GSH

**REPORT**
**GEOTECHNICAL STUDY**
**DR. PETERSON DENTAL**
**4121 WEST 13400 SOUTH**
**RIVERTON, UTAH**

Submitted To:

Dr. John M. Peterson
% JZW Architects
River Crossing Family Dental
12427 South 4000 West
Riverton, Utah 84096

Submitted By:

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

April 6, 2017

Job No. 1561-005-17

OK

April 6, 2017
Job No. 1561-005-17

Dr. John M. Peterson
% JZW Architects
River Crossing Family Dental
12427 South 4000 West
Riverton, Utah 84096

Dr. Peterson:

Re: Report
Geotechnical Study
Dr. Peterson Dental
4121 West 13400 South
Riverton, Utah

# 1. INTRODUCTION

## 1.1 GENERAL

This report presents the results of our geotechnical study performed for the proposed Dr. Peterson Dental facility to be located at 4121 West 13400 South in Riverton, Utah. The general location of the site with respect to major topographic features and existing facilities, as of 2017, is presented on Figure 1, Vicinity Map. A more detailed layout of the site showing the proposed development is presented on Figure 2, Site Plan. The approximate locations of the borings 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 Dr. John M. Peterson of River Crossing Family Dental and Mr. Alan Spilker 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 pavement recommendations, and geoseismic information to be utilized in the design and construction of the proposed development.

GSH Geotechnical, Inc.
473 West 4800 South
Salt Lake City, Utah 84123
Tel: 801.685.9190 Fax: 801.685.2990
www.gshgeo.com

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

1. A field program consisting of the drilling, logging, and sampling of 4 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. 17-0318 dated March 13, 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 proposed construction will consist of a 1- to 2-story, wood-frame office building with stucco, stone, or similar type veneer. The structure is anticipated to be constructed slab on grade.

Anticipated maximum column and wall loads will be on the order of 40 kips for columns and 3 kips per lineal foot for walls. Maximum average uniform floor slab loads are anticipated to be on the order of 150 pounds per square foot.

Associated parking/drive areas around the building will also be constructed of asphalt pavement with relatively light projected traffic that includes daily delivery trucks.

## 3. INVESTIGATIONS

### 3.1 FIELD PROGRAM

To define and evaluate the subsurface soil and groundwater conditions at the proposed site, 4 borings were drilled to depths of 5 to 16 feet below existing grade using a truck-mounted drill rig equipped with hollow-stem augers. Approximate locations of the borings are presented on Figure 2.

The field portion of our study was performed under the direct control and continual supervision of an experienced member of our geotechnical staff. During the drilling operations, a continuous log of the subsurface conditions encountered was maintained. In addition, samples of the typical soils encountered were obtained 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 observation and laboratory testing. Detailed graphical representation of the subsurface conditions encountered is presented on Figures 3A through 3D, Boring Logs. 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, 1.25-inch diameter slotted PVC pipe was installed in Borings B-1, B-2, and B-3 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 performed. 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 undisturbed samples. The results of these tests are presented on the boring logs, Figures 3A through 3D.

### 3.2.3 Partial Gradation Test

To aid in classifying the granular soils, a partial gradation test was performed. Results of the test are tabulated on the following table:

| Boring No. | Depth (feet) | Percent Moisture Content | Percent Passing No. 200 Sieve | Soil Classification |
|---|---|---|---|---|
| B-2 | 10 | 6.6 | 51.0 | SM/ML |

### 3.2.4 Consolidation Tests

To provide data necessary for our settlement analyses, consolidation tests were performed on 2 representative samples of the silty clay soils encountered at the site. The data obtained from these tests were used to calculate foundation movements which could occur from the anticipated foundation loadings. Based upon data obtained from the consolidation tests, the silty clay soils were moderately over-consolidated and will exhibit moderate strength and compressibility characteristics under the anticipated loadings. Detailed results of the tests are maintained within our files and can be transmitted to you, upon your request.

### 3.2.5 Chemical Tests

Laboratory testing is in progress; results will be transmitted as soon as they become available.

## 4. SITE CONDITIONS

### 4.1 SURFACE

The site is located on an approximately 1-acre, rectangular-shaped vacant/previously developed parcel. A cement pad, small shed, numerous fill piles, and debris remain on the site. Surface vegetation consists of sparse to dense grasses and weeds, small shrubs, and occasional large trees. The topography of the site is relatively level with relief across the site on the order of 1 to 2 feet throughout. The site is bordered by:

North: 13400 South Street followed by agricultural land

East: Residential structure with commercial truck yard

West: Vacant/undeveloped land followed by residential structures

South: South Hills Middle school. associated pavements and vacant/undeveloped land

## 4.2 SUBSURFACE SOIL AND GROUNDWATER

The soil conditions encountered at the borings were similar. The upper 1.5 to 3.5 feet of Borings B-1 and B-3 contained loose/disturbed soils considered to be non-engineered fill. From the surface in Borings B-2 and B-4, beneath fill soils in B-1 and B-3, and extending to a maximum depth of 7 feet, soft to medium stiff, slightly moist to moist, brown to dark brown silty clay was encountered. Underlying the clay soils to the maximum depths penetrated in Borings B-1, B-2, and B-3, loose to medium dense, dry to slightly moist, tan to brown, silty fine to medium sand/ fine to medium sandy silt was encountered.

The native silty clay soils underlying the fill are anticipated to exhibit moderate strength and moderate compressibility characteristics under the anticipated loading range.

For a more detailed description of subsurface conditions, please refer to Figures 3A through 3D, 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.

Groundwater was not encountered at the time of drilling operations or when it was measured 7 days following drilling. Seasonal and longer-term groundwater fluctuations could occur, with the highest seasonal levels generally occurring during the late spring and early summer months. We do not anticipate that groundwater levels will affect construction of the building.

## 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 placed onto suitable natural soils or structural fill extending to suitable natural soils.

The most significant geotechnical aspect of this site are:

1. The existing cement pad and structures

2. The presence of non-engineered fill soils and the potential for deeper fills to be encountered associated with previous development

The demolition of the existing cement pad and the removal of all associated debris and non-engineered fills should extend out 4 feet from the proposed buildings and 2 feet beyond pavements. Existing utilities (if encountered) will need to be removed or relocated per new construction needs.

Surficial non-engineered fills up to 3.5 feet thick were observed within the borings; deeper non-engineered fill associated with the existing pad and structures may be encountered. If encountered, non-engineered fill must be completely removed from footing, floor slab, and pavement areas.

Due to the potential for encountering deeper non-engineered fill soils at the site, GSH must verify that all non-engineered fill and loose/disturbed soils have been completely removed prior to the placement of structural site grading fills, floor slabs, footings, and pavements.

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

## 5.2 EARTHWORK

### 5.2.1 Site Preparation

Initial site work will include the demolition of the existing slab and the removal of all associated debris and non-engineered fills extending out 4 feet from the proposed buildings and 2 feet beyond pavements. Existing utilities (if encountered) will need to be removed or relocated per new construction needs.

Additional preparation shall consist of the removal of all surface vegetation, topsoil, root bulbs, sod, rubbish, construction debris, and any other deleterious materials. We estimate that approximately 4 to 6 inches of stripping may be necessary to remove most major roots, vegetation, and organics; however, local root balls from existing brush and trees will extend deeper and should be removed where encountered. Vegetation and other deleterious materials should be removed from the site. Stripped topsoil will be unsuitable for structural fill but may be stockpiled for subsequent landscaping purposes.

After stripping and prior to the placement of structural site grading fill, pavements, and slabs on grade, the prepared subgrade must be proof rolled 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.

Subgrade preparation as described must be completed prior to placing overlying structural site grading fills.

### 5.2.2 Temporary Excavations

Temporary construction excavations in cohesive soil (clay), not exceeding 4 feet in depth, may be constructed with near-vertical side slopes. Temporary excavations up to 8 feet deep in cohesive soils may be constructed with side slopes 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:1.0V). 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 (1.0H:1.0V).

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 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 possibly 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.

On-site fine-grained soils/fills (clays and silts) are not recommended for re-use as structural fill.

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 no more than 30 percent retained on the three-quarter-inch sieve.

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

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 moisture conditioned to between -1 and +3 percent of optimum moisture and compacted in accordance with the percent of the maximum dry density as determined by the ASTM[1] D-1557 (AASHTO[2] T-180) compaction criteria given in the table below:

| 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 10 | 95 |
| Outside area defined above | 0 to 5 | 90 |
| Outside area defined above | 5 to 10 | 95 |

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

After 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. Stabilization of the subgrade prior to the placement of structural site grading fill must be anticipated. In confined areas, subgrade preparation should consist of the removal of all loose or disturbed soils.

Coarse angular gravel and cobble mixtures (stabilizing fill), if utilized, shall 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 stabilizing 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.

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 (footings, floor slabs, flatwork, pavements, 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.

---

1 American Society for Testing and Materials

2 American Association of State Highway and Transportation Officials

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 (ASTMD-1557) method of compaction. GSH recommends that as the major utilities continue onto the site that these compaction specifications are followed.

Fine-grained soil, such as silts and clays, are not recommended for utility trench backfill in structural areas.

## 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 placed on natural soils or on properly compacted granular structural fill extending to native soils. The existing non-engineered fills are not suitable for the support of foundation and must be completely removed to expose suitable natural soils. For design, the following recommended parameters are provided:

| | |
|---|---|
| Minimum Depth of Embedment for Frost Protection | - 30 inches |
| Minimum Depth of Embedment for Non-frost Conditions | - 15 inches |
| Minimum Width for Continuous Wall Footings | - 18 inches |
| Minimum Width for Isolated Spread Footings | - 24 inches |
| Net Bearing Pressure for Real Load Conditions: Footings placed on native soils | - 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, 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 3 feet, the width of the structural fill at the base of the footing excavation would be a total of 5 feet, centered below the footing.

### 5.3.3 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 less than one inch.

Approximately 50 percent of the quoted settlement should occur 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 footings placed on natural silt/clay soils or 0.40 should be utilized for footings placed on 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 the friction component of the total is divided by 1.5.

## 5.5 LATERAL PRESSURES

The lateral pressure parameters, as presented within this section, assume that the backfill will consist of a 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 basement walls that are not more than 10 inches thick and 12 feet or less in height, 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 60 pounds per cubic foot. The above values assume that the surface of the soils slope behind the wall is horizontal, that the granular fill has been placed

GSH

and lightly compacted, not as a structural fill. If the fill is placed as a structural fill, the values should be increased to 45 pounds per cubic foot, 60 pounds per cubic foot, and 120 pounds per cubic foot, respectively. If the slope behind the wall is 2 horizontal to 1 vertical, the values for purely active walls and basement walls should increase to 57 pounds per cubic foot and 67 pounds per cubic foot, respectively.

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

| Seismic Uniform Lateral Pressures | | | |
|---|---|---|---|
| **Wall Height (Feet)** | **Active Pressure Case (psf)** | **Moderately Yielding Case (psf)** | **At Rest/Non-Yielding Case (psf)** |
| 4 | 50 | 85 | 120 |
| 6 | 70 | 125 | 180 |
| 8 | 100 | 170 | 240 |

## 5.6 FLOOR SLABS

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

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.

GSH recommends that the tops of all habitable floor slabs must be maintained a minimum of 4.0 feet above the highest anticipated normal groundwater level or the maximum groundwater level controlled by subdrains.

## 5.7 PAVEMENTS

The existing fine-grained soils will exhibit relatively 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). Under no circumstances shall pavements not be underlain by non-engineered fills, even if properly prepared. With the subgrade soils and the projected traffic, as discussed in Section 2, Proposed Construction, the pavement sections on the following page are recommended. In areas with tight maneuvering heavy vehicles, rigid pavements are recommended.

Flexible Pavements (Asphalt Concrete):

Parking Areas
(Moderate Volume of Automobiles and Light Trucks
with Occasional Medium and Heavy Trucks)
[1 equivalent 18-kip axle load per day]

| | |
|---|---|
| 3.0 inches | Asphalt concrete |
| 8.0 inches | Aggregate base course |
| Over | Suitable natural soils or structural fill extending to suitable natural soils |

Drive/Driveway Areas
(Moderate Volume of Automobiles and Light Trucks
with a Daily Medium Truck and Occasional Heavy Trucks)
[5 equivalent 18-kip axle loads per day]

| | |
|---|---|
| 3.0 inches | Asphalt concrete |
| 9.0 inches | Aggregate base course |
| Over | Suitable natural soils or structural fill extending to suitable natural soils |

Rigid Pavements (Non-reinforced Concrete):

Parking and Drive/Driveway Areas
(Moderate Volume of Automobiles and Light Trucks
with a Daily Medium Truck and Occasional Heavy Trucks)
[1 equivalent 18-kip axle load per day]

| | |
|---|---|
| 5.0 inches | Portland cement concrete (non-reinforced) |
| 4.0 inches | Aggregate base course |
| Over | Suitable natural soils or structural fill extending to suitable natural 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 and stabilized natural subgrade or site grading structural fills extending to suitable natural soils. Dumpster pads shall not be constructed overlying non-engineered fills.

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 TYPES

Laboratory testing is in progress; results will be transmitted as soon as they become available.

## 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).

### 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 active fault is the Salt Lake City Section of the Wasatch Fault, located about 7.8 miles 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 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 table on the following page 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 (40.5075 degrees north 111.9890 degrees west, respectively), the values for this site are tabulated on the following page.

| 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 | 47.2 | $F_a$ = 1.028 | 48.6 | 48.6 |
| 0.2 Seconds (Short Period Acceleration) | $S_S$ = 118.1 | $F_a$ = 1.028 | $S_{MS}$ = 121.3 | $S_{DS}$ = 80.9 |
| 1.0 Second (Long Period Acceleration) | $S_1$ = 39.2 | $F_v$ = 1.616 | $S_{M1}$ = 63.4 | $S_{D1}$ = 42.3 |

### 5.9.5 Liquefaction

The site is located in an area that has been identified by Salt Lake County as having "very low" liquefaction potential. Liquefaction is defined as a 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.

Saturated soils were not encountered within the depths explored. These conditions indicate that liquefaction is not likely, even during a major seismic event.

## 5.10 SITE VISITS

GSH must verify that all topsoil/disturbed soil, non-engineered fills, and any other unsuitable soils have been removed and that suitable soils have been encountered prior to placing site grading fills, footings, slabs, 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.**

Olivia T. Roberts
Staff Geologist

Reviewed by:

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

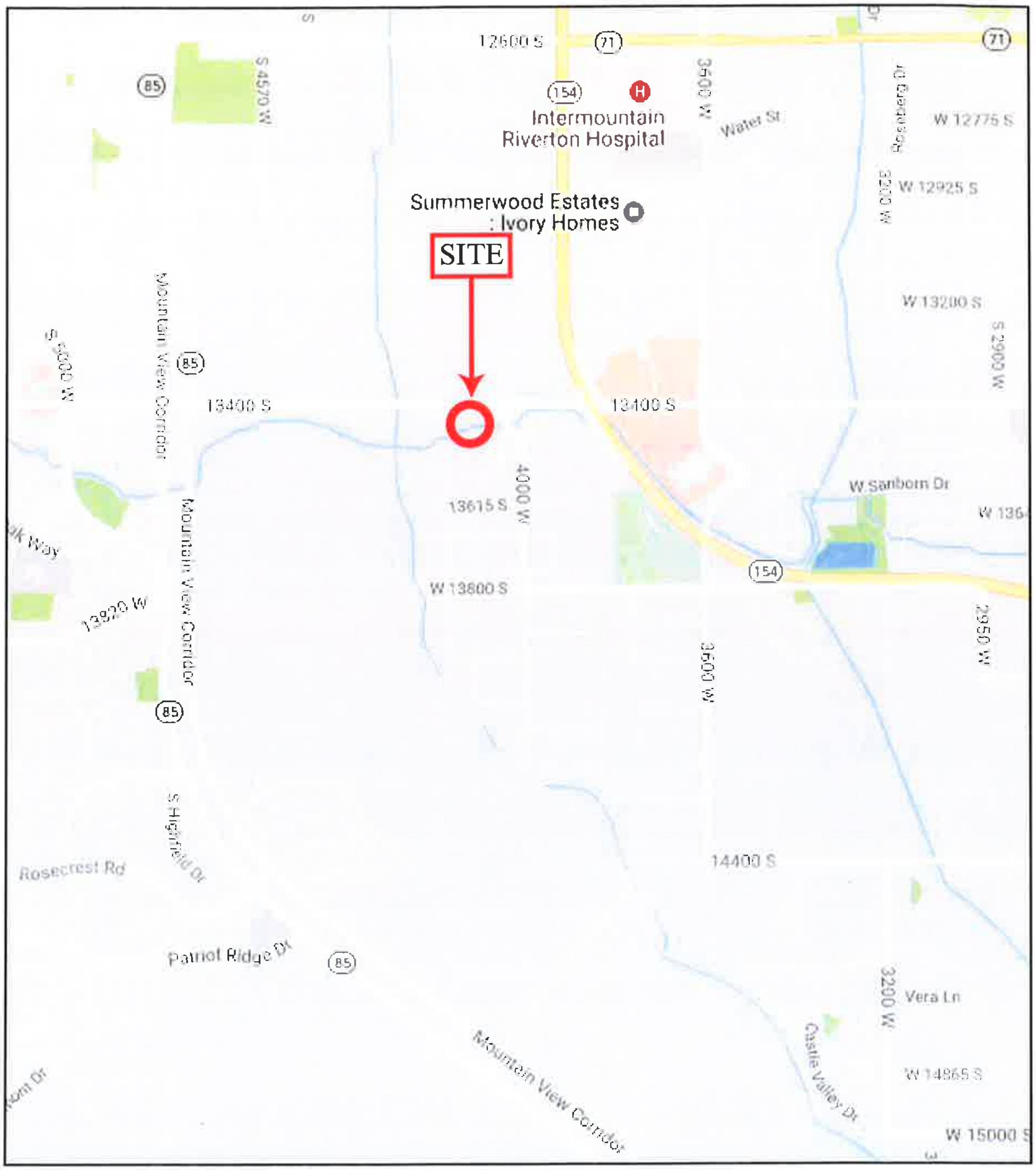
OTR/ADS:jlh

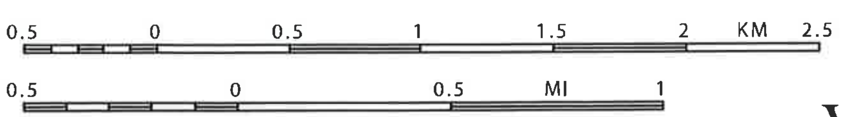
Encl. Figure 1, Vicinity Map
Figure 2, Site Plan
Figures 3A through 3D, Boring Logs
Figure 4, Key to Boring Log (USCS)

Addressee (email)

cc: Mr. Eric Jones (email)
JZW Architects

DR. JOHN PETERSON
JOB NO. 1561-005-17



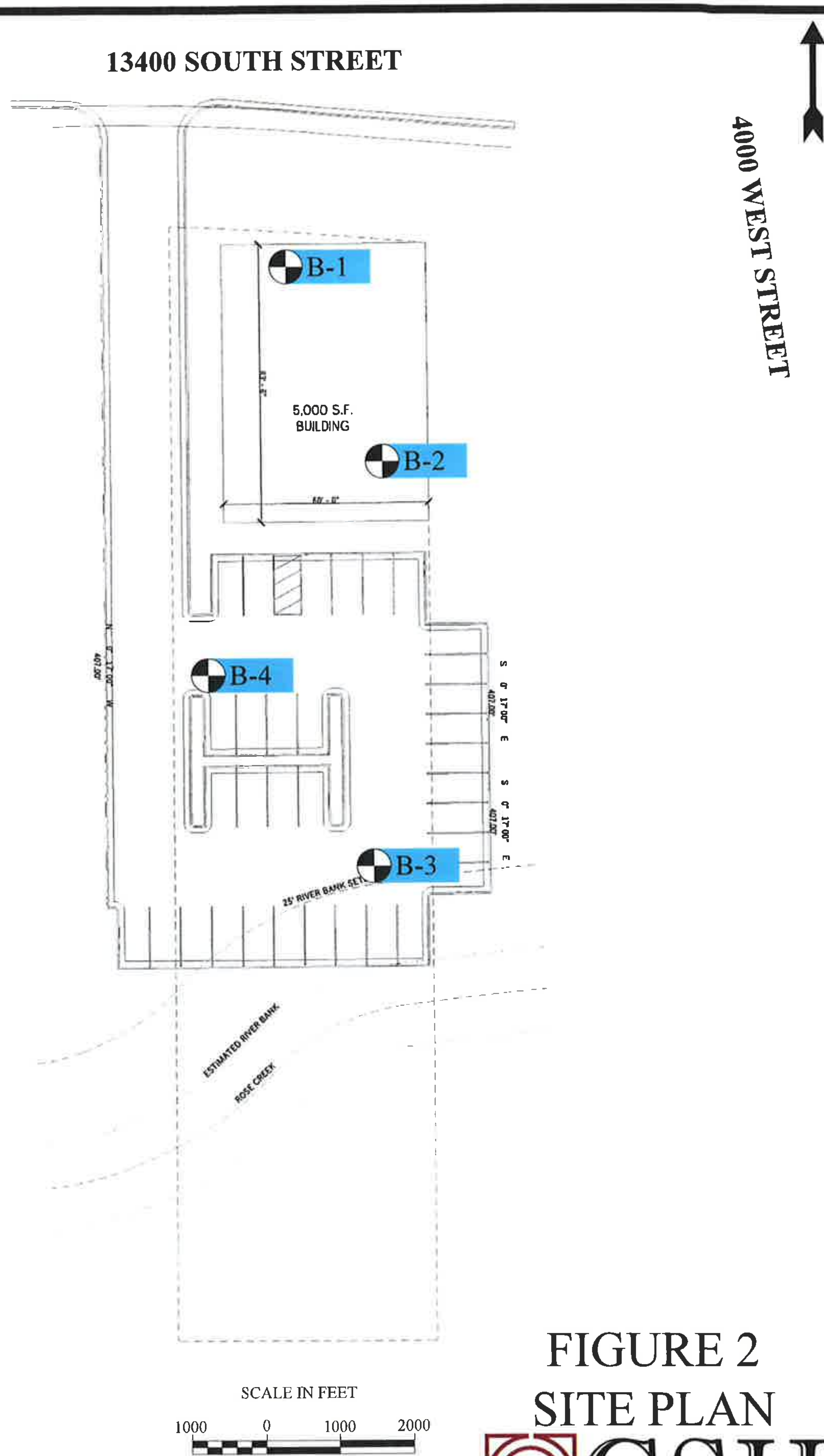




# FIGURE 1
# VICINITY MAP

GSH

REFERENCE:
ALL TRAILS - NATIONAL GEOGRAPHIC TERRAIN
DATED 2017

DR. JOHN PETERSON
JOB NO. 1561-005-17




# FIGURE 2
# SITE PLAN

REFERENCE:
ADAPTED FROM DRAWING ENTITLED
"DR. JOHN PETERSON DENTAL BUILDING, A0.2"
BY JZW ARCHITECTS, DATED MARCH 17, 2017

GSH

# BORING LOG



## BORING: B-1

CLIENT: Dr. John Peterson | PROJECT NUMBER: 1561-005-17

PROJECT: Dr. Peterson Dental | DATE STARTED: 3/28/17 | DATE FINISHED: 3/28/17

LOCATION: 4121 West 13400 South, Riverton, Utah | GSH FIELD REP.: ZM

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

GROUNDWATER DEPTH: Not Encountered (3/28/17 and 4/5/17) | 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 | SITLY CLAY, FILL<br>with fine sand and fine gravel, major roots (topsoil) to 4"; brown | | | | | | | | | loose to 4"<br>moist<br>medium stiff |
| | CL | SILTY CLAY<br>with some fine sand; brown | | 5 | | | | | | | moist<br>medium stiff |
| | | | | 21 | | | | | | | |
| | SM/ ML | SILTY FINE SAND / FINE SANDY SILT<br>with trace organics; light brown | 5 | | | | | | | | dry<br>loose |
| | | | | 19 | | 11.6 | 71 | | | | |
| | | | 10 | | | | | | | | medium dense |
| | | | | 18 | | | | | | | |
| | | End of Exploration at 13.5'.<br>No groundwater encountered at time of drilling.<br>Installed 1.25" diameter slotted PVC pipe to 13.5'. | 15 | | | | | | | | |
| | | | 20 | | | | | | | | |
| | | | 25 | | | | | | | | |

See Subsurface Conditions section in the report for additional information.

FIGURE 3A

# GSH — BORING LOG

Page: 1 of 1

**BORING: B-2**

CLIENT: Dr. John Peterson | PROJECT NUMBER: 1561-005-17

PROJECT: Dr. Peterson Dental | DATE STARTED: 3/28/17 | DATE FINISHED: 3/28/17

LOCATION: 4121 West 13400 South, Riverton, Utah | GSH FIELD REP.: ZM

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

GROUNDWATER DEPTH: Not Encountered (3/28/17 and 4/5/17) | 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<br>with trace fine sand and organics;brown | | | | | | | | | moist<br>soft |
| | | | | 4 | | | | | | | |
| | SM/ML | SILTY FINE TO MEDIUM SAND / FINE TO MEDIUM SANDY SILT<br>with trace clay; tan | | | | | | | | | dry<br>loose |
| | | | 5 | 22 | | 9.7 | 80 | | | | |
| | | grades with some fine and coarse gravel | 10 | 9 | | 6.6 | | 51 | | | |
| | | fine and coarse gravel grades out | 15 | 17 | | | | | | | |
| | | End of Exploration at 16.0'.<br>No groundwater encountered at time of drilling.<br>Installed 1.25" diameter slotted PVC pipe to 16.0'. | | | | | | | | | |
| | | | 20 | | | | | | | | |
| | | | 25 | | | | | | | | |

See Subsurface Conditions section in the report for additional information.

FIGURE 3B

# GSH — BORING LOG



## BORING: B-3

CLIENT: Dr. John Peterson | PROJECT NUMBER: 1561-005-17

PROJECT: Dr. Peterson Dental | DATE STARTED: 3/28/17 | DATE FINISHED: 3/28/17

LOCATION: 4121 West 13400 South, Riverton, Utah | GSH FIELD REP.: ZM

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

GROUNDWATER DEPTH: Not Encountered (3/28/17 and 4/5/17) | 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<br>with fine sand, minor roots (topsoil) to 6"; dark brown<br>grades with fine to coarse sand and trace fine and coarse gravel | | 7 | ⧗ | | | | | | moist<br>medium stiff |
| | CL | SILTY CLAY<br>with fine to medium sand; brown | 5 | 27 | ⧗ | | | | | | slightly moist<br>very stiff |
| | SM/ML | SILTY FINE SAND / FINE SANDY SILT<br>tan | 10 | 15 | ⧗ | 11.5 | 80 | | | | slightly moist<br>loose |
| | | End of Exploration at 11.0'.<br>No groundwater encountered at time of drilling.<br>Installed 1.25" diameter slotted PVC pipe to 11.0'. | 15, 20, 25 | | | | | | | | |

See Subsurface Conditions section in the report for additional information.

FIGURE 3C

GSH

# BORING LOG



## BORING: B-4

CLIENT: Dr. John Peterson | PROJECT NUMBER: 1561-005-17

PROJECT: Dr. Peterson Dental | DATE STARTED: 3/28/17 | DATE FINISHED: 3/28/17

LOCATION: 4121 West 13400 South, Riverton, Utah | GSH FIELD REP.: ZM

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

GROUNDWATER DEPTH: Not Encountered (3/28/17) | ELEVATION: ---

| WATER LEVEL | USCS | DESCRIPTION | DEPTH (FT.) | BLOW COUNT | SAMPLE SYMBOL | MOISTURE (%) | DRY DENSITY (PCF) | % PASSSING 200 | LIQUID LIMIT (%) | PLASTICITY INDEX | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Ground Surface | | | | | | | | | |
| | CL | SILTY CLAY<br>with fine sand; dark brown | 0 | | | | | | | | moist<br>medium stiff |
| | | | | | ◢ | | | | | | |
| | | | | | ◢ | | | | | | |
| | | End of Exploration at 5.0'.<br>No groundwater encountered at time of drilling. | 5 | | | | | | | | |
| | | | 10 | | | | | | | | |
| | | | 15 | | | | | | | | |
| | | | 20 | | | | | | | | |
| | | | 25 | | | | | | | | |

See Subsurface Conditions section in the report for additional information.

FIGURE 3D

CLIENT: Dr. John Peterson
PROJECT: Dr. Peterson Dental
PROJECT NUMBER: 1561-005-17

# 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 | 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