GSH

REPORT
GEOTECHNICAL STUDY
PROPOSED SCUBA DIVE AND SHELL OFFICE SPACE
APPROXIMATELY 2502 WEST 12600 SOUTH
RIVERTON, UTAH

Submitted To:

Mr. Eric Larson
2339 West 12420 South
Riverton, Utah 84065

Submitted By:

GSH Geotechnical, Inc.
473 West 4800 South
Salt Lake City, Utah 84123

March 24, 2017

Job No. 2367-001-17

OK
RC BKM

GSH

March 24, 2017
Job No. 2367-001-17

Mr. Eric Larson
2339 West 12420 South
Riverton, Utah 84065

Mr. Larson:

Re: Report
Geotechnical Study
Proposed SCUBA Dive and Shell Office Space
Approximately 2502 West 12600 South
Riverton, Utah

1. INTRODUCTION

1.1 GENERAL

This report presents the results of our geotechnical study performed at the site of the proposed SCUBA Dive and Shell Office Space located at approximately 2502 West 12600 South in Riverton, Utah. The general location of the site with respect to existing roadways, as of 2017, is presented on Figure 1, Vicinity Map. A more detailed layout of the site showing the proposed development and roadways is presented on Figure 2, Site Plan. The approximate locations of the borings completed 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. Eric Larson and Mr. Robert Gifford of GSH Geotechnical, Inc. (GSH).

In general, the objectives of this study were to:

1. Define and evaluate the subsurface soil and groundwater conditions at the proposed site.

2. Provide appropriate foundation, earthwork, and pavement recommendations, and geoseismic information to be utilized in the design and construction of the proposed facility.

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

1. A field program consisting of the drilling, logging, and sampling of 8 borings.

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. 17-0242 dated March 1, 2017.

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 borings, 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 multi-use office structure will have a footprint of approximately 12,800 square feet located within the central portion of the approximately 1-acre parcel. The building will be 1-extended level in height above grade with a swimming pool constructed within the building. Construction will consist of wood-framing supported on conventional concrete spread and continuous wall footings.

Projected maximum column and continuous wall loads are on the order of 80 to 100 kips and 2 to 4 kips per lineal foot, respectively.

At-grade paved parking will be part of the overall site development. Projected traffic in the pavement areas is anticipated to consist of a light volume of automobiles and light trucks, occasional medium-weight trucks, and occasional heavyweight trucks (garbage trucks).

Maximum site grading cuts and fills are anticipated to be on the order of 2 to 3 feet.

3. SITE INVESTIGATIONS

3.1 FIELD PROGRAM

In order to define and evaluate the subsurface soil and groundwater conditions across the site, 8 exploration borings were drilled within the proposed building footprint to depths of about 5 to 21 feet below existing grades. The borings were drilled using a truck-mounted rotary drill rig equipped with hollow-stem augers. The approximate locations of the borings 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 drilling operations, a continuous log of the subsurface conditions encountered was maintained. In addition, samples of the typical soils penetrated were obtained for subsequent laboratory testing and examination. The soils were classified in the field based upon visual and textural examination. These classifications were later supplemented by subsequent inspection and testing in our laboratory. Detailed graphical representation of the subsurface conditions encountered is presented on Figures 3A through 3H, Log of Borings. Soils were classified in accordance with the nomenclature described on Figure 4, Key to Boring Log (USCS).

A 3.25-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 at select locations. 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.

Following completion of drilling operations, a 1.25-inch diameter slotted PVC pipe was installed in Borings B-1, B-3, and B-5 to provide a means of monitoring the groundwater fluctuations. The borings were backfilled with auger cuttings.

3.2 LABORATORY TESTING

3.2.1 General

In order to provide data necessary for our engineering analyses, a laboratory testing program was completed. The program included moisture and density, partial gradation, consolidation, and chemical tests. The following paragraphs describe the tests and summarize the test data.

3.2.2 Moisture and Density Tests

To aid in classifying the soils and to help correlate other test data, moisture and density tests were performed on selected samples. The results of these tests are presented on the boring logs, Figures 3A through 3H.

3.2.3 Partial Gradation Tests

To aid in classifying the granular soils, partial gradation tests were performed. Results of the tests are tabulated below and are presented on the boring logs, Figures 3A through 3H.

Boring No.	Depth (feet)	Percent Passing No. 200 Sieve	Moisture Content Percent	Soil Classification
B-1	20.0	8.4	3.0	SP/SM
B-5	10.0	51.8	9.1	SM/ML

3.2.4 Consolidation Tests

To provide data necessary for our settlement analysis, a consolidation test was performed on each of 2 representative samples of the near-surface natural clay soils encountered. The results of the tests indicate that the samples tested were moderately over-consolidated and will exhibit moderate strength and compressibility characteristics under the anticipated loading range. Detailed results of the tests are maintained within our files and can be transmitted to you, upon your request.

3.2.5 Chemical Tests

To determine if the site soils will react detrimentally with concrete, chemical tests were performed on a representative sample of the near-surface soils encountered at the site. The results of the chemical tests are tabulated below:

Boring No.	Depth (feet)	Soil Classification	Total Water Soluble Sulfate (mg/kg-dry)	pH
B-1	2.5	CL	659	9.02

4. SITE CONDITIONS

4.1 SURFACE

The site consists of a vacant/undeveloped, rectangular-shaped, 1-acre parcel located at approximately 2502 West 12600 South in Riverton, Utah. It is sparsely vegetated with various weeds and grasses within the central portion with occasional trees along the perimeter. The topography of the site is relatively flat and slopes down to the east with a total relief of approximately 2 to 3 feet.

The site is bounded to the north by multi-family residential structures, to the east by a multi-tenant commercial structure with associated pavements, to the south by 12600 South Street, and to the west by a credit union and associated pavements.

4.2 SUBSURFACE SOIL AND GROUNDWATER

The soil conditions encountered within the borings were relatively similar. Non-engineered fill soils were encountered at the surface and extended to depths ranging from 0.5 to 1 foot within Borings B-1, B-2, B-3, and B-5. Loose/disturbed topsoil was encountered to a depth of about 5 inches in the remaining borings. Underlying the non-engineered fill, natural soils were encountered. The natural soils consisted of silty clay that extended to depths ranging from 8.5 to 11 feet in Borings B-1, B-2, B-4, and B-5, and to the maximum depths explored in the remaining borings. Underlying the clay, sand soils with varying silt content were encountered to the maximum depths explored.

The natural clay soils were slightly moist to moist, stiff to hard, and light brown to brown in color. The natural clay soils are anticipated to exhibit moderate strength and compressibility characters under the anticipated load range.

The natural granular soils were slightly moist to moist, medium dense to very dense, and light brown to brown in color. The natural granular soils are anticipated to exhibit relatively high strength and low compressibility characteristics under the anticipated load range.

Groundwater was not encountered within the borings to depths explored at the time of drilling, nor again when the piezometers were measured on March 23, 2016. Groundwater is projected to be at depths greater than 21 feet below ground surface and is not anticipated to affect construction.

For a more detailed description of the subsurface conditions encountered, please refer to Figure 3A through 3H, Boring Logs. The lines designating the interface between soil types on the boring logs generally represent approximate boundaries. In situ, the transition between soil types may be gradual.

5. DISCUSSIONS AND RECOMMENDATIONS

5.1 SUMMARY OF FINDINGS

The results of our study indicate that the proposed structure may be supported upon conventional spread and continuous wall foundations upon suitable natural soils and/or structural fill extending to suitable natural soils.

A surficial layer of non-engineered fill up to one foot thick in some of the borings was encountered during the field investigation. This fill may extend to greater depths in other areas of the site. All non-engineered fill and loose/disturbed topsoil must be completely removed below the structure and pavements.

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

In the following sections, detailed discussions pertaining to earthwork, foundations, lateral resistance, floor slabs, pavements, 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, loose surficial fill piles (if encountered), and any other deleterious materials from beneath an area extending out at least 4 feet from the perimeter of the proposed building and 2 feet beyond pavements and exterior flatwork areas. Vegetation and other deleterious materials should be removed from the site. Topsoil, although unsuitable for utilization as structural fill, may be stockpiled for subsequent landscaping purposes.

Non-engineered fill soil was encountered to a depth of 1.5 to 1 foot below ground surface within the borings and may extend to greater depths in other areas of the site. All non-engineered fill soils must be completely removed to expose suitable natural soils below the structure and pavements.

Subsequent to the above operations and prior to the placement of footings, structural site grading fill, floor slabs, and pavements, the exposed natural subgrade must be proof rolled by passing moderate-weight rubber tire-mounted construction equipment over the surface at least twice. If any loose, soft, or disturbed zones are encountered, they must be completely removed below footings. If removal depth required is greater than 2 feet, GSH must be notified to provide further recommendations. Below floor slab and pavement areas, unsuitable soils encountered during re-compaction and/or proof rolling must be removed to a maximum depth of 2 feet and replaced with compacted granular structural fill.

5.2.2 Temporary Excavations

Temporary construction excavations in cohesive soil, not exceeding 4 feet in depth and above or below the groundwater table, may be constructed with near-vertical sideslopes. Temporary excavations up to 8 feet deep in fine-grained cohesive soils, above or below the water table, may be constructed with sideslopes no steeper than one-half horizontal to one vertical (0.5H:1V). Excavations deeper than 8 feet are not anticipated at the site.

For granular (cohesionless) soils, construction excavations above the water table, not exceeding 4 feet, should be no steeper than one-half horizontal to one vertical (0.5H:1V). For excavations up to 8 feet in granular soils and above the water table, the slopes should 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 8 feet are not anticipated at the site.

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 is defined as all fill which will ultimately be subjected to structural loadings, such as imposed by footings, floor slabs, pavements, etc. Structural fill will be required as backfill over foundations and utilities, as site grading fill, and as replacement fill below footings. All structural fill must be free of sod, rubbish, topsoil, frozen soil, and other deleterious materials.

Structural site grading fill is defined as structural fill placed over relatively large open areas to raise the overall grade. For structural site grading fill, the maximum particle size shall not exceed 4 inches; although, occasional larger particles, not exceeding 8 inches in diameter, may be incorporated if placed randomly in a manner such that "honeycombing" does not occur and the desired degree of compaction can be achieved. The maximum particle size within structural fill placed within confined areas shall be restricted to 2 inches.

All imported granular structural fill shall consist of a fairly well graded mixture of sand and gravel containing less than 20 percent fines (percent by weight of material passing the U.S. No. 200 sieve) and no more than 30 percent retained on the 0.75-inch sieve.

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

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 AASHTO[1] T-180 (ASTM[2] D-1557) compaction criteria in accordance with the table on the following page.

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1 American Association of State Highway and Transportation Officials
2 American Society for Testing and Materials

Location	Total Fill Thickness (feet)	Minimum Percentage of Maximum Dry Density
Beneath an area extending at least 3 feet beyond the perimeter of the structure	0 to 8	95
Site Grading Fills Outside area defined above	0 to 5	90
Site Grading fills Outside area defined above	5 to 8	95
Utility Trenches	--	96
Aggregate base	--	96

Structural fills greater than 8 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 should consist of the removal of all loose or disturbed soils.

Non-structural fill may be placed in lifts not exceeding 12 inches in loose thickness and compacted by passing construction, spreading, or hauling equipment over the surface at least twice.

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 proof rolled and/or properly compacted prior to the construction of any exterior flatwork over a backfilled trench. Proof rolling shall 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 proof rolling, they shall 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-1a or A-1b (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. GSH recommends that as the major utilities continue onto the site that these compaction specifications are followed.

Fine-grained soils, such as clays/silts, are not recommended as trench backfill.

5.3 SPREAD AND CONTINUOUS WALL FOUNDATIONS

5.3.1 Design Data

The proposed structure may be supported upon conventional spread and continuous wall foundations established upon suitable natural soils and/or 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	- 18 inches
Minimum Recommended Width for Isolated Spread Footings	- 24 inches
Recommended Net Bearing Pressure for Real Load Conditions	- 2,500 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.

5.3.2 Installation

Under no circumstances shall the footings be established upon non-engineered fills, loose or disturbed soils, topsoil, sod, rubbish, construction debris, other deleterious materials, frozen soils, or within ponded water. If unsuitable soils are encountered, they must be completely removed and replaced with compacted structural fill.

The width of structural fill, where placed below footings, should 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 feet, the width of the structural fill at the base of the footing excavation would be a total of 4 feet, centered below the footing.

5.3.3 Settlements

Settlements of foundations designed and installed in accordance with above recommendations and supporting maximum projected structural loads are anticipated to be less than 1 inch. Settlements are expected to occur rapidly, with approximately 40 percent or more of the settlements occurring during construction.

5.4 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 footings and the supporting soils. In determining frictional resistance, a coefficient of 0.30 should be utilized for foundations placed on native soils and a coefficient of 0.45 should be utilized for foundations placed over 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.

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

5.5 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), granular backfill may be considered equivalent to a fluid with a density of 45 pounds per cubic foot. For very rigid non-yielding walls, granular backfill should be considered equivalent to a fluid with a density of at least 55 pounds per cubic foot. The above values assume that the surface of the soils slope behind the wall is horizontal and that the granular fill within 3 feet of the wall will be compacted with hand-operated compacting equipment.

For seismic loading of retaining walls/below-grade walls, the uniform lateral pressures on the following page, in pounds per square foot (psf), should be added based on wall depth and wall case.

Uniform Lateral Pressures*			
Wall Height (Feet)	**Active Pressure Case (psf)**	**Moderately Yielding Case (psf)**	**At Rest/Non-Yielding Case (psf)**
4	25	55	85
6	40	85	130
8	55	115	175
10	65	140	215

* Linear interpolation may be applied between depths

5.6 FLOOR SLABS

Floor slabs may be established upon properly prepared suitable natural soils and/or upon structural fill extending to properly prepared suitable natural soils. Under no circumstances shall floor slabs be established over non-engineered fills, loose or disturbed soils, sod, rubbish, construction debris, other deleterious materials, frozen soils, or within ponded water.

In order to facilitate curing of the concrete, it is recommended that floor slabs be directly underlain by at least 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 designed according to previous recommendations (average uniform pressure of 150 pounds per square foot or less) is anticipated to be less than one-half of an inch; however, due to the existing fill material at the site, floor slab movement may be non-uniform, even when placed on properly prepared non-engineered fill.

5.7 PAVEMENTS

The existing soils will exhibit poor pavement support characteristics when saturated or nearly saturated. All pavement areas must be prepared as previously discussed (see Section 5.2.1, Site Preparation). Based on the subgrade soils and the projected traffic as discussed in Section 2, Proposed Construction, the pavement sections are recommended on the following pages.

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Parking Areas

(Light Volume of Automobiles and Light Trucks,
Occasional Medium-Weight Trucks,
No Heavyweight Trucks)
[Less than 1 equivalent 18-kip axle load per day]

Flexible:

3.0 inches	Asphalt concrete
7.0 inches	Aggregate base
Over	Suitable natural subgrade soils and/or structural site grading fill extending to suitable natural subgrade soils

Rigid:

5.0 inches	Portland cement concrete (non-reinforced)
4.0 inches	Aggregate base
Over	Suitable natural subgrade soils and/or structural site grading fill extending to suitable natural subgrade soils

Primary Drive Lanes
(Moderate Volume of Automobiles and Light Trucks,
Light Volume of Medium-Weight Trucks,
and Occasional Heavy-Weight Trucks)
[5 equivalent 18-kip axle loads per day]

Flexible:

3.0 inches	Asphalt concrete
9.0 inches	Aggregate base
Over	Suitable natural subgrade soils and/or structural site grading fill extending to suitable natural subgrade soils

Rigid:

5.5 inches	Portland cement concrete (non-reinforced)
4.0 inches	Aggregate base
Over	Suitable natural subgrade soils and/or structural site grading fill extending to suitable natural subgrade soils

For dumpster pads, we recommend a pavement section consisting of 6.5 inches of Portland cement concrete, 4.0 inches of aggregate base, over properly prepared suitable natural subgrade or site grading structural fills extending to suitable natural soils.

These above rigid pavement sections are for non-reinforced Portland cement concrete. Concrete should be designed in accordance with the American Concrete Institute (ACI) and joint details should conform to the Portland Cement Association (PCA) guidelines. The concrete should have a minimum 28-day unconfined compressive strength of 4,000 pounds per square inch and contain 6 percent ±1 percent air-entrainment.

5.8 CEMENT TYPE

The laboratory tests indicate that the natural clay soils tested contain a moderate amount of water soluble sulfates. Based on our test results, concrete in contact with the on-site soil will have a moderate potential for sulfate reaction (ACI 318, Table 4.3.1). To achieve the required protection against sulfate-related corrosion, we recommend a maximum water-to-cement ratio of 0.5 (by weight, normal weight aggregate concrete) and using Type II cement in concrete to obtain a minimum compressive strength of 4,000 pounds per square inch (psi). Details can be found in the above ACI reference and in the Portland Cement Association publication, "Design and Control of Concrete Admixtures."

5.9 GEOSEISMIC SETTING

5.9.1 General

Utah municipalities have adopted the International Building Code (IBC) 2015. The IBC 2015 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 2015 edition.

5.9.2 Faulting

Based upon our review of available literature, no active faults are known to pass through or immediately adjacent to the site. The nearest mapped active fault is the Salt Lake City Section of the Wasatch Fault, approximately 6 miles to the east of the site.

5.9.3 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 2015) can be utilized.

5.9.4 Ground Motions

The IBC 2015 code is based on 2008 USGS mapping, which provides values of short and long period accelerations for the Site Class B-C boundary for the Maximum Considered Earthquake (MCE). This Site Class B-C boundary represents a hypothetical bedrock surface and must be corrected for local soil conditions. The following table summarizes the peak ground and short and long period accelerations for an MCE event and incorporates a soil amplification factor for a Site Class D soil profile in the fourth column. Based on the site latitude and longitude (40.5229 degrees north and 111.9536 degrees west, respectively), the values for this site are tabulated below:

Spectral Acceleration Value, T	Site Class B Boundary [mapped values] (% g)	Site Coefficient	Site Class D [adjusted for site class effects] (% g)	Design Values (% g)
Peak Ground Acceleration	51.8	F_a = 1.000	51.8	34.5
0.2 Seconds (Short Period Acceleration)	S_S = 129.5	F_a = 1.000	S_{MS} = 129.5	S_{DS} = 86.3
1.0 Second (Long Period Acceleration)	S_1 = 43.0	F_v = 1.570	S_{M1} = 67.5	S_{D1} = 45

5.9.5 Liquefaction

The site is located in an area that has been identified by Christenson and Shaw[3] as having a "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.

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3 Christenson, Gary E. and Shaw, Lucas M., 2008, Liquefaction Special Study Areas, Wasatch Front and Nearby Areas, Utah.

Due to the clayey nature of the upper soils and the density of the lower granular soils within the exploration borings and absence of groundwater, liquefaction is unlikely to occur during the design seismic event within the depths explored.

5.10 SITE VISITS

Prior to placement of foundations and site grading fills, GSH must verify that the existing non-engineered fill has been completely removed and that suitable natural soils have been encountered below floor slabs, footings, and pavements.

5.11 CLOSURE

If you have any questions or would like to discuss these items further, please feel free to contact us at (801) 685-9190.

Respectfully submitted,

GSH Geotechnical, Inc.

Robert A. Gifford
Staff Geotechnical Engineer/Geologist

Reviewed by:

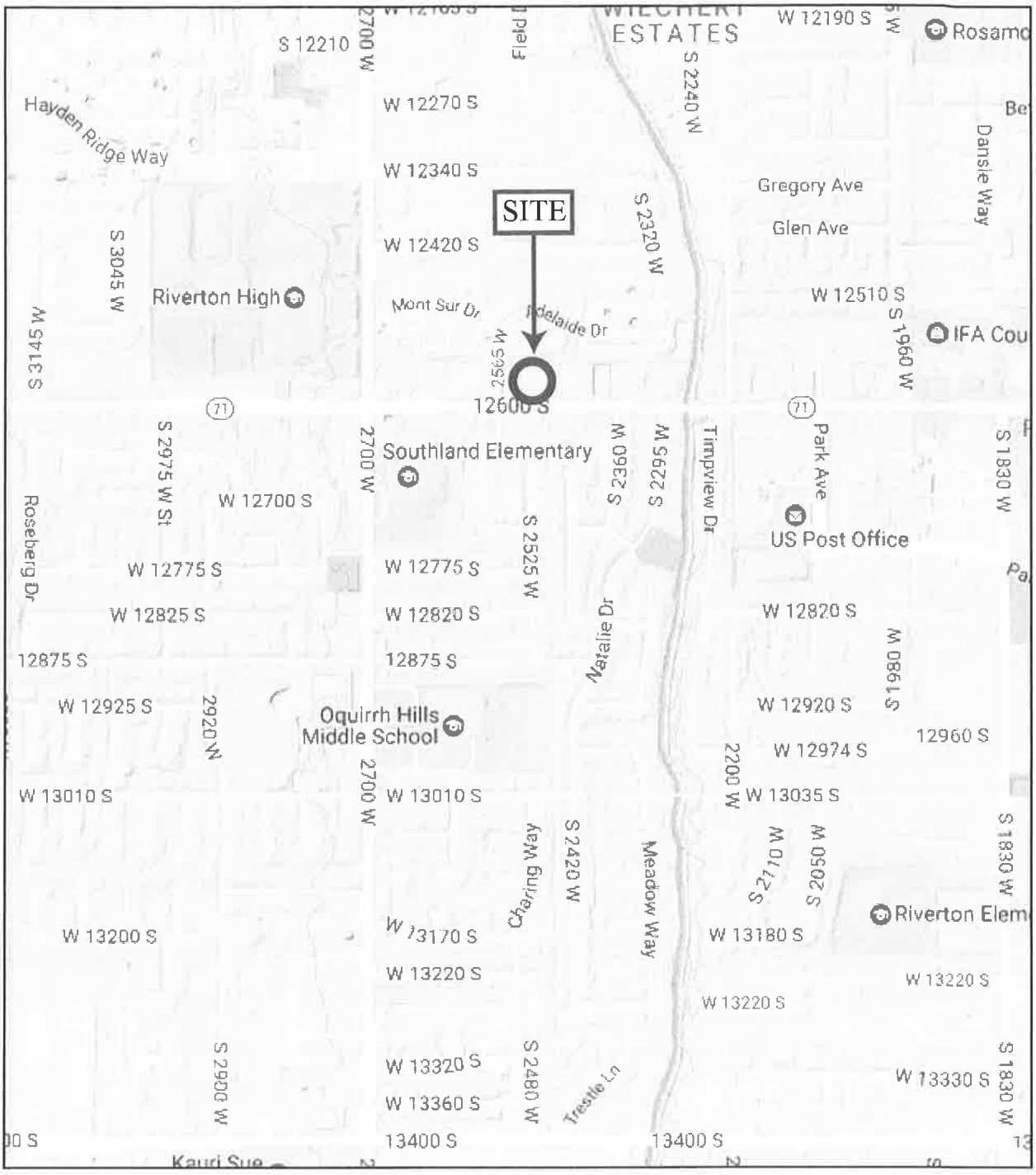
Alan D. Spilker, P.E.
State of Utah No. 334228
President/Senior Geotechnical Engineer

RAG/ADS:jlh

Encl. Figure 1, Vicinity Map
Figure 2, Site Plan
Figures 3A Through 3H, Log of Boring
Figure 4, Key to Boring Log (USCS)

Addressee (email)

MR. ERIC LARSON
JOB NO. 2367-001-17



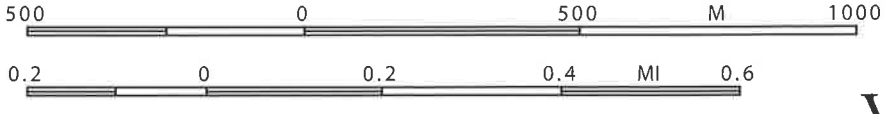


FIGURE 1
VICINITY MAP

REFERENCE:
ALL TRAILS - NATIONAL GEOGRAPHIC TERRAIN
DATED 2017

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JOB NO. 2367-001-17

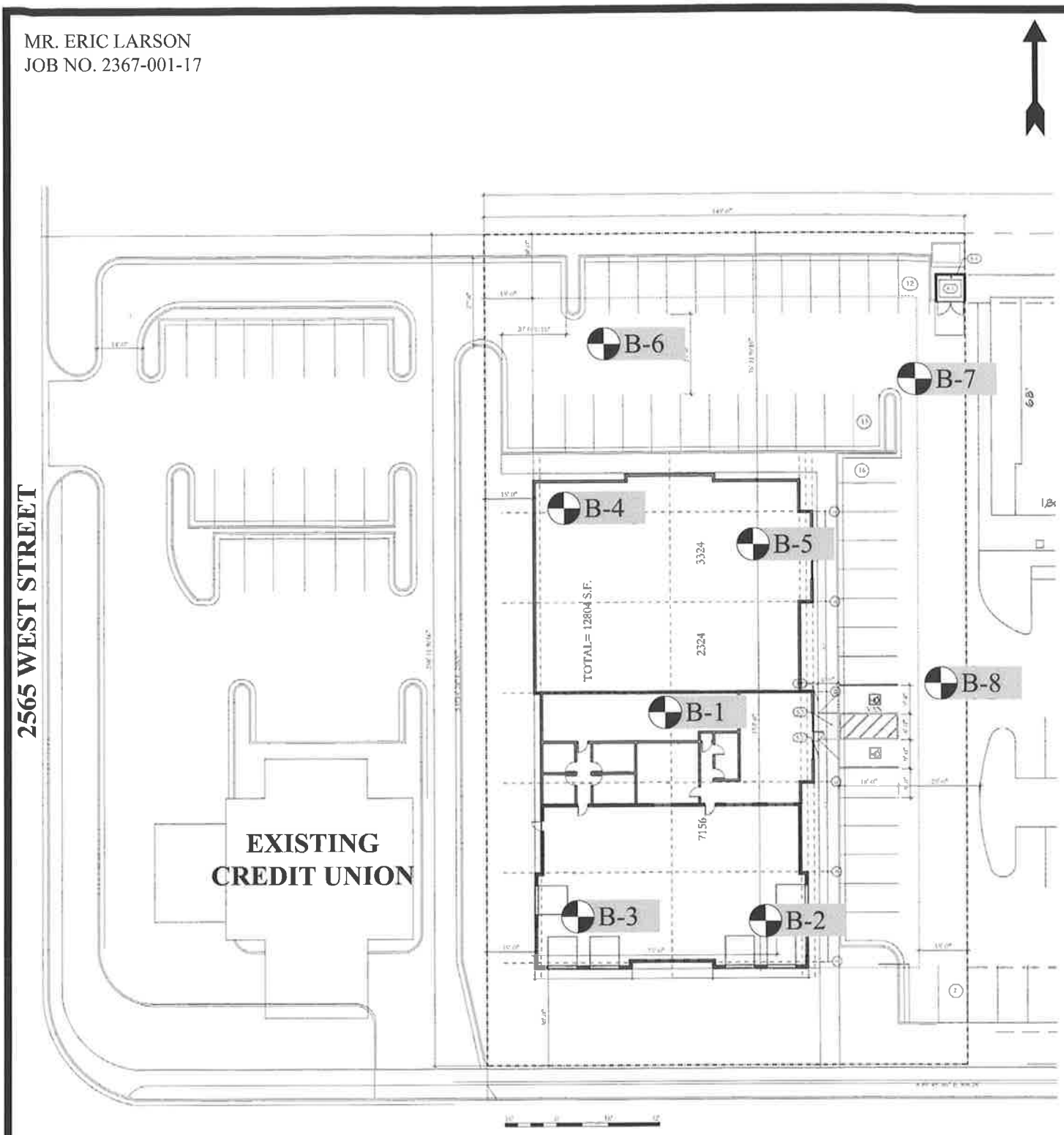

FIGURE 2
SITE PLAN

REFERENCE:
ADAPTED FROM DRAWING ENTITLED
"SCUBA DIVE AND SHELL OFFICE SPACE SITE PLAN, A1.01"
BY BAROS DESIGN, DATED 9/20/16

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GSH	BORING LOG Page: 1 of 1	BORING: B-1

CLIENT: Mr. Eric Larson — PROJECT NUMBER: 2367-001-17

PROJECT: Proposed SCUBA Dive and Shell Office Space — DATE STARTED: 3/14/17 — DATE FINISHED: 3/14/17

LOCATION: Approximately 2502 West 12600 South, Riverton, Utah — GSH FIELD REP.: TH

DRILLING METHOD/EQUIPMENT: 3-3/4" ID Hollow-Stem Auger — HAMMER: Automatic — WEIGHT: 140 lbs — DROP: 30"

GROUNDWATER DEPTH: Not Encountered (3/14/17 & 3/23/17) — ELEVATION: ---

WATER LEVEL	USCS	DESCRIPTION	DEPTH (FT.)	BLOW COUNT	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
		Ground Surface	0								
	CL FILL	SILTY CLAY, FILL with fine to coarse sand and fine and coarse gravel; major roots (topsoil) to 5"; brown									slightly moist loose
	CL	SILTY CLAY with some fine sand; brown		39		18.0	108				moist very stiff
			5	27		27.0	82				
	SM	SILTY FINE SAND with occasional fine gravel; brown	10	100							slightly moist dense
	SP/ SM	FINE TO COARSE SAND with some fine gravel and silt; light brown	15	75		3.0		8.4			slightly moist very dense
		grades with occasional fine gravel	20	27							medium dense
		End of Exploration at 21.0' No groundwater encountered at time of drilling Installed 1.25" diameter slotted PVC pipe to 21.0'	25								

See Subsurface Conditions section in the report for additional information.

FIGURE 3A

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BORING LOG

Page: 1 of 1

BORING: B-2

CLIENT: Mr. Eric Larson
PROJECT NUMBER: 2367-001-17
PROJECT: Proposed SCUBA Dive and Shell Office Space
DATE STARTED: 3/14/17 DATE FINISHED: 3/14/17
LOCATION: Approximately 2502 West 12600 South, Riverton, Utah
GSH FIELD REP.: TH
DRILLING METHOD/EQUIPMENT: 3-3/4" ID Hollow-Stem Auger
HAMMER: Automatic WEIGHT: 140 lbs DROP: 30"
GROUNDWATER DEPTH: Not Encountered (3/14/17)
ELEVATION: ---

WATER LEVEL	USCS	DESCRIPTION	DEPTH (FT.)	BLOW COUNT	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
		Ground Surface	0								
	SC FILL	CLAYEY FINE TO COARSE SAND, FILL with silt and fine gravel; brown									slightly moist loose
	CL	SILTY CLAY with trace fine sand; brown									moist very stiff
				35		25.7	92				
		grades with some fine sand; gray	5								slightly moist
				30							
				69		19.6	70				hard
		End of Exploration at 10.0' No groundwater encountered at time of drilling	10								
			15								
			20								
			25								

See Subsurface Conditions section in the report for additional information.

FIGURE 3B

GSH

BORING LOG

Page: 1 of 1

BORING: B-3

CLIENT: Mr. Eric Larson
PROJECT NUMBER: 2367-001-17
PROJECT: Proposed SCUBA Dive and Shell Office Space
DATE STARTED: 3/14/17 DATE FINISHED: 3/14/17
LOCATION: Approximately 2502 West 12600 South, Riverton, Utah
GSH FIELD REP.: TH
DRILLING METHOD/EQUIPMENT: 3-3/4" ID Hollow-Stem Auger
HAMMER: Automatic WEIGHT: 140 lbs DROP: 30"
GROUNDWATER DEPTH: Not Encountered (3/14/17 & 3/23/17)
ELEVATION: ---

WATER LEVEL	USCS	DESCRIPTION	DEPTH (FT.)	BLOW COUNT	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
		Ground Surface	0								
	CL FILL	FINE TO COARSE SANDY CLAY, FILL with fine gravel and silt; brown									slightly moist loose
	CL	SILTY CLAY with some fine sand; brown		37							moist very stiff
		grades with trace fine sand; light brown		88		12.9	98				hard
			5								
				33							very stiff
			10								
	SM	SILTY FINE TO COARSE SAND with fine gravel; brown									slightly moist very dense
				67							
		End of Exploration at 14.0' Installed 1.25" diameter slotted PVC pipe to 14.0'	15								
			20								
			25								

See Subsurface Conditions section in the report for additional information.

FIGURE 3C

GSH BORING LOG

Page: 1 of 1

BORING: B-4

CLIENT: Mr. Eric Larson
PROJECT NUMBER: 2367-001-17
PROJECT: Proposed SCUBA Dive and Shell Office Space
DATE STARTED: 3/14/17 DATE FINISHED: 3/14/17
LOCATION: Approximately 2502 West 12600 South, Riverton, Utah
GSH FIELD REP.: TH
DRILLING METHOD/EQUIPMENT: 3-3/4" ID Hollow-Stem Auger
HAMMER: Automatic WEIGHT: 140 lbs DROP: 30"
GROUNDWATER DEPTH: Not Encountered (3/14/17)
ELEVATION: ---

WATER LEVEL	USCS	DESCRIPTION	DEPTH (FT.)	BLOW COUNT	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
		Ground Surface	0								
	CL	SILTY CLAY with trace fine sand; major roots (topsoil)to 5"; light brown									slightly moist very stiff
				35							
			5	37		17.7	89				moist
	SP/SM	FINE SAND with silt; brown									slightly moist medium dense
			10	15							
		End of Exploration at 11.0' No groundwater encountered at time of drilling	15								
			20								
			25								

See Subsurface Conditions section in the report for additional information.

FIGURE 3D

GSH	BORING LOG Page: 1 of 1	BORING: B-5

CLIENT: Mr. Eric Larson — PROJECT NUMBER: 2367-001-17

PROJECT: Proposed SCUBA Dive and Shell Office Space — DATE STARTED: 3/14/17 — DATE FINISHED: 3/14/17

LOCATION: Approximately 2502 West 12600 South, Riverton, Utah — GSH FIELD REP.: TH

DRILLING METHOD/EQUIPMENT: 3-3/4" ID Hollow-Stem Auger — HAMMER: Automatic — WEIGHT: 140 lbs — DROP: 30"

GROUNDWATER DEPTH: Not Encountered (3/14/17) — ELEVATION: ---

WATER LEVEL	USCS	DESCRIPTION	DEPTH (FT.)	BLOW COUNT	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
		Ground Surface	0								
	SP/SC FILL	FINE TO COARSE SAND, FILL with clay and fine gravel; major roots (topsoil) to 5"; brown									slightly moist loose
	CL	SILTY CLAY with trace fine sand; brown		41		21.1	104				moist very stiff
		grades with fine sand; light brown	5	38							
	SM/ML	SILTY FINE TO COARSE SAND/FINE TO COARSE SANDY SILT with some fine gravel; brown with oxidation	10	20		9.1		51.8			moist medium dense
			15	88							very dense
		End of Exploration at 16.0' No groundwater encountered at time of drilling Installed 1.25" diameter slotted PVC pipe to 16.0'	20								
			25								

See Subsurface Conditions section in the report for additional information.

FIGURE 3E

GSH BORING LOG

Page: 1 of 1

BORING: B-6

CLIENT: Mr. Eric Larson
PROJECT NUMBER: 2367-001-17
PROJECT: Proposed SCUBA Dive and Shell Office Space
DATE STARTED: 3/14/17 DATE FINISHED: 3/14/17
LOCATION: Approximately 2502 West 12600 South, Riverton, Utah
GSH FIELD REP.: TH
DRILLING METHOD/EQUIPMENT: 3-3/4" ID Hollow-Stem Auger
HAMMER: Automatic WEIGHT: 140 lbs DROP: 30"
GROUNDWATER DEPTH: Not Encountered (3/14/17)
ELEVATION: ---

WATER LEVEL	USCS	DESCRIPTION	DEPTH (FT.)	BLOW COUNT	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
		Ground Surface	0								
	CL	SILTY CLAY with trace fine sand; major roots (topsoil) to 5"; brown									slightly moist stiff
		grades light brown	5								
		End of Exploration at 5.0' No groundwater encountered at time of drilling									
			10								
			15								
			20								
			25								

See Subsurface Conditions section in the report for additional information.

FIGURE 3F

GSH

BORING LOG

Page: 1 of 1

BORING: B-7

CLIENT: Mr. Eric Larson | PROJECT NUMBER: 2367-001-17

PROJECT: Proposed SCUBA Dive and Shell Office Space | DATE STARTED: 3/14/17 | DATE FINISHED: 3/14/17

LOCATION: Approximately 2502 West 12600 South, Riverton, Utah | GSH FIELD REP.: TH

DRILLING METHOD/EQUIPMENT: 3-3/4" ID Hollow-Stem Auger | HAMMER: Automatic | WEIGHT: 140 lbs | DROP: 30"

GROUNDWATER DEPTH: Not Encountered (3/14/17) | ELEVATION: ---

WATER LEVEL	USCS	DESCRIPTION	DEPTH (FT.)	BLOW COUNT	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
		Ground Surface	0								
	CL	SILTY CLAY with trace fine sand; major roots (topsoil) to 5"; brown									slightly moist stiff
		End of Exploration at 5.0' No groundwater encountered at time of drilling	5								
			10								
			15								
			20								
			25								

See Subsurface Conditions section in the report for additional information.

FIGURE 3G

GSH

BORING LOG

Page: 1 of 1

BORING: B-8

CLIENT: Mr. Eric Larson | PROJECT NUMBER: 2367-001-17

PROJECT: Proposed SCUBA Dive and Shell Office Space | DATE STARTED: 3/14/17 | DATE FINISHED: 3/14/17

LOCATION: Approximately 2502 West 12600 South, Riverton, Utah | GSH FIELD REP.: TH

DRILLING METHOD/EQUIPMENT: 3-3/4" ID Hollow-Stem Auger | HAMMER: Automatic | WEIGHT: 140 lbs | DROP: 30"

GROUNDWATER DEPTH: Not Encountered (3/14/17) | ELEVATION: ---

WATER LEVEL	USCS	DESCRIPTION	DEPTH (FT.)	BLOW COUNT	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
		Ground Surface	0								
	CL	SILTY CLAY with trace fine sand; brown									slightly moist stiff
		grades light brown	5								
		End of Exploration at 5.0' No groundwater encountered at time of drilling									
			10								
			15								
			20								
			25								

See Subsurface Conditions section in the report for additional information.

FIGURE 3H

CLIENT: Mr. Eric Larson
PROJECT: Proposed SCUBA Dive and Shell Office Space
PROJECT NUMBER: 2367-001-17

KEY TO BORING LOG

WATER LEVEL	USCS	DESCRIPTION	DEPTH (FT.)	BLOW COUNT	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSSING 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:

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.

MODIFIERS:

Trace <5%

Some 5-12%

With > 12%

MOISTURE CONTENT (FIELD TEST):

Dry: Absence of moisture, dusty, dry to the touch.

Moist: Damp but no visible water.

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	Well-Graded Gravels, Gravel-Sand Mixtures, Little or No Fines
			GP	Poorly-Graded Gravels, Gravel-Sand Mixtures, Little or No Fines
		GRAVELS WITH FINES (appreciable amount of fines)	GM	Silty Gravels, Gravel-Sand-Silt Mixtures
			GC	Clayey Gravels, Gravel-Sand-Clay Mixtures
	SANDS More than 50% of coarse fraction passing through No. 4 sieve.	CLEAN SANDS (little or no fines)	SW	Well-Graded Sands, Gravelly Sands, Little or No Fines
			SP	Poorly-Graded Sands, Gravelly Sands, Little or No Fines
		SANDS WITH FINES (appreciable amount of fines)	SM	Silty Sands, Sand-Silt Mixtures
			SC	Clayey Sands, 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 o f Low Plasticity
	SILTS AND CLAYS Liquid Limit greater than 50%		MH	Inorganic Silts, Micacious or Diatomacious 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

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

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

FIGURE 4

GSH