Gordon Spilker Huber
Geotechnical Consultants, Inc.

REPORT
GEOTECHNICAL STUDY
DIVISION OF WILDLIFE RESOURCES
SPRINGVILLE FISH HATCHERY – RACEWAY COVERS
1115 NORTH MAIN STREET
SPRINGVILLE, UTAH
DFCM PROJECT NO. 08259520/ CONTRACT NO. 097297

Submitted To:

State of Utah
Division of Facilities Construction and Management
4110 State Office Building
Salt Lake City, Utah 84114

Submitted By:

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

February 19, 2009

Job No. 0128-035-09

February 19, 2009
Job No. 0128-035-09

State of Utah
Division of Facilities Construction and Management
4110 State Office Building
Salt Lake City, Utah 84114

Attention: Mr. Bob Anderson

Ladies and Gentlemen:

Re: Report
Geotechnical Study
Division of Wildlife Resources
Springville Fish Hatchery – Raceway Covers
1115 North Main Street
Springville, Utah
DFCM Project No. 08259520/Contract No. 097297

1. INTRODUCTION

1.1 GENERAL

This report presents the results of our geotechnical study performed for the proposed raceway cover at the site of the Department of Natural Resources Springville Fish Hatchery which is located at 1115 North Main Street in Springville, Utah. The general location of the site with respect to major topographic features and existing facilities, as of 1998, is presented on Figure 1, Vicinity Map. The location of the proposed raceway cover, on an aerial photograph base, is presented on Figure 2, Site Plan. The 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 Mr. Bob Anderson of the State of Utah, Division of Facilities Construction Management (DFCM), and Mr. Alan Spilker of Gordon Spilker Huber Geotechnical Consultants, 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, pavement, and geoseismic recommendations to be utilized in the design and construction of the proposed facility.

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

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

2. A laboratory testing program.

3. An office program consisting of the correlation of available data, engineering analyses, and the preparation of this geotechnical report.

1.3 AUTHORIZATION

Authorization was provided by returning a signed copy of DFCM Project No. 08259520/Contract No. 09729.

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

As part of the process of raising fish, fingerling fish are allowed to grow in concrete channels that are approximately three feet deep and three feet wide. These concrete channels are often called raceways. A raceway cover is proposed to be constructed over the existing raceways at the Springville Fish Hatchery. The raceway cover will consist of a one- to one-extended-level structure placed slab-on-grade and projected to be of steel-frame construction with steel veneer (skin). Structural loads will be transmitted down through interior and exterior columns to supporting foundations. It is our understanding there will be no continuous wall foundations associated with the structure. The maximum column loads, as provided by the structural engineer for the project, are on the order of 120 to 150 kips. Floor slabs are not anticipated but in the event new concrete is

placed, loads will be light (less than 200 pounds per square foot). If heavier footing or floor slab loads are anticipated, GSH must be contacted as soon as possible to review our recommendations.

Traffic in parking areas is projected to consist of a light volume of automobiles and light trucks and occasional medium-weight trucks. In primary roadway areas, it is projected that the traffic will consist of a moderate volume of automobiles and light trucks and a very light volume of medium- and heavy-weight trucks. If heavier traffic loads are anticipated, GSH must be contacted as soon as possible to review our recommendations.

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

3. SITE INVESTIGATIONS

3.1 FIELD PROGRAM

In order to define and evaluate the subsurface soil and groundwater conditions across the site, 7 exploration borings were drilled to depths ranging from 14.0 to 16.5 feet below existing grades using a rubber tire-mounted rotary drill rig. The boreholes were advanced using hollow-stem augers. The approximate locations of the borings are presented on Figure 2.

The field portion of our study was under the direct control and continual supervision of an experienced member of our geotechnical staff. During the course of the drilling operations, a continuous log of the subsurface conditions encountered was maintained. In addition, samples of the typical soils and fills penetrated were obtained for subsequent laboratory testing and examination. The soils were classified in the field based upon visual and textural examination. These classifications were later supplemented by subsequent inspection and testing in our laboratory. Detailed graphical representation of the subsurface conditions encountered during this study is presented on Figures 3A through 3G, 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 sampler (Dames & Moore) was utilized in the majority of the subsurface sampling at the site. Additionally, a 2.0-inch outside diameter, 1.38-inch inside diameter drive sampler (SPT) was 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, one and one-quarter-inch diameter slotted PVC pipe was installed in Boring B-1 and Borings B-3 through B-7 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 completed. The program included moisture, density, consolidation, partial gradation, sulfate, and pH tests. The following paragraphs describe the tests and summarize the test data.

3.2.2 Moisture and Density Tests

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

3.2.3 Consolidation Tests

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

3.2.4 Partial Gradation Tests

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

Boring No.	Depth (feet)	Percent Passing No. 200 Sieve	Soil Classification
B-5	4.5	11.6	GC/GP SC/SP
B-5	10.5	8.7	GM/GP
B-5	15.5	23.9	SC/GC

3.2.5 pH and Soluble Sulfates Tests

To determine if the site soils will react detrimentally with concrete, pH and soluble sulfates tests were performed on a representative sample of the natural near-surface soils. The results of those tests are tabulated on the following page.

Boring No.	Depth (feet)	Soil Classification	pH	Water Soluble Sulfate (mg/kg-dry)
B-4	3.0	CL	7.58	1,400

4. SITE CONDITIONS

4.1 SURFACE

The raceway cover is proposed to be located at the existing Department of Natural Resources Springville Fish Hatchery at 1150 North Main Street in Springville, Utah. The site contains existing concrete fish runs, asphalt concrete pavements, and existing single-story structures with associated landscaped areas. The site is bounded to the west by Main Street with multi-story residential structures beyond; north and south of the site are open RV storage areas; and to the east is undeveloped wetlands.

The site is relatively flat with an overall relief of approximately three to four feet across the site sloping downward to the west. The majority of the site near the fish runs is covered with asphalt concrete pavement and/or gravel.

4.2 SUBSURFACE SOIL

From the surface in each boring, with the exception of Boring B-5, and extending to depths of one-half to seven feet, is non-engineered fills consisting of pavements, roadbase, silty clay with varying amounts of gravel and silty sand. The non-engineered fills will exhibit variable and, in most cases, poor engineering characteristics. Additionally, topsoil/loose disturbed soils were encountered in Borings B-5 through B-7.

Underneath the non-engineered fills and from the surface in Boring B-5 is natural silty clay with some fine sand. The clay is soft to stiff, moist to saturated, and dark brown, gray, and black. The clay extends to the explored depths of 14.0 to 16.5 feet in Borings B-1, B-2, B-4, B-6, and B-7. In Borings B-3 and B-5, the clay extends to depths of nine and three and one-half feet, respectively. The clay will exhibit moderate to moderately low strength and moderate to moderately high compressibility characteristics within the anticipated loading range.

Underneath the silty clay in B-3 and B-5 are sands and gravels with varying amounts of clay and silt. The sands and gravels are loose to dense, saturated, gray, will exhibit moderate high strength and low compressibility characteristics within the anticipated loading range.

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.

4.3 GROUNDWATER

To facilitate monitoring future groundwater fluctuations, prior to backfilling each boring, with the exception of Boring B-2, slotted PVC pipe was installed. The following chart summarizes the groundwater levels measured:

Boring No.	Groundwater Depth (feet)	
	January 16, 2009	**February 11, 2009***
B-1	7.0	5.0
B-2	6.0	No Pipe Installed
B-3	6.0	0.5**
B-4	5.0	2.7
B-5	4.0	2.6
B-6	6.0	1.7
B-7	8.0	3.0

* Stabilized groundwater depths
** The PVC pipe installed in Boring B-3 extends through the surficial layer of clay into underlying sands and gravels and artesian conditions are present, creating a high water level within the pipe.

Seasonal and longer-term groundwater fluctuations of one to two feet should be anticipated. The highest seasonal levels will generally occur during the late spring and summer months.

5. DISCUSSIONS AND RECOMMENDATIONS

5.1 SUMMARY OF FINDINGS

The most significant geotechnical aspects of the site are:

1. The highly compressible layer of silty clay generally encountered from depths of approximately five to eight feet in Borings B-3 and B-6.

2. The shallow depth to groundwater and potential artesian conditions at Boring B-3.

3. Non-engineered fills encountered to depths of one-half to seven feet at each boring with the exception of Boring B-5.

Highly compressible, slightly over-consolidated layers of silty clay were encountered from depths of approximately five to eight feet in Borings B-3 and B-6. Results of the consolidation testing indicate the clays have a relatively low preconsolidation pressure and will exhibit high compressibility characteristics under the proposed loads. It is likely that the soft silty clay will be encountered in isolated locations throughout the site.

Groundwater measurements taken on February 11, 2009 indicate groundwater is relatively close to the surface. The majority of the measurements were between 1.7 and 3.0 feet. A measurement of one-half foot was measured in Boring B-3, which may indicate an artesian condition due to the boring penetrating the silty clays into the underlying sands and gravels.

Non-engineered fills were encountered within most of the borings and were likely placed in association with the construction of the existing raceways. The non-engineered fills will exhibit variable and, most likely, poor engineering characteristics and are not suitable for the support of buildings, rigid pavements, or exterior flatwork. Non-engineered fills may remain beneath flexible pavement areas if properly prepared as discussed in this report.

Due to the soft clays and the potential for artesian groundwater conditions, GSH recommends the following options.

The first option is the installation of a permanent area dewatering system in association with the foundations of the raceway cover. Within this option, the dewatering system will be installed to an appropriate depth (approximately 18 inches below the bottom of the raceway channels) on the outside of exterior footings and adjacent to interior footings. Subsequent to the installation of the area drain, the soft silty clay soils within footing locations will be excavated, removed, and replaced with select granular structural fill.

The removal of the soft clay soils will cause groundwater to enter into the excavation. The groundwater will need to be controlled to the full depth of the temporary excavation until structural fill has been placed and compacted. It is recommended that structural fill contain at a minimum 20 percent fines (passing the No. 200 sieve) to render it less permeable. Subsequent to the placement of structural fill and footings, temporary dewatering may cease, allowing groundwater to flow into the permanent area dewatering system.

The dewatering system will have two benefits. The first is to reduce groundwater elevations for constructability and the second is to reduce the potential for infiltration of potentially Whirling Disease contaminated groundwater into the raceways. The dewatering system will require a suitable gravity discharge point or a sump with a suitably sized pump. The disadvantage of the dewatering system is that the dewatering of groundwater where artesian conditions are encountered may create large water flows and potentially affect the water level of up-gradient surface water

(wetlands). Water collected in the area dewatering system can be re-used and pumped either into the pretreatment system or into the wetlands. Details of the area dewatering system are discussed in Section 5.6, Area Subdrain, of this report.

The second option is to install deep foundation through the soft clay soils and into the underlying sands and gravels. As previously mentioned, the soft clay soils are anticipated to be in isolated locations across the site and each footing may or may not need deep foundations. GSH recommends that each footing location be pre-drilled to verify the presence of soft clay soils. If the soft clay soils are not encountered, then conventional spot footings may be utilized overlying 18 inches of replacement structural fill. If the soft clay soils are encountered, deep foundations will be required. Deep foundations may include helical piers or driven pipe piles. Details for deep foundations may be provided upon request.

A third option is to place conventional spot footings at a depth of two and one-half feet on the natural clay soils and design the structure to withstand total settlement of two to three inches and a differential settlement of one to one and one-half inches. If overall settlement is unacceptable after the structure is completed, helical piers may be installed post-construction to level the structure.

In the following sections, detailed discussions pertaining to earthwork, foundations, pavements, the geoseismic setting of the site, and other geotechnical parameters that could affect design, construction, or performance of the proposed facilities are presented.

5.2 EARTHWORK

5.2.1 Site Preparation

Preparation of the site will consist of the removal of non-engineered fills, loose/disturbed surficial soil, surface vegetation, topsoil, and other deleterious materials from beneath an area extending at least three feet beyond the perimeter of the proposed structure, rigid pavements, or exterior flatwork areas. In flexible pavement areas, the existing non-engineered fill and/or loose/disturbed surficial soils may remain provided that they do not contain deleterious material and the upper nine inches are scarified, moisture prepared, and compacted to the requirements for structural fill. Even if properly prepared, some long-term movements of flexible pavements overlying existing non-engineered fill, and/or loose/disturbed surficial soils may occur. If these long-term movements are not acceptable, the non-engineered fill and loose/disturbed surficial soils must be completely removed.

Subsequent to the above operations and prior to the placement of footings, structural site grading fill, floor slabs, or pavements, the exposed subgrade must be proofrolled by running moderate-weight rubber tire-mounted construction equipment uniformly over the surface at least three times. If excessively soft or otherwise unsuitable soils/fills are encountered beneath footings, they must be completely removed. In pavement and floor slab areas, unsuitable soils/fills encountered during proofrolling must be removed to a maximum depth of two feet and replaced with compacted granular structural fill.

Surface vegetation and other deleterious materials should generally be removed from the site. The on-site soils can be utilized as structural site grading fill if they meet the requirements of such. The natural fine-grained soils will require close moisture control and may be very difficult, if not impossible, to properly place and compact during wet and cold periods of the year.

5.2.2 Temporary Excavations

Within excavations at the site, groundwater is anticipated at depths of approximately one-half to five feet. Temporary construction excavations not exceeding four feet in depth, above or below the water table within the non-engineered fills and natural silty clay, may be constructed with near-vertical side slopes. Deeper construction excavations up to eight feet in depth in the natural cohesive (clay) soils, above or below the water table, may be constructed with sideslopes no steeper than one-half horizontal to one vertical. Deeper construction excavations up to eight feet in depth in the natural silty and clayey sands and gravels, above or below the water table, may be constructed with sideslopes no steeper than one horizontal to one vertical. Excavations deeper than eight feet are not anticipated.

Excavations below the groundwater in these sands and gravels will be extremely difficult since these soils will tend to "flow" into the excavations. This condition will require significant effort to stabilize and will likely include significantly flatter sideslopes, dewatering, and/or the use of shoring/bracing. GSH anticipates that temporary dewatering will be required during excavation of footing and soft silty clay soils.

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

5.2.3 Structural Fill

Structural fill will be required as site grading fill, as backfill over foundations and utilities, and potentially as replacement fill below footings. All structural fill must be free of sod, rubbish, construction debris, frozen soil, and other deleterious materials. Structural site grading fill is defined as fill placed over fairly large open areas to raise the overall site grade.

To stabilize soft subgrade conditions or where structural fill is required to be placed below a level one foot above the water table at the time of construction, a mixture of coarse gravels and cobbles and/or one and one-half- to two-inch minus gravel (stabilizing fill) should be utilized.

The maximum particle size within structural site grading fill shall 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. In confined areas, the maximum particle size shall be restricted to two and one-half inches.

The on-site soils can be utilized as structural site grading fill if they meet the requirements of such. The fine-grained soils will require that very close moisture control be maintained during placement

and compaction. It will be very difficult, if not impossible, to properly place and compact these fills during wet and cold periods of the year. Generally, we recommend that all imported structural fill consist of a well-graded mixture of sands and gravels with no more than 18 percent fines (material passing the No. 200 sieve). In areas where soft clays are removed overlying the deeper sands and gravels, we recommend that structural fill consist of a well-graded mixture of sands and gravels with no less than 20 percent fines (material passing the No. 200 sieve). Granular fills are recommended in all confined areas.

Non-structural site grading fill is defined as all fill material not designated as structural fill and may consist of any cohesive or granular soils not containing excessive amounts of degradable material.

5.2.4 Fill Placement and Compaction

All structural fill should be placed in lifts not exceeding eight inches in loose lift thickness. Structural fills up to 10 feet thick, as well as all structural fills beneath an area extending out at least 3 feet from the perimeter of the structures, must be compacted to at least 95 percent of the maximum dry density as determined by the AASHTO[1] T-180 (ASTM[2] D-1557) compaction criteria. Structural fills greater than 10 feet are not anticipated at the site. Structural fills less than 5 feet thick, which are not beneath an area extending out at least 3 feet from the perimeter of the structure, should be compacted to at least 90 percent of the above-defined criteria.

Coarse gravel and cobble mixtures (stabilizing fills), where utilized for subgrade stabilization, 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 fill may be compacted by passing moderately heavy construction equipment or large self-propelled compaction equipment over the surface of each lift 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.

Prior to the placement of structural site grading fill, pavements, floor slabs, or footings, the exposed subgrade must be prepared as discussed in Section 5.2.1, Site Preparation, of this report. In confined areas, subgrade preparation must consist of the removal of all loose or disturbed soils.

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

5.2.5 Utility Trenches

All utility trench backfill material below structurally loaded facilities (flatwork, floor slabs, roads, etc.) shall be placed at the same density requirements established for structural fill. If the surface of the backfill becomes disturbed during the course of construction, the backfill should be proofrolled

---

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

and/or properly compacted prior to the construction of any exterior flatwork over a backfilled trench. Proofrolling 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 proofrolling, they shall 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-1 or A-1a (AASHTO Designation – basically granular soils with limited fines) soils be used as backfill over utilities. These organizations are also requiring that in public roadways the backfill over major utilities be compacted over the full depth of fill to at least 96 percent of the maximum dry density as determined by the AASHTO T-180 (ASTM D-1557) method of compaction. We recommend that as the major utilities continue onto the site that these compaction specifications are followed.

The fine-grained soils/fills are not recommended for use as trench backfill.

5.3 SPREAD AND CONTINUOUS WALL FOUNDATIONS

5.3.1 Design Data

The proposed structure can be supported upon conventional spread foundations established upon suitable natural soils and/or structural fill extending to suitable natural soils. Options for foundation systems have been discussed previously in this report. The soft clay soils encountered at some locations at the site are not suitable for the support of conventional spread footings and must be removed and replaced with granular structural fill. Alternatively, in areas where soft clay soils are encountered, deep foundations or alternative designs may be implemented. GSH can provide information for alternative designs upon request. 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
Minimum Recommended Width for Isolated Spread Footings	- 24 inches
Recommended Net Bearing Pressure for Real Load Conditions for footings placed on a minimum of 18 inches of granular structural fill	- 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.

5.3.2 Installation

Under no circumstances shall the footings be established upon or overlying non-engineered fills, unsuitable, soft natural clay soils, loose/disturbed soils, sod, rubbish, topsoil, 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. If granular soils become loose or disturbed, they must be recompacted to the requirements for structural fill.

The width of structural replacement fill below footings shall be equal to the width of the footing plus one foot for each foot of fill thickness.

5.3.3 Settlements

Settlements of foundations designed and installed in accordance with the above recommendations (on replacement fill extending to suitable soils - first option), and supporting maximum anticipated structural loads, are anticipated to be approximately one-half to five-eighths of an inch. Settlements are expected to occur rapidly with approximately 50 to 60 percent of the settlements occurring during construction.

Settlements for helical piers may be provided by the selected helical pier installer/manufacturer (for second option).

Total settlements for footings established on the natural clayey soils area are anticipated to be between two and three inches. Differential settlements are anticipated to be between one and one and one-half inches (for third option).

If loads greater than those discussed in Section 2., Proposed Construction, of this report are to be imposed, GSH must be contacted so that our recommendations can be reviewed and amended, if necessary.

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 0.40 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.

5.5 FLOOR SLABS

It is anticipated that floor slabs will only be placed in limited areas within the footprint of the structure. Floor slabs must be established upon suitable natural soils and/or upon structural fill extending to suitable natural soils. Under no circumstances shall floor slabs be established upon, loose or disturbed soils, non-engineered fills, sod, rubbish, deleterious materials, frozen soils, or within ponded water. In order to provide a capillary break and to facilitate curing of the concrete, it is recommended that floor slabs be directly underlain by at least four inches of "free-draining" fill, such as "pea" gravel or three-quarters- to one-inch minus clean gap-graded gravel.

Settlement of lightly loaded floor slabs (200 pounds per square foot or less) is anticipated to be minor (less than one-quarter inch).

5.6 AREA SUBDRAIN

5.6.1 General

As previously discussed, an area drain is required to provide for constructability of the proposed foundations and to reduce the potential for groundwater intrusion into the raceways.

5.6.2 Area Subdrains

Area subdrains should consist of a six-inch diameter perforated or slotted plastic or PVC pipe enclosed in clean gravel. The invert of a subdrain should be at least 18 inches below the top of the lowest raceway. The gravel portion of the drain should extend two inches laterally and below the perforated pipe and at least one foot above the top of the adjacent raceway. To reduce the possibility of plugging, the gravel must be wrapped with a geotextile, such as Mirafi 140N or equivalent. Above the subdrain, a minimum four-inch-wide zone of "free-draining" sand and gravel should extend to within two feet of final grade. The slope of the subdrain should be at least 0.3 percent. The gravel placed around the drain pipe should be clean, three-quarters to one-inch minus gap-graded gravel and/or "pea" gravel. GSH recommends that the area subdrain be installed around the perimeter of the exterior footings with at least one drain traversing longitudinally through the center of the raceways. The subdrains can be discharged into storm drains, a sump with a suitably sized pump, or other suitable down-gradient location.

5.7 PAVEMENTS

The existing non-engineered fills and natural clay soils encountered at the site will exhibit poor pavement support characteristics when saturated or near saturated. Non-engineered fills and topsoil/loose disturbed soils may remain in flexible pavement areas if they are properly prepared, as previously mentioned. Considering the non-engineered fills and natural clay as the subgrade soils and the projected traffic as discussed in Section 2., Proposed Construction, the following pavement sections are recommended:

Parking Areas

(Light Volume of Automobiles and Light Trucks,
Occasional Medium-Weight Trucks,
and No Heavy-Weight Trucks)
[1 equivalent 18-kip axle loads per day]

Flexible:

2.5 inches	Asphalt concrete
7.0 inches	Aggregate base course
Over	Properly prepared existing non-engineered fill, and/or existing loose/disturbed soils, or suitable natural soils, and/or structural site grading fill extending to these soils

Rigid:

5.0 inches	Portland cement concrete (non-reinforced)
3.0 inches	Aggregate base course
Over	Properly prepared suitable natural soils, and/or structural site grading fill extending to these soils*

* Under no circumstances should rigid pavements be placed overlying non-engineered fills and/or loose/disturbed soils.

Primary Roadway Areas

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

Flexible:

3.0 inches	Asphalt concrete
8.0 inches	Aggregate base course
Over	Properly prepared existing non-engineered fill, and/or existing loose/disturbed soils, or suitable natural soils, and/or structural site grading fill extending to these soils

Rigid:

6.0 inches	Portland cement concrete (non-reinforced)
4.0 inches	Aggregate base course
Over	Properly prepared suitable natural soils, and/or structural site grading fill extending to these soils*

* Under no circumstances should rigid pavements be placed overlying non-engineered fills and/or loose/disturbed soils.

For dumpster pads, we recommend a pavement section consisting of six and one-half inches of Portland cement concrete, four inches of aggregate base course, over properly prepared natural subgrade or site grading structural fills.

These 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 with 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

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

5.9 GEOSEISMIC SETTING

5.9.1 General

Utah municipalities adopted the International Building Code (IBC) 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 structure must be designed in accordance with the procedure presented in Section 1613, Earthquake Loads, of the IBC 2006 edition.

5.9.2 Faulting

Based upon our review of available literature, no active faults are known to pass through or immediately adjacent to the site. The nearest active fault is the Provo segment of the Wasatch fault approximately one-third mile east of the site. The Wasatch fault zone is considered capable of generating earthquakes as large as magnitude 7.4.

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 (40.18048 degrees north and -111.60928 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	50.2	50.2
0.2 Seconds, (Short Period Acceleration)	$S_S = 125.4$	$S_{MS} = 125.4$
1.0 Seconds (Long Period Acceleration)	$S_1 = 52.7$	$S_{M1} = 79.0$

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

The site is located in an area that has been mapped by Utah County as having a "moderate potential" for liquefaction. Liquefaction is defined as the condition when saturated, loose, fine sand-type soils lose their support capabilities because of excessive pore water pressure which develops during a seismic event. Clayey soils, even if saturated, will not liquefy during a major seismic event.

Due to the clayey nature of the majority of soils and the dense nature of the granular soils encountered on the site, liquefaction will not likely occur during the design seismic event. Calculations were performed using the procedures described in NCEER-97-0022 entitled, "Proceedings of the NCEER Workshop on Evaluation of Liquefaction Resistance of Soils," and only apply to the saturated cohesionless deposits.

GSH
Gordon Spilker Huber
Geotechnical Consultants, Inc.

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.

Alan D. Spilker, State of Utah No. 334228
Professional Engineer

Reviewed by:

Joshua M. Whitney, State of Utah No. 6252902
Professional Engineer

ADS/JMW:jlh

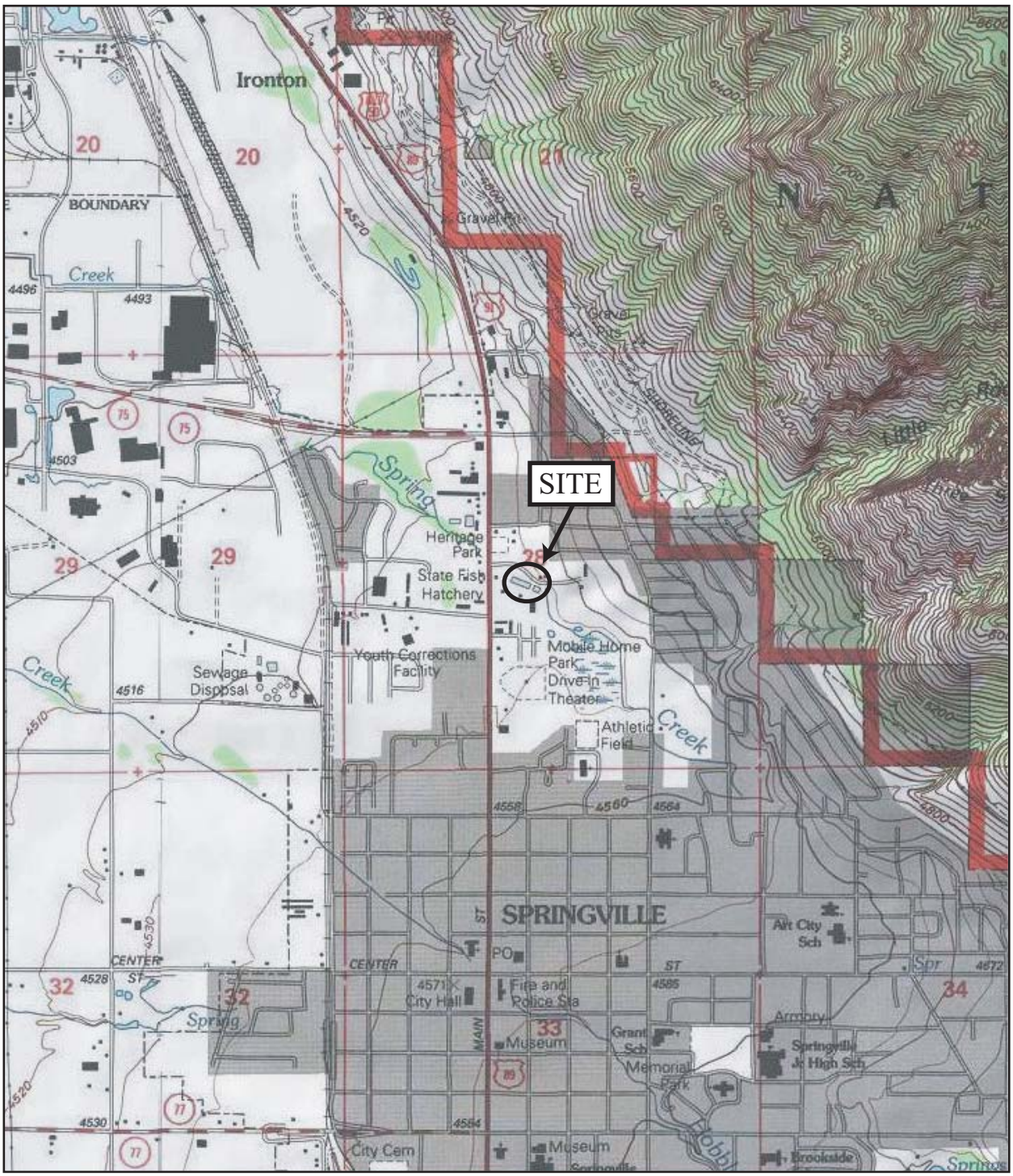
Encl. Figure 1, Vicinity Map
Figure 2, Site Plan
Figures 3A through 3G, Log of Borings
Figure 4, Unified Soil Classification System

Addressee (3 + email)
cc: Ms. Nicole Anderson (email only)
Great Basin Engineering – South
2010 North Redwood Road
Salt Lake City, Utah 84116

Mr. Richard Hartman (email only)
Springville Hatchery
1155 North Main
Springville, Utah 84663

Mr. Tim Miles (email only)
Department of National Resources
Division of Wildlife Resources
1594 West North Temple, Suite 2110
Salt Lake City, Utah 84114

STATE OF UTAH - DFCM
JOB NO. 0128-035-09



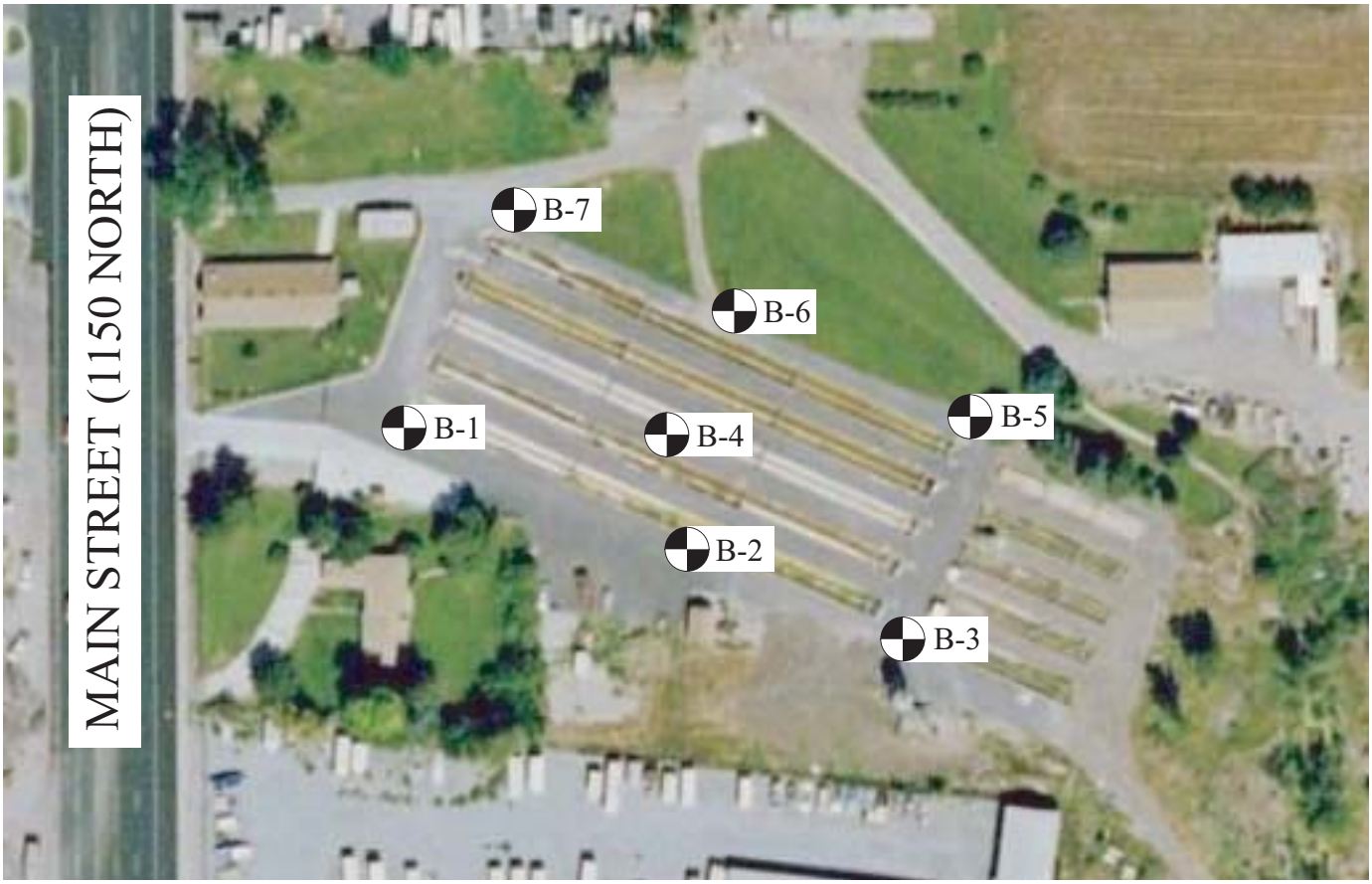
SCALE IN FEET
1000 0 1000 2000

FIGURE 1
VICINITY MAP

REFERENCE:
USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE MAPS
TITLED "SPRINGVILLE, UTAH" AND "PROVO, UTAH"
BOTH DATED 1998

GSH
Gordon Spilker Huber
Geotechnical Consultants, Inc.

STATE OF UTAH - DFCM
JOB NO. 0128-035-09



NOT TO SCALE

FIGURE 2
SITE PLAN

REFERENCE:
ADAPTED FROM AERIAL PHOTOGRAPH
BY GOOGLE EARTH, DATED 2008

GSH
Gordon Spilker Huber
Geotechnical Consultants, Inc.

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

Project Name: Proposed Raceway Cover
Project No.: 0128-035-09
Location: 1115 North Main Street, Springville, Utah
Client: State of Utah - DFCM
Drilling Method: 3-3/4" ID Hollow-Stem Auger
Date Drilled: 01-16-09
GSH Field Rep.: RJG
Elevation: Overall Site Approximately 4538' +/-
Water Level: 7.0' (01-16-09) 5.0' (02-11-09)
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								
		2.5"ASPHALT CONCRETE									
		3.5" ROADBASE, FILL 3/4" minus									moist medium stiff
		SILTY CLAY with some fine sand; brown (CL)		7							
		grades with cemented nodules; brown with oxidation mottling	5	7		26.9		97			saturated
		grades with occasional layers up to 1' thick of clayey fine to coarse sand; brown and gray with oxidation	10	20							stiff
			15	15		26.7		97			
		Stopped drilling at 15.0'. Stopped sampling at 16.5'. Installed 1-1/4" diameter slotted PVC pipe to 16.5'.	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: Proposed Raceway Cover
Project No.: 0128-035-09
Location: 1115 North Main Street, Springville, Utah
Client: State of Utah - DFCM
Drilling Method: 3-3/4" ID Hollow-Stem Auger
Date Drilled: 01-16-09
GSH Field Rep.: RJG
Elevation: Overall Site Approximately 4538' +/-
Water Level: 6.0' (01-16-09)
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								
		2.5"ASPHALT CONCRETE									moist
		21.5" ROADBASE, FILL 3/4" minus									medium dense
		SILTY CLAY with some fine and coarse gravel; brown and dark brown (CL)									moist medium stiff
				7							
			5								very moist
				7							saturated
											stiff
				12		28.6		96			
			10								
		grades with trace organics; gray									medium stiff
				8		34.0		86			
		Stopped drilling at 13.0'.	15								
		Stopped sampling at 14.5'.									
			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

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

Project Name: Proposed Raceway Cover
Project No.: 0128-035-09
Location: 1115 North Main Street, Springville, Utah
Client: State of Utah - DFCM
Drilling Method: 3-3/4" ID Hollow-Stem Auger
Date Drilled: 01-16-09
GSH Field Rep.: RJG
Elevation: Overall Site Approximately 4538' +/-
Water Level: 6.0' (01-16-09) 0.5' (02-11-09)
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								
		2.5"ASPHALT CONCRETE									
		9.5" ROADBASE, FILL 3/4" minus									saturated moist soft
		SILTY CLAY with some fine sand; dark brown (CL)									
		grades with some fine and coarse gravel		9		24.7		100			very moist medium stiff
			5								
		grades with some fine sand and trace organics; gray and black		3		57.3		66			soft
		CLAYEY GRAVEL fine to coarse gravel; dark gray (GC)	10	38							saturated dense
		grades with some fine to coarse sand and fine and coarse gravel with trace silt; grading silty	15	23							medium dense
		Stopped drilling at 14.0'.									
		Stopped sampling at 15.5'.									
		Installed 1-1/4" diameter slotted PVC pipe to 15.5'.	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: Proposed Raceway Cover
Project No.: 0128-035-09
Location: 1115 North Main Street, Springville, Utah
Client: State of Utah - DFCM
Drilling Method: 3-3/4" ID Hollow-Stem Auger
Date Drilled: 01-16-09
GSH Field Rep.: RJG
Elevation: Overall Site Approximately 4538' +/-
Water Level: 5.0' (01-16-09) 2.7' (02-11-09)
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								
		2.5"ASPHALT CONCRETE									
		9.5" ROADBASE, FILL 3/4" minus									moist very soft
		SILTY CLAY, FILL with some fine and coarse gravel; brown (CL-FILL)		33		14.1		121			saturated
			5								
		SILTY CLAY with some fine sand; cemented nodules; brownish-tan with oxidation (CL)		15		13.5		106			saturated stiff
		grades without cemented nodules; gray with trace organics	10	12		26.8		96			
		grades with trace fine sand; gray	15	3							soft
		Stopped drilling at 15.0'. Stopped sampling at 16.5'. Installed 1-1/4" diameter slotted PVC pipe to 16.5'.	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 3D

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

Project Name: Proposed Raceway Cover
Project No.: 0128-035-09
Location: 1115 North Main Street, Springville, Utah
Client: State of Utah - DFCM
Drilling Method: 3-3/4" ID Hollow-Stem Auger
Date Drilled: 01-16-09
GSH Field Rep.: RJG
Elevation: Overall Site Approximately 4538' +/-
Water Level: 4.0' (01-16-09) 2.6' (02-11-09)
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								
		SILTY CLAY with some fine and coarse gravel; major roots (topsoil) to 2"; brown (CL)									loose to 2" moist
				10							very moist stiff
											saturated
		GRAVEL AND SAND with some clay; fine and coarse gravel; fine to coarse sand; gray (GC/GP/SC/SP)	5	30		14.7	11.6				medium dense
		GRAVEL with some fine to coarse sand and some silt; fine to coarse gravel; gray (GM/GP)									saturated medium dense
			10	20		14.0	8.7				
		CLAYEY SAND AND GRAVEL fine to coarse sand; fine and coarse gravel; gray (SC/GC)									saturated loose
			15	7		19.5	23.9				
		Stopped drilling at 15.0'.									
		Stopped sampling at 16.5'.									
		Installed 1-1/4" diameter slotted PVC pipe to 16.5'.	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 3E

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

Project Name: Proposed Raceway Cover
Project No.: 0128-035-09
Location: 1115 North Main Street, Springville, Utah
Client: State of Utah - DFCM
Drilling Method: 3-3/4" ID Hollow-Stem Auger
Date Drilled: 01-16-09
GSH Field Rep.: RJG
Elevation: Overall Site Approximately 4538' +/-
Water Level: 6.0' (01-16-09) 1.7' (02-11-09)
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, FILL with some fine and coarse gravel; major roots (topsoil) to 2"; gray (CL/GC-FILL)	0								loose to 2" very moist medium stiff saturated
		SILTY CLAY with some fine sand; gray and black (CL)		9		26.3		89			saturated
			5	4		32.1		91			
				6		30.8		87			medium stiff
			10								
		grades with trace fine sand and trace organics; gray		3							soft
		Stopped drilling at 12.5'.	15								
		Stopped sampling at 14.0'.									
		Installed 1-1/4" diameter slotted PVC pipe to 14.0'.									
			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 3F

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

Project Name: Proposed Raceway Cover
Project No.: 0128-035-09
Location: 1115 North Main Street, Springville, Utah
Client: State of Utah - DFCM
Drilling Method: 3-3/4" ID Hollow-Stem Auger
Date Drilled: 01-16-09
GSH Field Rep.: RJG
Elevation: Overall Site Approximately 4538' +/-
Water Level: 8.0' (01-16-09) 3.0' (02-11-09)
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, FILL with some fine and coarse gravel; major roots (topsoil) to 2"; dark brown (CL-FILL)	0								loose to 2" moist very stiff
	▼			28							saturated
		SILTY SAND, FILL with trace clay; fine to coarse sand; brown (SM-FILL)									saturated medium dense
			5	58							
		SILTY CLAY with some fine sand; grayish-brown (CL)									saturated stiff
			10	6							
			15	13							
		Stopped drilling at 15.0'. Stopped sampling at 16.5'. Installed 1-1/4" diameter slotted PVC pipe to 16.5'.	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

UNIFIED SOIL CLASSIFICATION SYSTEM

FIELD IDENTIFICATION PROCEDURES				GRAPH SYMBOL	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)	GRAPH SYMBOL	LETTER SYMBOL [1]	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

APPERENT 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 thichness

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

GSH
Gordon Spilker Huber
Geotechnical Consultants, Inc.