Gordon Spilker Huber
Geotechnical Consultants, Inc.

REPORT
GEOTECHNICAL STUDY
PHASE V, COTTONWOOD HILLS
PUD SUBDIVISION
THE COTTONWOODS AT MOUNTAIN GREEN
MORGAN COUNTY, UTAH

Submitted To:

Gardner Development Company
90 South 400 West, Suite 330
Salt Lake City, Utah 84101

Submitted By:

Gordon Spilker Huber Geotechnical Consultants, Inc.
4426 South Century Drive, Suite 100
Salt Lake City, Utah 84123

March 17, 2008

Job No. 0023-015-08

March 17, 2008
Job No. 0023-015-08

Gardner Development Company
90 South 400 West, Suite 330
Salt Lake City, Utah 84101

Attention: Mr. Rulon Gardner

Gentlemen:

Re: Report
Geotechnical Study
Phase V, Cottonwood Hills
PUD Subdivision
The Cottonwoods at Mountain Green
Morgan County, Utah

1. INTRODUCTION

1.1 GENERAL

This report presents the results of our geotechnical study performed within the Phase V portion of Cottonwood Hills PUD Subdivision, which is located east of Phase II and between Phases III and IV at The Cottonwoods at Mountain Green in Morgan County, Utah. The general location of the site with respect to major topographic features and existing facilities and other phases of the overall development, as of 1990 and 1998, is presented on Figure 1, Vicinity Map. A more detailed layout of Phase V showing site-specific topography and proposed roads is presented on Figure 2, Site Plan. The locations of borings drilled in conjunction with this and previous studies[1,2] in the area are also presented on Figure 2. Due to difficult accessibility caused by large accumulation of snowfall across the site at the time of the field work, all of the borings completed were within the lower west flatter part of Phase V. During the late spring, supplemental test pits are recommended within the steeper excavation portions of the site.

---

1 "Report, Geotechnical Study, Proposed Morgan Utah North Meetinghouse, Southwest Corner of Silverleaf Drive and Harvard Drive, North Portion of Phase III The Cottonwoods at Mountain Green, Morgan County, Utah," GSH Job No. 0153-033-07, dated January 21 2008.

2 "Report, Geotechnical Study, Phase III and Phase IV of Cottonwood Hills PUD Subdivision, Northeast of Phase I and II, the Cottonwoods at Mountain Green, Morgan County, Utah," GSH Job No. 0023-009-07, dated January15, 2007.

Gordon Spilker Huber Geotechnical Consultants, Inc.
4426 South Century Drive, Suite 100
Salt Lake City, Utah 84123
Tel: (801) 685-9190 Fax: (801) 685-2990
www.gshgeotech.com

During the course of this study, many of the conclusions and recommendations were presented to the design team and owner.

1.2 OBJECTIVES AND SCOPE

The objectives and scope of our study were planned in discussions between Messrs. Rulon Gardner and Ben White of Gardner Development Company; and Mr. Bill Gordon of Gordon Spilker Huber Geotechnical Consultants, Inc. (GSH).

In general, the primary objectives of this study were to:

1. Define and evaluate the subsurface soil and groundwater conditions across the site.

2. Provide appropriate subdrain, earthwork, foundation, floor slab, and pavement recommendations, and geoseismic parameters to be utilized in the design and construction of the proposed development.

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

1. A field program consisting of the drilling, logging, and sampling of 9 borings to depths ranging from 3.0 to 21.5 feet.

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 Mr. Rulon Gardner of Gardner Development Company.

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 Phases V portion of the overall project is being developed for residential structures. Construction will include single-family residential homes, town homes, and primary and secondary subdivision roadways. Proposed layout of the roadways is presented on Figure 2.

The single-family residential structures will generally be two to three levels in height and are desired to include partial- or full-depth basements. Depending upon terrain, the lowest level of many of the structures, primarily within the eastern half of Phase V, will likely walkout on the downslope side of the lots. Below grade, the structures will be of reinforced concrete construction. Above grade, the structures will be of typical wood-frame construction. Structural loads will be transmitted down through bearing walls and columns to the supporting foundations. Maximum anticipated wall and column loads will be on the order of 2 to 3 kips per lineal foot and 20 to 30 kips, respectively. Many of the subgrade walls associated with the structures will also act as retaining walls. Depending upon site terrain, minor to moderate cuts and fills may be required as part of development of individual lots.

Town homes will be two to three levels in height, with the first level being established at grade; that is, below-grade levels are not proposed. These structures will be of wood-frame construction with structural loads being transmitted down through bearing walls and isolated columns. Maximum wall and column loads should be on the order of 3 to 4 kips per lineal foot and 30 to 40 kips, respectively.

The majority of the north-south roadways within Phase V will be constructed with relatively flat final grades. Cuts and fills for the roadways will be on the order of two to five feet. East-to-west roadways will have moderate to steep grades up to approximately 15 percent.

Primary roadways, Silver Leaf Drive and Harvard Drive, run around the north, south, and west perimeters of the site. A north extension of Park Meadows Drive will run though the middle of the site. In addition, a new primary roadway will run northeast-east, southeast, and then east from the northern portion of the Park Meadows Drive extension. Projected long-term traffic over the primary roadway will include a moderate to high volume of automobiles and light trucks and light volume of medium- and heavy-weight trucks and school buses. Secondary roadways will branch off the primary roadways. Traffic over these roadways will be lighter. During construction build-out period, volume of medium- and heavy-weight trucks will be significantly higher.

As presently laid out, primary utilities will run beneath the roadways. In addition, beneath all of the roadways will be fairly large diameter perforated subdrain pipes that will not only collect groundwater but will provide a point of discharge for subdrain systems associated with the residential structures, retaining walls, etc. Perforated area subdrains are present beneath Silver Leaf Drive and Harvard Drive. Ensign Engineering & Land Surveying, Inc. is presently trying to obtain the drawing showing the depths of the subdrains. Overall site development earthwork, in addition to that associated with the roadways, could require cuts and fills of five to six feet.

3. SITE INVESTIGATIONS

3.1 FIELD PROGRAM

In order to define and evaluate the subsurface soil and groundwater conditions across Phase V, a total of 9 exploration borings were drilled to depths ranging from 3.0 to 21.5 feet with an all-terrain truck-mounted drill rig equipped with hollow-stem augers. These borings were drilled between the existing Silver Leaf Drive and west of the proposed Park Meadows Drive extension (approximate west half of Phase V). The east portion of Phase V was not accessible at the time of the field work due to large accumulation of snow fall compounded by steeper terrain. Locations of the borings drilled in conjunction with this study and previous studies in the area 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 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 inspection and testing in our laboratory. Detailed graphical representation of the subsurface conditions encountered is presented on Figures 3A through 3I, Log of Borings. Soils were classified in accordance with the nomenclature described on Figure 4, Unified Soil Classification System.

A 3.25-inch outside diameter, 2.42-inch inside diameter drive (Dames & Moore) sampler was utilized in the subsurface sampling at the site. 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, one and one-quarter-inch diameter slotted PVC pipe was installed in Borings B-1, and B-3 through B-9, in order to provide a means of monitoring the groundwater fluctuations.

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, Atterberg limits, partial gradation, and chemical tests. The following paragraphs describe the tests and summarize the test data. It should be noted that laboratory data obtained in conjunction with our January 15, 2007 and January 21, 2008 reports were also reviewed as part of this study. There is good correlation of laboratory data from all of the reports.

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 3I.

3.2.3 Atterberg Limits Tests

To aid in classifying the soils and to help correlate other test data, an Atterberg limits test was performed on each of two representative samples. Results of the tests are tabulated below:

Boring No.	Depth (feet)	Liquid Limit (percent)	Plastic Limit (percent)	Plasticity Index (percent)	Soils Classification
B-1	10.5	43	22	21	CL*
B-7	2.5	28	19	9	CL

* Portion of the overall clayey gravel with some sand sample passing the No. 40 sieve.

3.2.4 Partial Gradation Test

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

Boring No.	Depth (feet)	Percent Passing No. 200 Sieve	Soil Classification
B-7	10.5	6.9	GP-GC

3.2.5 Consolidation Tests

To provide data necessary for our settlement analyses, a consolidation test was performed upon each of two representative samples of the fine-grained clay soils encountered in the exploration borings. The results indicate that the finer-grained soils are moderately over-consolidated and will exhibit moderate compressibility characteristics when loaded below the over-consolidation pressure. These soils are typical of those encountered in Phases II, IV, and V. Detailed results of the tests are maintained within our files and can be transmitted to you, upon your request.

3.2.6 Chemical Tests

To determine if the site soils will react detrimentally with concrete, chemical tests were performed on a representative sample of the silty clay soils encountered in Boring B-3 at a depth of three and one-half feet below existing grade. The results of the chemical test are tabulated below:

Boring No.	Depth (feet)	pH	Total Water Soluble Sulfate (ppm)
B-3	3.5	7.1	<10

4. SITE CONDITIONS

4.1 GEOLOGIC SETTING

The predominant bedrock in the area consists of the Norwood Tuff, which is of Oligocene to Miocene age (7 to 37 million years before present). The Norwood Tuff consists of white to tan weathered volcanic tuff and tuffaceous deposits that are soft and easily eroded. The Norwood Tuff was not encountered in our borings. The Norwood Tuff, in areas, is blanketed by Quaternary Age (less than three million years old) conglomerate. The conglomerate has been described as consisting of cemented coarse gravels, cobbles, and boulders in a matrix of sand. Below an elevation of approximately 5170 feet, the surficial soils are primarily of lacustrine (Lake Bonneville) deposition. At higher elevations, the soils are of colluvial and alluvial deposition origin.

4.2 SURFACE

The site is located between Phases III (to the north) and IV (to the south). Silver Leaf Drive borders the site along the west and north. The east is bound by a vacant, relatively steep hillside sloping from east-to-west. The site, itself, can be divided into two topography distinct areas. The western third or so is relatively flat and includes a gentle south-to-north running shallow drainage near the eastern limit. The drainage extends beneath Silver Leaf Drive. To the north of Silver Leaf Drive, the drainage becomes much more significant.

The eastern two-thirds of the site slopes moderately down to the west. Steepest slopes are on the order of six horizontal to one vertical.

Running south-to-north and then northeast just east of the proposed north extension of Park Meadows Drive is a man-made drainage canal which has been deactivated. During the field portion of this study, the site was blanketed by more than three to four feet of snow. Site vegetation consists of a moderate growth of up to knee-high grasses and weeds.

4.3 SUBSURFACE SOIL

The soil conditions encountered in each of the borings, to the depths penetrated, were relatively similar. The upper approximately three to six inches of the natural soils are loose with one to three inches of topsoil in most of the borings. The exception is the area of Borings B-5 through B-7 where the topsoil may have been previously stripped.

In general, subsurface soils encountered to depths of 3.0 to 21.5 plus feet consist of silty clays with layers of fine sandy clays/clayey fine sand. These soils are of lacustrine origin below approximate elevation 5170 feet, and of alluvial and colluvial deposits at higher elevations. These soils will exhibit moderate strength and compressibility characteristics and, when tested, do not exhibit moisture sensitive characteristics.

The silty clay soils in many borings are underlain by very dense gravels with some sand and clayey gravels with some sands. This could be the upper weathered portion of the conglomerate bedrock. These soils/bedrock exhibit very high strength and low compressibility characteristics and are not moisture sensitive.

In the areas east of the proposed north extension of Park Meadows Drive, shallower soils over conglomerate bedrock area projected.

4.4 SUBDRAINS

4.4.1 GENERAL

Two subdrain systems will need to be installed at the site. The first is an area subdrain system which will aid in lowering and controlling the groundwater table across the site and provide a point of gravity discharge for the second subdrain system, which will consist of individual subdrains associated with the proposed residential structures, retaining wall, etc.

Previous data and available data to date indicate two groundwater gradient across the site. The first runs east-to-west from the higher topography down to the existing natural drainage which runs south-to-north and then under Silver Leaf Drive. The second runs basically south-to-north in the lower, flatter western third of the site.

As discussed previously, area subdrains are projected to underlie Silver Leaf Drive to the west and north and Harvard Drive to the south. Copies of the drawings depicting the exact locations and depths of these subdrains are being obtained.

To facilitate upcoming earthwork operations, it is imperative that at least the area subdrains, primary and secondary, be installed as quickly as possible.

4.4.2 AREA SUBDRAINS

4.4.2.1 Primary Lines

We recommend that three primary area subdrains be installed. The locations and alignment of these subdrains are shown on Figure 2. These subdrains should consist of eight-inch diameter slotted or perforated PVC or other durable material pipe extending at least eight feet below existing grade. It may not be economically practical to extend the major area subdrain to this depth along the roadway which will extend east-southeast and then south from the northern portion of the proposed Park Meadows Drive or along the southeast portion of Park Meadows Drive. The subdrains should slope at least 0.5 percent to suitable points of gravity discharge, which will ultimately be the more significant drainage located on the immediate north side of Silver Leaf Drive. Subdrain pipes should be encased in one-half- to three-quarter-inch clean gap-graded gravel extending 2 inches below and laterally and at least 18 inches above the top of the pipe. The gravels must be wrapped in a geotextile fabric, such as Mirafi 140N or equivalent. Extending up from the top of the gravel to final grade, the backfill, at least 12 inches in width, must consist of a “free-draining” or “well-draining” coarse sand and gravel mixture. This will act as a chimney drain directing “higher” groundwater to the subdrain below. As laid out, the primary subdrains should collect the east-to-west near-surface groundwater at Park Meadows Drive and the south-to-north groundwater just north of Harvard Drive. Installation of these primary subdrains will require extension below Silver Leaf Drive to the north. It is strongly recommended that the westerly most primary subdrain line through the existing drainage be first initiated by excavating open ditches. This will rapidly lower the groundwater table for subsequent installation.

4.4.2.2 Secondary Lines

The secondary lines would be similar to the primary lines except six inches in diameter.

4.4.3 INDIVIDUAL SUBDRAINS

These subdrains would be constructed around the up-gradient and side-gradient sides of the below-grade extensions of the residential structures, from behind retaining structures, and/or to facilitate drainage in areas such as parking lots, etc. These subdrains should consist of four-inch diameter slotted or perforated PVC or other durable material with the invert being established at least two feet below the top of the lowest adjacent slab in build areas at the top of the retaining wall footings, and at least 3 to 4 feet below-grade in pavement and landscaping areas. The pipes must be encased in one-half to three-quarter inch diameter slotted PVC pipe extending two inches below laterally and at least 12 inches above the top of the adjacent slab or pipe. The gravels would, again, be wrapped in a geotextile fabric, such as Mirafi 140N or equivalent. Minimum slope of these individual subdrains would be at least 0.25 percent to the primary or secondary area subdrains. Extending up from the perimeter foundation subdrains to within two feet of final grade should be a chimney drain consisting of a synthetic drain board or at least 12-inch-wide zone of “free-draining” granular material. The gravels would be separated from the backfill with the geotextile fabric. The top of the gravel would be covered with the geotextile fabric and then covered by at least 24 inches of low permeability soil sloping at least 3 percent for a distance of 5 feet away from the perimeter of the structures. For residential structures, we strongly recommend that the below-grade portions be waterproofed prior to the installation of the subdrain.

4.5 GROUNDWATER

Immediately following drilling operations, the groundwater was measured in each boring. On February 20, 2008, we returned to the site and measured the groundwater within the piezometers placed in the borings. Groundwater measurements are tabulated below:

Boring No.	Groundwater Depth (feet)	
	February 12, 2008*	**February 20, 2008**
B-1	No groundwater encountered to 12 feet	No groundwater encountered to 12 feet
B-2	No groundwater encountered to 3.0 feet	Pipe not installed
B-3	9.0	2.6
B-4	No groundwater encountered to 17 feet	3.8
B-5	15.0	No groundwater encountered to 21.5 feet
B-6	No groundwater encountered to 21.5 feet	18.6
B-7	10.0	8.1
B-8	13.0	12.7
B-9	No groundwater encountered to 9.5 feet	No groundwater encountered to 9.5 feet

* During drilling, not stabilized

The natural groundwater gradients appear to be running east-to-west across the upper portion of the site and then south- to- north through the lower, flatter western portion of the site. Groundwater depths, as of February 20, 2008, are shown on Figure 2. Boring B-3, with the highest measured groundwater, is located within a low-lying drainage running to the north.

Seasonal and longer-term groundwater fluctuations on the order of three to four feet must be anticipated. Highest levels will occur during the late spring and early summer months.

5. DISCUSSIONS AND RECOMMENDATIONS

5.1 SUMMARY OF FINDINGS

The most significant geotechnical aspects of the site are:

1. Groundwater depths varied within the borings between 2.5 feet to 18.5 feet during the field portion of this study. Groundwater levels will rise during the spring and early summer months. Similar to Phases II, III, and IV, we strongly recommend that relatively deep area subdrains be installed, along with other utilities beneath the roadways in Phase V. The subdrain will aid in lowering and controlling area-wide groundwater conditions and provide a point of gravity discharge for perimeter subdrains associated with proposed residential structures.

2. Due to difficult accessibility caused by large accumulation of snowfall across the site at the time of the field work, all of the borings completed were within the lower west half of Phase V. Subsurface soils within the east half of the site must be determined once the site is more accessible.

The proposed structures may be supported upon conventional spread and continuous wall foundations established upon suitable natural soils and/or structural fill extending to suitable natural soils. Detailed earthwork, foundations, and pavement recommendations presented in our reports dated June 21, 2005 and January 15, 2007[3] remain applicable.

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

5.2 SLOPE STABILTY CONSIDERATIONS

5.2.1 Conditions Most Affecting Slope Stability

Personnel with GSH have been performing geotechnical studies in the area since mid-1975. During the mid 1970's, this reviewer was asked by representatives of the Utah Geological Survey to work with their agency in determining the most probable cause or causes of the number of very severe slides in the Highlands area. Based upon the initial studies and numerous studies over the years, it is obvious the two most predominant factors affecting slope instability are groundwater and adverse grading. In addition, the majority of the homes in the area which have experience damage due to slope instability have been constructed at or near the crests of slopes. In general, avoiding construction of homes near the crest of slopes, immediately up- or down-gradient of large cuts and fills, maintaining non-structurally supported slopes at

[3] "Report, Geotechnical Study, Phase III and Phase IV of Cottonwood Hills PUD Subdivision, Northeast of Phased I and II, the Cottonwoods at Mountain Green, Morgan County, Utah," GSH Job No. 0023-009-07.

approximately three horizontal to one vertical, avoiding cuts which will undermine existing slopes and dewatering will help mitigate problems associated with slope instability.

In conjunction with our study dated January 15, 2007, Phases III and IV slope stability analyses were conducted for slopes of two and one-half horizontal to one vertical (conservatively steep) and 40 feet in height with a near-horizontal slope at the toe and crest. Groundwater was projected to be 15 feet below the ground surface at the toe at the two and one-half horizontal to one vertical slope. This study, along with results of the analyses presented in our June 21, 2006[4] study indicates that conservatively steep slopes, as much as two and one-half horizontal to one vertical, not disrupted by excessive cutting and filling and with a conservatively high water table exhibit more than required factors of safety under static and dynamic loading.

In conjunction with site development, it must also be noted that beneath the base of all of the roadways, separate perforated area subdrains will be installed. These subdrains will not only lower and control overall groundwater but will be a point of gravity discharge for the perimeter foundations, retaining walls, and areas subdrains, which will be part of the development of individual lots.

5.3 EARTHWORK

5.3.1 Site Preparation

Prior to initiation of major construction activities, all surface vegetation, topsoil, and other deleterious materials must be removed from an area extending out at least two feet from the perimeter of all proposed structural facilities, homes, driveways, roadways, etc. Surface vegetation and other deleterious materials should be removed from the site area. Topsoil, although minimal, may be stockpiled for subsequent landscaping purposes. Topsoil is not suitable for utilization as structural fill.

Subsequent to stripping and prior to the placement of structural site grading fill, pavements, and floor slabs, the exposed subgrade must be proofrolled by passing moderate-weight rubber tire-mounted construction equipment over the surface at least twice. If excessively soft or loose soils are encountered, they must be removed to a maximum depth of two feet and replaced with structural fill.

Cuts and fills for the roadways should be balanced to minimize each and maintain near as possible the existing grades and at a minimum three horizontal to one vertical.

4 "Report, Geotechnical Study, Phase II Portion of Cottonwood Hills PUD Subdivision, North of Old Highway 30 and East of Mountain Green, Morgan County, Utah," GSH Job No. 0023-006-06, dated June 21, 2006.

5.3.2 Excavations

Temporary construction excavations in cohesive soil not exceeding four feet in depth, above or below the groundwater table, may be constructed with near-vertical sideslopes. Temporary excavations up to 10 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.

Construction excavation above the water table, in granular soils, and not exceeding four feet, should be no steeper than one-half horizontal to one vertical. For excavations up to 10 feet in granular soils and above the water table, the slopes should be no steeper than one horizontal to one vertical. Excavations encountering saturated cohesionless soils will be difficult since these soils will tend to flow into the excavation and will require very flat sideslopes and/or shoring, bracing, and dewatering.

These temporary construction excavations should not be left open any longer than required for normal construction of a proposed single-family residential structure. Leaving, especially the deeper excavations, open for longer periods of time could result in the initiation of slope instability.

Static groundwater measured eight days after completion of the nine borings within the lower half of the site ranged from 2.6 feet in Boring B-3 to deeper than 21.5 feet in Boring B-5.

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.

5.3.3 Structural Fill

Structural fill is defined as all fill which will ultimately be subjected to structural loadings, including foundations, floor slabs, roadways, structural embankments, etc. All structural fill must be free of sod, rubbish, construction debris, frozen soil, and other deleterious materials. The maximum particle size for structural site grading fill, should generally not exceed four inches; although, occasional particles up to six to eight inches may be incorporated provided that they do not result in “honeycombing” or preclude the obtainment of the desired degree of compaction. Structural site grading fill is defined as fill placed over fairly large open areas to raise the overall site grade. In confined areas, the maximum particle size should generally be restricted to two inches. The maximum plasticity index of the portion of the fill passing the No. 40 sieve should not exceed 19 percent.

Of greater concern with regard to overall development is that the structural fills placed not be highly permeable and, thus, provide a means of conveyance of water into the subsurface sequence. The on-site silty clay, clayey silt/silty clay mixtures properly placed and compacted will have low permeability characteristics. Generally, backfill associated with utilities in roadways are granular, which can be highly permeable. In this case, it is strongly recommended that the backfills in confined areas, even though granular, contain at least 25 percent fines.

Having this percentage of fines within a well-graded granular material will result in a relatively low permeability material after it is properly placed and compacted.

5.3.4 Fill Placement and Compaction

All structural fill should be placed in lifts not exceeding eight inches in loose lift thickness. Structural fill placed beneath the building pad or as part of pavement sections should be compacted to at least 95 percent of the maximum dry density as determined by the AASHTO[5] T-180 (ASTM[6] D-1557) compaction criteria. Structural site grading fills up to 8 feet, which are not beneath the building pad area should be compacted to at least 92 percent of the above-defined criteria. Structural fills greater than 8 feet thick are not anticipated. Structural fill pads beneath proposed buildings are not anticipated to exceed three feet.

Prior to the placement of the structural site grading fills, the subgrade should be prepared as discussed in Section 5.4.1, Site Preparation, of this report. In confined areas, subgrade preparation should consist of the removal of all loose or disturbed soils.

When placing fills against slopes that are steeper than four horizontal to one vertical, benches having maximum vertical heights of 12 inches should be stepped into the hillside, thus allowing for the more positive bond between the natural soils and the structural fills.

5.3.5 Final Cut and Fill Slopes

Considering maintenance, drainage, and stability, it is recommended that all cut and fill slopes be constructed no steeper than two and one-half horizontal to one vertical. If more rapid grade transitions are required, retainage structures should be utilized. We strongly recommend that the maximum height of any retainage structure be restricted to eight feet. Up to four feet stacked rock walls may be utilized. Above four feet, reinforced concrete walls are recommended.

5.3.6 Utility Trenches

All utility trench backfill material below structurally loaded facilities (flatwork, floor slabs, roads, etc.) should 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 should be proofrolled and/or properly compacted prior to the construction of any exterior flatwork over a backfilled trench. Proofrolling may be performed by passing moderately loaded rubber tire-mounted construction equipment uniformly over the surface at least twice. If excessively loose or soft areas are encountered during proofrolling, they should be removed to a maximum depth of two 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

5 American Association of State Highway and Transportation Officials
6 American Society for Testing and Materials

over utilities. In order not to provide a conveyance for water into the subgrade soil, it is our recommendation that the backfill meet the requirements stated in Section 5.4.3. These organizations are also requiring that in public roadways the backfill over major utilities be compacted over the full depth of fill to at least 96 percent of the maximum dry density as determined by the AASHTO T-180 (ASTM D-1557) method of compaction. We recommend that as the major utilities continue onto the site that these compaction specifications are followed.

5.4 SPREAD AND CONTINUOUS WALL FOUNDATIONS

5.4.1 Design Data

The results of our analyses indicate that the proposed residential structures and retaining walls may be supported upon conventional spread and continuous wall foundations established upon suitable undisturbed natural soils 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	- 2,000 pounds per square foot
Bearing Pressure Increase for Seismic Loading	- 50 percent

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

5.4.2 Installation

Under no circumstances should the footings be underlain by topsoil, loose or disturbed soils, frozen soil, or other deleterious materials or established upon unsuitable soils such as the dark brown to black compressible soil encountered in the January 15, 2007 report within the nearby Phase III. If unsuitable soils are encountered, they must be removed and replaced with compacted granular fill. The width replacement fill should be equal to the width of the footing plus one foot for each foot of fill thickness.

5.4.3 Settlements

Settlements of foundations designed and installed in accordance with the above recommendations and supporting typical residential loading should not exceed three-eighths of an inch. Settlements will occur almost concurrently with construction loading.

5.5 LATERAL RESISTANCE

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

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

5.6 LATERAL PRESSURES

The lateral pressure parameters, as presented within this section, assume that the backfill will consist of the soils as discussed in Section 5.5.3, Settlements, and be placed and compacted in accordance with the recommendations presented herein. These backfill materials by design will exhibit low permeability characteristics. It is, therefore, essential that subdrains be associated with all walls. 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), the backfill may be considered equivalent to a fluid with a density of 45 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, backfill may be considered equivalent to a fluid with a density of 66 pounds per cubic foot. For very rigid non-yielding walls, backfill should be considered equivalent to a fluid with a density with at least 75 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 and lightly compacted, not as a structural fill. If the fill is placed as a structural fill, the values should be increased to 60 pounds per cubic foot, 75 pounds per cubic foot, and 130 pounds per cubic foot, respectively. If the slope behind the wall is two horizontal to one 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, a uniform pressure of 150 pounds per square foot should be added.

5.7 AT-GRADE SLABS

Typically, we recommend that a four-inch layer of "free-draining" clean gap-graded crushed gravel be placed beneath the at-grade slabs. However, this layer is a possible means of conveyance of water into the subsurface sequence and is not recommended at the site. Instead, we recommend a four-inch layer of aggregate base be placed beneath the at-grade slab with a continuous impermeable visqueen layer being placed between the natural soils and the aggregate base. Settlements of at-grade slabs should be negligible.

5.8 PAVEMENTS

The natural fine-grained soils and/or structural site grading fill consisting of natural fine-grained soil will exhibit poor pavement support characteristics when saturated or nearly saturated. Using the silty clay as the typical subgrade, the pavement sections below are recommended:

Secondary Subdivision Roadway Areas

(Moderate Volume of Automobiles and Light Trucks,
Light Volume of Medium-Weight Trucks,
and Occasional Heavy-Weight Trucks)
[Cul-De-Sac and Loop Roads]

3.5 inches	Asphalt concrete
8.0 inches	Aggregate base course
Over	Properly prepared subgrade or compacted or structural fill

Projected traffic over the primary roadway will include a moderate to high volume of automobiles and light trucks and light volume of medium- and heavy-weight trucks and school buses.

Primary Overall Access Roadways

(Moderate to High Volume of Automobiles and Light Trucks,
Light Volume of Medium- and Heavy-Weight Trucks and Buses)

4.5 inches	Asphalt concrete
9.0 inches	Aggregate base course
18.0 inches	Granular subbase
Over	Properly prepared fine-grained subgrade

Lesser sections may be applicable for less heavily loaded roadways. These sections will be provided once specific traffic information becomes available. Subdrains beneath the roadway will greatly aid in stabilizing the subgrade. It is strongly recommended that heavy construction traffic be restricted over the pavements during the "spring thaw" period. This is when the subgrade is saturated.

5.9 GEOSEISMIC SETTING

5.9.1 General

Utah municipalities adopted the International Building Code (IBC) 2006 and International Residential Code for One- to Two-Family Dwellings 2006 on January 1, 2007. The IBC 2006 code determines the seismic hazard for a site based upon 2002 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 structures must be designed in accordance with the procedure presented in Section 1613, Earthquake Loads, of the IBC 2006 edition.

5.9.2 Faulting

Based on our review of available literature, no active faults pass through or immediately adjacent to the site. No evidence of active faulting on or near the proposed sites was observed in our analysis of aerial photography and review of available literature. The nearest mapped active faults are the Wasatch fault approximately eight miles to the west, and the Morgan fault system, located approximately one mile to the east (Black, 2003).

5.9.3 Soil Class

For dynamic structural analysis, the Site Class D - Stiff Soil Profile as defined in Table 1613.5.2, Site Class Definitions, of the IBC 2006 can be utilized.

5.9.4 Ground Motions

The IBC 2006 code is based on 2002 USGS (United States Geologic Survey) 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 a MCE event and incorporates a soil amplification factor for a Site Class D soil profile in the second column. Based on the site latitude and longitude (41.1494 degrees north and 111.7529 degrees west, respectively), the values for this site are tabulated below:

Spectral Acceleration Value, T Seconds	**Site Class B-C Boundary [mapped values] (% g)**	**Site Class D [adjusted for site class effects] (% g)**
Peak Ground Acceleration	37.0	41.8
0.2 Seconds, (Short Period Acceleration)	$S_S = 92.4$	$S_{MS} = 104.4$
1.0 Seconds (Long Period Acceleration)	$S_1 = 34.1$	$S_{M1} = 58.5$

The IBC 2006 code design accelerations (S_{DS} and S_{D1}) are based on multiplying the above accelerations (adjusted for site class effects) for the MCE event by two-thirds (⅔).

5.9.5 Liquefaction

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. Medium stiff to hard stiff silty clay and dense to very dense gravels were encountered from the surface to a depth of 21.5 feet. The clay soils are cohesive and are not susceptible to liquefaction, even during a major seismic event. Also, based on the relative high density of the gravel soils, we project that the potential for liquefaction at the site is low to very low.

We appreciate the opportunity of providing this service for you. If you have any questions or require additional information, please do not hesitate to contact us.
Respectfully submitted,

GSH Geotechnical Consultants, Inc.

Bryan N. Roberts, State of Utah No. 276476
Professional Engineer

Reviewed by:

William J. Gordon, State of Utah No. 146417
Professional Engineer

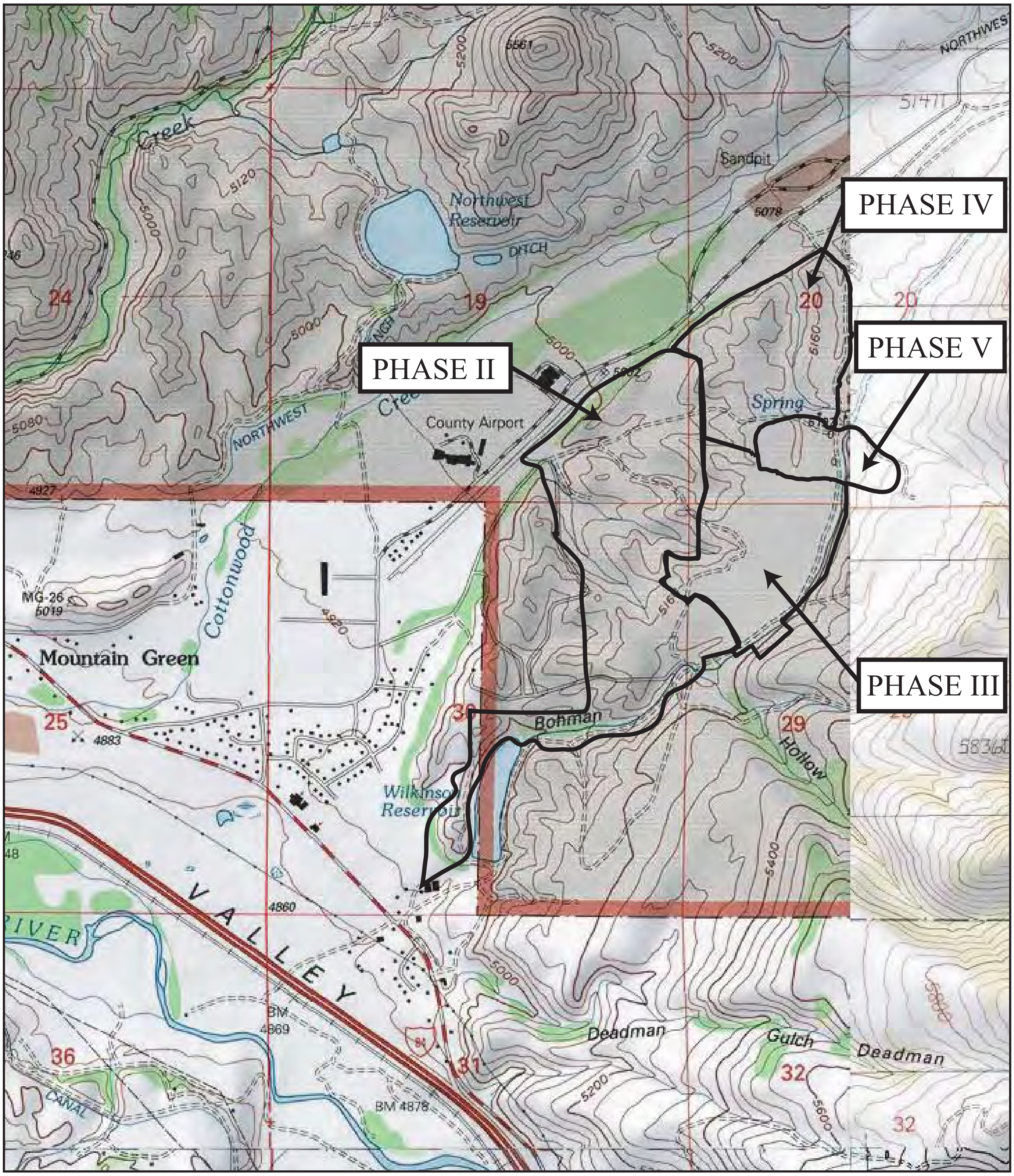
BNR/WJG:sn/klw

Encl. Figure 1, Vicinity Map
Figure 2, Site Plan
Figures 3A through 3I, Log of Borings
Figure 4, Unified Soil Classification System

Addressee (5)
c: Mr. Bob Elder (1)
Ensign Engineering & Land Surveying, Inc.
90 East Fort Union Boulevard
Midvale, Utah 84047-1565

Mr. Scott Gardner (1)
Gardner Development Company
90 South 400 West, Suite 330
Salt Lake City, Utah 84101

GARDNER DEVELOPMENT COMPANY
JOB NO. 0023-015-08

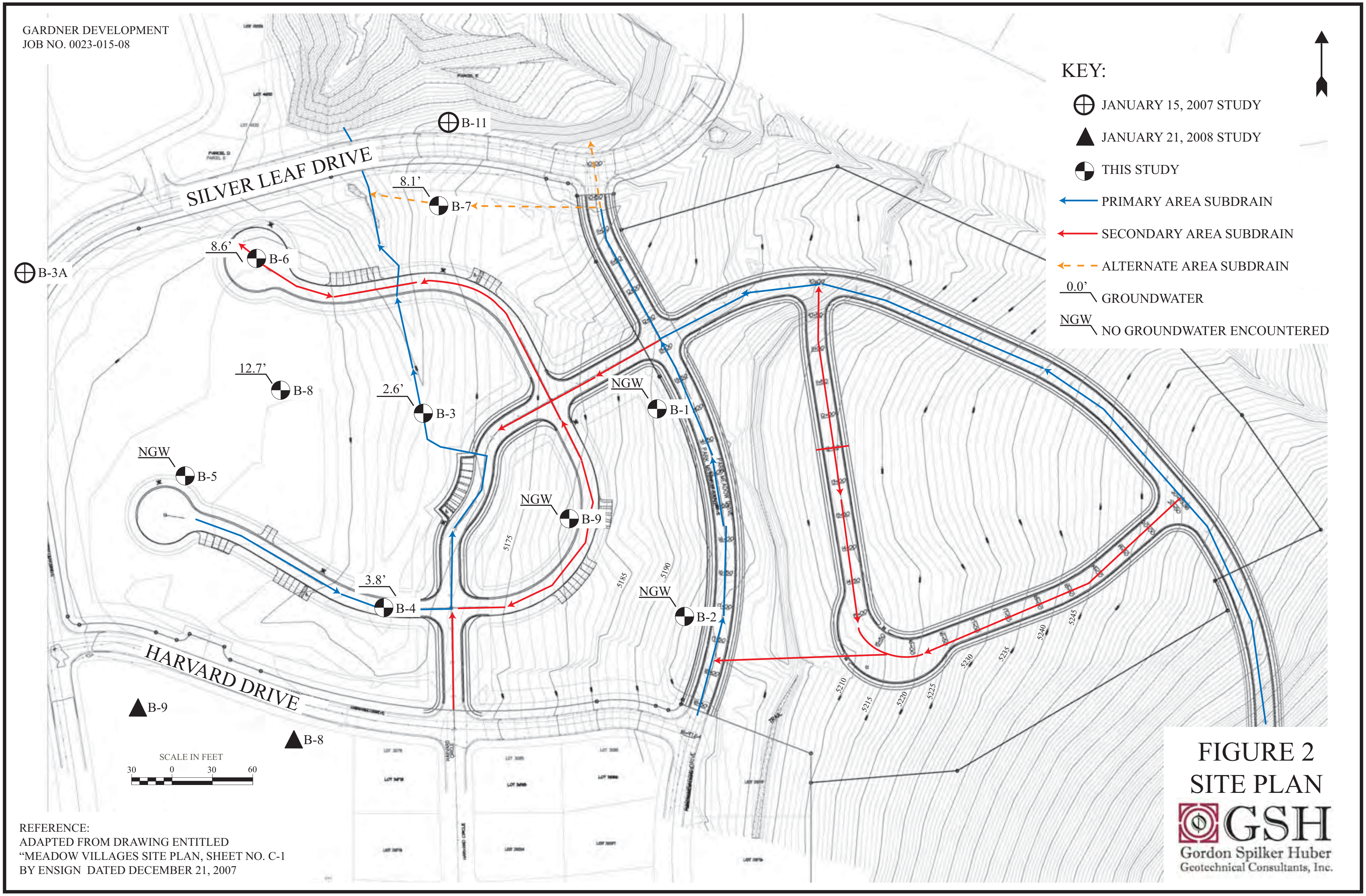


SCALE IN FEET
1000 0 1000 2000

FIGURE 1
VICINITY MAP

GSH
Gordon Spilker Huber
Geotechnical Consultants, Inc.

REFERENCE:
USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE MAPS
TITLED “SNOW BASIN, UTAH” DATED 1998 AND
“DURST MOUNTAIN, UTAH” DATED 1990


GARDNER DEVELOPMENT
JOB NO. 0023-015-08
KEY:
JANUARY 15, 2007 STUDY
JANUARY 21, 2008 STUDY
THIS STUDY
PRIMARY AREA SUBDRAIN
SECONDARY AREA SUBDRAIN
ALTERNATE AREA SUBDRAIN
0.0' GROUNDWATER
NGW NO GROUNDWATER ENCOUNTERED
SILVER LEAF DRIVE
HARVARD DRIVE
B-11
B-3A
8.1' B-7
8.6' B-6
12.7' B-8
2.6' B-3
NGW B-1
NGW B-5
NGW B-9
3.8' B-4
NGW B-2
B-9
B-8
SCALE IN FEET
30 0 30 60
REFERENCE:
ADAPTED FROM DRAWING ENTITLED
"MEADOW VILLAGES SITE PLAN, SHEET NO. C-1
BY ENSIGN DATED DECEMBER 21, 2007
FIGURE 2
SITE PLAN
GSH
Gordon Spilker Huber
Geotechnical Consultants, Inc.

Gordon Spilker Huber Geotechnical Consultants, Inc.
Salt Lake City, Utah 84123

Project Name: Phase V, Cottonwood Hills PUD Subdivision
Project No.: 0023-015-08
Location: Cottonwoods at Mountain Green, Morgan Cnty, UT
Client: Gardner Development Company
Drilling Method: 3-3/4" ID Hollow-Stem Auger
Date Drilled: 02-12-08
Elevation: Overall Site Approximately 5200' +/-
Water Level: No groundwater encountered (02-12-08 & 02-20-08)
Remarks:

Graphical Log	Water Level	DESCRIPTION	DEPTH FT.	BLOWS/FT	SAMPLE SYMBOL	MOISTURE (%)	% PASSING 200	DRY DENSITY (PCF)	Liquid Limit (%)	Plastic Limit (%)	REMARKS
		Ground Surface									
		SILTY CLAY with some fine sand; major roots (topsoil) to 2"-3"; blocky structure; trace organics; brown to reddish-brown (CL)	0								loose 3"-4"; slightly moist to moist; hard
				96	⧗						
			5	56	⧗	20.7		118			very stiff
		CLAYEY GRAVEL with some fine to coarse sand; fine and coarse gravel; brown (GC)	10	99	⧗				43	22	moist; dense
		Drilling refusal at 12.0' on cobbles. Stopped sampling at 11.5'. Installed 1-1/4" diameter slotted PVC pipe to 11.5'. No groundwater encouneter at time of drilling.	15								
			20								
			25								

The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary for a proper understanding of the nature of the subsurface material.

FIGURE 3A

Gordon Spilker Huber Geotechnical Consultants, Inc.
Salt Lake City, Utah 84123

Project Name: Phase V, Cottonwood Hills PUD Subdivision
Project No.: 0023-015-08
Location: Cottonwoods at Mountain Green, Morgan Cnty, UT
Client: Gardner Development Company
Drilling Method: 3-3/4" ID Hollow-Stem Auger
Date Drilled: 02-12-08
Elevation: Overall Site Approximately 5200' +/-
Water Level: No groundwater encountered (02-12-08)
Remarks:

Graphical Log	Water Level	DESCRIPTION	DEPTH FT.	BLOWS/FT	SAMPLE SYMBOL	MOISTURE (%)	% PASSING 200	DRY DENSITY (PCF)	Liquid Limit (%)	Plastic Limit (%)	REMARKS
		Ground Surface									
		SILTY CLAY with some fine sand; major roots (topsoil) to 1"-2"; trace organics; brown (CL)	0								loose 3"-4" moist stiff
				12							
		Drilling refusal at 3.0' on cobbles.									
		Stopped sampling at 2.5'.	5								
		No groundwater encouneter at time of drilling.									
			10								
			15								
			20								
			25								

The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary for a proper understanding of the nature of the subsurface material.

FIGURE 3B

BOREHOLE B-3

Gordon Spilker Huber Geotechnical Consultants, Inc.
Salt Lake City, Utah 84123

Project Name: Phase V, Cottonwood Hills PUD Subdivision
Project No.: 0023-015-08
Location: Cottonwoods at Mountain Green, Morgan Cnty, UT
Client: Gardner Development Company
Drilling Method: 3-3/4" ID Hollow-Stem Auger
Date Drilled: 02-12-08
Elevation: Overall Site Approximately 5200' +/-
Water Level: 9.0' (02-12-08) 2.6' (02-20-08)
Remarks:

DESCRIPTION	DEPTH FT.	BLOWS/FT	SAMPLE SYMBOL	MOISTURE (%)	% PASSING 200	DRY DENSITY (PCF)	Liquid Limit (%)	Plastic Limit (%)	REMARKS
Ground Surface	0								
SILTY CLAY with some fine sand; major roots (topsoil) to 1"-2"; trace organics; brown (CL)									loose 3"-4" moist to very moist medium stiff
		8							
grades gray	5								
some fine and coarse gravel; oxidation mottling; brown to greenish-brown		16							stiff moist stiff
GRAVEL with some fine to coarse sand and trace silt; fine and coarse gravel; light brown (GP)									
	10	100 5"							saturated very dense
Drilling refusal at 11.0'.									
Stopped sampling at 10.5'.									
Installed 1-1/4" diameter slotted PVC pipe to 11.0'.									
	15								
	20								
	25								

The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary for a proper understanding of the nature of the subsurface material.

FIGURE 3C

Gordon Spilker Huber Geotechnical Consultants, Inc.
Salt Lake City, Utah 84123

Project Name: Phase V, Cottonwood Hills PUD Subdivision
Project No.: 0023-015-08
Location: Cottonwoods at Mountain Green, Morgan Cnty, UT
Client: Gardner Development Company
Drilling Method: 3-3/4" ID Hollow-Stem Auger
Date Drilled: 02-12-08
Elevation: Overall Site Approximately 5200' +/-
Water Level: No groundwater encountered (02-12-08) 3.8' (02-20-08)
Remarks:

Graphical Log	Water Level	DESCRIPTION	DEPTH FT.	BLOWS/FT	SAMPLE SYMBOL	MOISTURE (%)	% PASSING 200	DRY DENSITY (PCF)	Liquid Limit (%)	Plastic Limit (%)	REMARKS
		Ground Surface									
		SILTY CLAY with some fine sand; major roots (topsil) to 1"-2"; trace organics; slightly blocky; trace rootholes; dark brown (CL)	0								loose 3"-4" moist stiff
				18	X						
	▼										
		grades brown	5	10	X	19.1		103			moist to very moist medium stiff
		GLAYEY GRAVEL with some fine to coarse sand; fine and coarse gravel; oxidation mottling; brown (GC)									moist to very moist very dense
			10	100 5"	X						
		drilling indicates occasional cobbles									
		SANDY CLAY with occasional to some fine and coarse gravel; light brown to brown (CL)	15	69	X						moist medium dense
		Drilling refusal at 17.0'.									
		Stopped sampling at 16.5'.									
		Installed 1-1/4" diameter slotted PVC pipe to 17.0'.	20								
		No groundwater encouneter at time of drilling.									
			25								

The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary for a proper understanding of the nature of the subsurface material.

FIGURE 3D

BOREHOLE B-5

Gordon Spilker Huber Geotechnical Consultants, Inc.
Salt Lake City, Utah 84123

Project Name: Phase V, Cottonwood Hills PUD Subdivision
Project No.: 0023-015-08
Location: Cottonwoods at Mountain Green, Morgan Cnty, UT
Client: Gardner Development Company
Drilling Method: 3-3/4" ID Hollow-Stem Auger
Date Drilled: 02-12-08
Elevation: Overall Site Approximately 5200' +/-
Water Level: 15.0' (02-12-08) No groundwater encountered (02-20-08)
Remarks:

Graphical Log	Water Level	DESCRIPTION	DEPTH FT.	BLOWS/FT	SAMPLE SYMBOL	MOISTURE (%)	% PASSING 200	DRY DENSITY (PCF)	Liquid Limit (%)	Plastic Limit (%)	REMARKS
		Ground Surface									
		SILTY CLAY with some fine sand and fine and coarse gravel; no toposil; blocky structure; trace pinholes; light brown mottling; reddish-brown (CL)	0								moist very stiff
				25	X						
		grades occasional silty fine sand partings up to 1/8" thick; light brown mottling	5	38	X	18.5		93			
		grades with no mottling; clayey sand layers up to 1/4" thick; reddish-brown oxidation	10	29	X	24.7		98			
		SANDY CLAY/CLAYEY SAND with occasional layers up to 4" thick of clayey fine sand; brown (CL)									saturated stiff
	▼		15	21	X						
		grades with occasional layers up to 6" thick of silty fine sand	20	18	X						
		Stopped drilling at 20.0'. Stopped sampling at 21.5'. Installed 1-1/4" diameter slotted PVC pipe to 21.5'.	25								

The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary for a proper understanding of the nature of the subsurface material.

FIGURE 3E

Gordon Spilker Huber Geotechnical Consultants, Inc.
Salt Lake City, Utah 84123

BOREHOLE B-6

Project Name: Phase V, Cottonwood Hills PUD Subdivision
Project No.: 0023-015-08
Location: Cottonwoods at Mountain Green, Morgan Cnty, UT
Client: Gardner Development Company
Drilling Method: 3-3/4" ID Hollow-Stem Auger
Date Drilled: 02-13-08
Elevation: Overall Site Approximately 5200' +/-
Water Level: No groundwater encountered (02-13-08) 18.6' (02-20-08)
Remarks:

Graphical Log	Water Level	DESCRIPTION	DEPTH FT.	BLOWS/FT	SAMPLE SYMBOL	MOISTURE (%)	% PASSING 200	DRY DENSITY (PCF)	Liquid Limit (%)	Plastic Limit (%)	REMARKS
		Ground Surface	0								
		SANDY CLAY/CLAYEY SAND with some silt; no topsoil; fine sand; reddish-brown (CL/SC)									moist very stiff
				34	X						
		SILTY CLAY occasional layers up to 1" thick of silty fine sand; light brown oxidation mottling; reddish-brown (CL)	5								moist very stiff
				46	X	17.7		107			
		SILTY CLAY AND SAND occasional layers up to 6" thick of silty fine sand; brown (CL/SM)	10	31	X						moist very stiff
		SILTY CLAY with some fine sand; brown (CL)									very moist to saturated stiff
			15	13	X	31.6		89			
		grades with trace fine sand; grayish-brown	20	10	X						saturated medium stiff
		Stopped drilling at 20.0'. Stopped sampling at 21.5'. Installed 1-1/4" diameter slotted PVC pipe to 21.5'.	25								

The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary for a proper understanding of the nature of the subsurface material.

FIGURE 3F

Gordon Spilker Huber Geotechnical Consultants, Inc.
Salt Lake City, Utah 84123

Project Name: Phase V, Cottonwood Hills PUD Subdivision
Project No.: 0023-015-08
Location: Cottonwoods at Mountain Green, Morgan Cnty, UT
Client: Gardner Development Company
Drilling Method: 3-3/4" ID Hollow-Stem Auger
Date Drilled: 02-13-08
Elevation: Overall Site Approximately 5200' +/-
Water Level: 10.0' (02-13-08) 8.1' (02-20-08)
Remarks:

Graphical Log	Water Level	DESCRIPTION	DEPTH FT.	BLOWS/FT	SAMPLE SYMBOL	MOISTURE (%)	% PASSING 200	DRY DENSITY (PCF)	Liquid Limit (%)	Plastic Limit (%)	REMARKS
		Ground Surface									
		SILTY CLAY with some fine sand; no topsoil; blocky structure; trace organics; reddish-brown (CL)	0								moist very stiff
				33							
		grades less sand; oxidation mottling; gray and brown	5								
				41							
	▼										
		GRAVEL with some clay and fine to coarse sand; fine and coarse gravel; gray and brown (GP/GC)	10								saturated very dense
				113							
		Drilling refusal at 12.0' on cobbles. Stopped sampling at 10.5'. Installed 1-1/4" diameter slotted PVC pipe to 12.0'.	15								
			20								
			25								

The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary for a proper understanding of the nature of the subsurface material.

FIGURE 3G

Gordon Spilker Huber Geotechnical Consultants, Inc.
Salt Lake City, Utah 84123

BOREHOLE B-8

Project Name: Phase V, Cottonwood Hills PUD Subdivision
Project No.: 0023-015-08
Location: Cottonwoods at Mountain Green, Morgan Cnty, UT
Client: Gardner Development Company
Drilling Method: 3-3/4" ID Hollow-Stem Auger
Date Drilled: 02-13-08
Elevation: Overall Site Approximately 5200' +/-
Water Level: 13.0' (02-13-08) 12.7' (02-20-08)
Remarks:

DESCRIPTION	DEPTH FT.	BLOWS/FT	SAMPLE SYMBOL	MOISTURE (%)	% PASSING 200	DRY DENSITY (PCF)	Liquid Limit (%)	Plastic Limit (%)	REMARKS
Ground Surface	0								
SILTY CLAY with some fine sand; no topsoil; dark brown (CL)									loose 3"-4" moist stiff
grades reddish-brown; light brown mottling		11	X						
	5								
grades with occasional layers up to 1/16" thick of silty fine sand partings		19	X	10.9		105			
	10								
(water level ▼)		9	X	36.4		88			saturated medium stiff
	15								
grades trace fine sand; grayish-brown		7	X						
Stopped drilling at 17.0'.									
Stopped sampling at 18.5'.	20								
Installed 1-1/4" diameter slotted PVC pipe to 18.5'.									
	25								

The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary for a proper understanding of the nature of the subsurface material.

FIGURE 3H

Gordon Spilker Huber Geotechnical Consultants, Inc.
Salt Lake City, Utah 84123

Project Name: Phase V, Cottonwood Hills PUD Subdivision
Project No.: 0023-015-08
Location: Cottonwoods at Mountain Green, Morgan Cnty, UT
Client: Gardner Development Company
Drilling Method: 3-3/4" ID Hollow-Stem Auger
Date Drilled: 02-13-08
Elevation: Overall Site Approximately 5200' +/-
Water Level: No groundwater encountered (02-13-08 & 02-20-08).
Remarks:

Graphical Log	Water Level	DESCRIPTION	DEPTH FT.	BLOWS/FT	SAMPLE SYMBOL	MOISTURE (%)	% PASSING 200	DRY DENSITY (PCF)	Liquid Limit (%)	Plastic Limit (%)	REMARKS
		Ground Surface									
		SILTY CLAY with some fine sand; major roots (topsoil) to 1"-2"; blocky structure; trace organics; rootholes; reddish-brown (CL)	0								loose 3"-4" moist very stiff
				50		13.9		94			
		grades with light brown mottling	5	56		15.4		116			
				100 4"							
		CLAYEY GRAVEL fine and coarse gravel with some sand; brown (GC)									very moist very dense
			10								
		Drilling refusal at 9.0'.									
		Stopped sampling at 9.5'.									
		Installed 1-1/4" diameter slotted PVC pipe to 9.5'.									
		No groundwater encountered at time of drilling.									
			15								
			20								
			25								

The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary for a proper understanding of the nature of the subsurface material.

FIGURE 3I

UNIFIED SOIL CLASSIFICATION SYSTEM

FIELD IDENTIFICATION PROCEDURES				LETTER SYMBOL [1]	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS More than half of material is larger than No. 200 sieve size. [2] (The No. 200 sieve size is about the smallest particle visible to the naked eye)	GRAVELS More than half of coarse fraction is larger than No. 4 sieve size. (For visual classifications, the 1/4" size may be used as equivalent to the No. 4 sieve size.)	CLEAN GRAVELS (Little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes.	GW	Well graded gravels, gravel-sand mixtures, little or no fines.
			Predominantly one size or a range of sizes with some intermediate sizes missing.	GP	Poorly graded gravels, gravel-sand mixtures, little or no fines.
		GRAVELS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below).	GM	Silty gravels, poorly graded gravel-sand-silt mixtures.
			Plastic fines (for identification procedures see CL below).	GC	Clayey gravels, poorly graded gravel-sand-clay mixtures.
	SANDS More than half of coarse fraction is smaller than No. 4 sieve size. (For visual classifications, the 1/4" size may be used as equivalent to the No. 4 sieve size.)	CLEAN SANDS (Little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate particle sizes.	SW	Well graded sands, gravelly sands, little or no fines.
			Predominantly one size or a range of sizes with some intermediate sizes missing.	SP	Poorly graded sands, gravelly sands, little or no fines.
		SANDS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below).	SM	Silty sands, poorly graded sand-silt mixtures.
			Plastic fines (for identification procedures see CL below).	SC	Clayey sands, poorly graded sand-clay mixtures.

		IDENTIFICATION PROCEDURES ON FRACTION SMALLER THAN No. 40 SIEVE SIZE				
		DRY STRENGTH (CRUSHING CHARACTERISTICS)	DILATANCY (REACTION TO SHAKING)	TOUGHNESS (CONSISTENCY NEAR PLASTIC LIMIT)	LETTER SYMBOL	TYPICAL DESCRIPTIONS
FINE GRAINED SOILS More than half of material is smaller than No. 200 sieve size. (The No. 200 sieve size is about the smallest particle visible to the naked eye)	SILTS AND CLAYS Liquid limit less than 50	None to slight	Quick to slow	None	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sand with slight plasticity.
		Medium to high	None to very slow	Medium	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
		Slight to medium	Slow	Slight	OL	Organic silts and organic silt-clays of low plasticity.
	SILTS AND CLAYS Liquid limit greater than 50	Slight to medium	Slow to none	Slight to medium	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		High to very high	None	High	CH	Inorganic clays of high plasticity, fat clays.
		Medium to high	None to very slow	Slight to medium	OH	Organic clays of medium to high plasticity.
HIGHLY ORGANIC SOILS		Readily identified by color, odor, spongy feel and frequently by fibrous texture.			Pt	Peat and other highly organic soils.

[1] Boundary classifications: —Soils possessing characteristics of two groups are designated by combinations of group symbols. For example GW—GC, well graded gravel—sand mixture with clay binder.
[2] All sieve sizes on this chart are U.S. standard.

GENERAL NOTES

1. In general, Unified Soil Classification Designations presented on the logs were evaluated by visual methods only. There rore, actual designations (based on laboratory testing) may differ.

2. Lines seperating strata on the logs represent approximate boundaries only Actual transitions may be gradual.

3. Logs represent general soil conditions observed at teh point of exploration onthe date indicated.

4. No warranty is provided as to the continuity of soil conditions between individual sample locations.

FINE - GRAINED SOIL

CONSISTENCY	SPT (blows/ft)	TORVANE UNDRAINED SHEAR STRENGTH (tsf)	POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH (tsf)	FIELD TEST
Very Soft	<2	<0.125	<0.25	Easily penetrated several inches by Thumb. Squeezes through fingers.
Soft	2 - 4	0.125 - 0.25	0.25 - 0.5	Easily penetrated 1 " by Thumb . Molded by light finger pressure.
Medium Stiff	4 - 8	0.25 - 0.5	0.5 - 1.0	Penetrated over 1/2 " by Thumb with moerate effort. Molded by strong finger pressure.
Stiff	8 - 15	0.5 - 1.0	1.0 - 2.0	Indented about 1/2 " by Thumb but penetrated only with great effort
Very Stiff	15 - 30	1.0 - 2.0	2.0 - 4.0	Readily indented by Thumbnail
Hard	>30	>2.0	>4.0	Indented with difficulty by Thumbnail

LOG KEY SYMBOLS

- Bulk / Bag Sample
- Thin Wall
- Standard Penetration Split Spoon Sampler
- No Recovery
- Rock Core
- 3-3/4" ID D&M Sampler
- 3" ID D&M Sampler
- Water Level
- California Sampler

COARSE -GRAINDE SOIL

APPARENT DENSITY	SPT (blows/ft)	RELATIVE DENSITY (%)	FIELD TEST
Very Loose	<4	0 - 15	Easily penetrated with 1/2 " reinforcing rod pushed by hand
Loose	4 - 10	15 - 35	Difficult to penetrated with 1/2 " reinforcing rod pushed by hand
Medium Dense	10 - 30	35 - 65	Easily penetrated a foot with 1/2 " reinforcing rod driven with 5-lb hammer
Dense	30 - 50	65 - 85	Difficult to penetrated a foot with 1/2 " reinforcing rod driven with 5-lb hammer
Very Dense	>50	85 - 100	Penetrated only a few inches with 1/2 " reinforcing rod driven with 5-lb hammer

STRATIFICATION

DESCRIPTION	THICKNESS
SEAM	1/16 - 1/2 "
LAYER	1/2 - 12 "

DESCRIPTION	THICKNESS
Occasional	One or less per foot of thickness
Frequent	More than on per foot of thickness

CEMENTATION

DESCRIPTION	DESCRIPTION
Weakely	Crumbles or breaks with handling of slight finger pressure
Moderately	Crumbles or breaks with considerable finger pressure
Strongly	Will not crumbles or breaks with finger pressure

MODIFIERS

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

MOISTURE CONTENT

DESCRIPTION	FIELD TEST
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible water, usually soil below Water Table

FIGURE 4

Gordon Spilker Huber
Geotechnical Consultants, Inc.