subgrade. AGEC does not address the potential for damage to roads, utilities, and paved areas, and further assessment of the extent of expansive soils on the property may be necessary to address this issue. I concur with other recommendations to reduce losses from shallow ground water and earthquake ground shaking.

REFERENCE

Applied Geotechnical Engineering Consultants, Inc., 1996, Geotechnical and landslide study - Green Hill Country Estates Phase VI, part of sections 4 and 9, T6N, R2E SLB&M - Weber County, Utah: Midvale, Utah, unpublished consultant's report, 21 p.