Applied Geotechnical Engineering Consultants, P.C.

GEOTECHNICAL INVESTIGATION

PROPOSED SUBDIVISION

1750 WEST 11800 SOUTH

RIVERTON, UTAH

PREPARED FOR:

PINNACLE BUILDING GROUP
4877 SOUTH TAYLORS PARK DRIVE
SALT LAKE CITY, UTAH 84123

ATTENTION: STEVE MURDOCK

PROJECT NO. 1060752

AUGUST 2, 2006

600 West Sandy Parkway • Sandy, Utah 84070 • (801) 566-6399 • FAX (801) 566-6493

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EXECUTIVE SUMMARY

1. The subsurface soils encountered at the site consist of approximately 1 ½ feet of fill in Test Pit TP-1 and ½ foot of topsoil in Test Pit TP-2 overlying clay which extends to depths of approximately 12 and 1 ½ feet in Test Pits TP-1 and TP-2, respectively. Sand was encountered below the clay and extends the full depth of Test Pit TP-1, approximately 15 feet, and to a depth of approximately 7 feet in Test Pit TP-2. Clay was encountered below the sand in Test Pit TP-2 and extends the full depth of the test pit, approximately 13 feet.

2. No subsurface water was encountered to the maximum depth investigated at the time of excavation of the test pits and when checked 7 days after excavation.

3. The site is suitable for the proposed construction. The buildings may be supported on spread footings bearing on the undisturbed natural soil or on compacted structural fill and may be designed for a net allowable bearing pressure of 1,500 pounds per square foot. Footings bearing on at least 2 feet of compacted structural fill may be designed for a net allowable bearing pressure of 2,500 pounds per square foot.

4. The upper natural soil consists of clay which will be easily disturbed by construction traffic when it is very moist to wet such as in the winter and spring or at times of prolonged rainfall or where excavations extend to very moist soil. Placement of 1 to 2 feet of granular fill will provide limited access for construction equipment when the upper soil is very moist to wet.

5. Geotechnical information related to foundations, subgrade preparation, pavement design and materials is included in the report.

SCOPE

This report presents the results of a geotechnical investigation for the proposed subdivision to be located at 1750 West 11800 South in Riverton, Utah. The report presents the subsurface conditions encountered, laboratory test results and recommendations for foundations and pavement. The study was conducted in general accordance with our proposal dated June 26, 2006.

Field exploration was conducted to obtain information on the subsurface conditions. Samples obtained from the field investigation were tested in the laboratory to determine physical and engineering characteristics of the on-site soil. Information obtained from the field and laboratory was used to define conditions at the site for our engineering analysis and to develop recommendations for the proposed foundations and pavement.

This report has been prepared to summarize the data obtained during the study and to present our conclusions and recommendations based on the proposed construction and the subsurface conditions encountered. Design parameters and a discussion of geotechnical engineering considerations related to construction are included in the report.

SITE CONDITIONS

At the time of our field investigation, there was a house at the northeast corner of the property and some sheds southwest of the house. The remainder of the property consists of fields.

Vegetation at the site consists of grass and weeds with some trees.

The ground surface at the site slopes gently down to the south.

The areas surrounding the site consists both of residential and agricultural properties. The north edge of the property is bordered by 11800 South Street which is a two-lane, asphalt-paved road in good condition.

FIELD STUDY

The field study was conducted on July 21, 2006. Two test pits were excavated at the approximate locations indicated on Figure 1 using a rubber-tired backhoe. The test pits were logged and soil samples obtained by an engineer from AGEC. Logs of the subsurface conditions encountered in the test pits are graphically shown on Figure 2.

The test pits were backfilled without significant compaction. The backfill in the test pits should be properly compacted where it will support proposed, buildings, slabs or pavement.

SUBSURFACE CONDITIONS

The subsurface soils encountered at the site consist of approximately 1½ feet of fill in Test Pit TP-1 and ½ foot of topsoil in Test Pit TP-2 overlying clay which extends to depths of approximately 12 and 1½ feet in Test Pits TP-1 and TP-2, respectively. Sand was encountered below the clay and extends the full depth of Test Pit TP-1, approximately 15 feet, and to a depth of approximately 7 feet in Test Pit TP-2. Clay was encountered below the sand in Test Pit TP-2 and extends the full depth of the test pit, approximately 13 feet.

A description of the various soils encountered in the test pits follows:

Fill - The fill consists of lean clay with sand. It is slightly moist, brown and contains some roots.

Topsoil - The topsoil consists of lean clay with sand. The topsoil is slightly moist, dark brown and contains roots and organics.

Lean Clay - The clay contains some sand. It is slightly moist to very moist, medium stiff to very stiff and brown to gray.

Laboratory tests performed on samples of the clay indicate that it has natural moisture contents ranging from 20 to 37 percent and natural dry densities ranging from 82 to 101 pounds per cubic foot (pcf).

Results of consolidation tests performed on samples of the clay in the area indicate that the clay will compress a small amount with the addition of light to moderate loads.

An unconfined compressive strength of 1395 pounds per square foot (psf) was measured for a sample of the clay.

Silty Sand - The sand contains a small to moderate amount of silt. It is medium dense, slightly moist and brown to gray.

Laboratory tests performed on a sample of the sand indicate it has a natural moisture content of 7 percent.

Results of the laboratory tests are summarized on Table I and are included on the logs of the test pits.

SUBSURFACE WATER

No subsurface water was encountered to the maximum depth investigated, approximately 15 feet. Slotted PVC pipe was installed in Test Pit TP-2 to facilitate future measurement of the water level. The pipe was checked for water 7 days after excavation of the test pits. There was no water in the pipe at that time.

PROPOSED CONSTRUCTION

We understand that the property will be subdivided for seven residential lots. We have assumed that houses will be one to three-story, wood-frame structures with the potential for basements.

We have assumed maximum column loads of 20 kips and maximum wall loads of up to 2½ kips per lineal foot.

A cul-de-sac road is planned to extend into the proposed subdivision. We have assumed traffic for the cul-de-sac consisting of 100 cars and two delivery trucks per day and two garbage trucks per week.

If the proposed construction, building loads or traffic is significantly different from what is described above, we should be notified so that we can reevaluate the recommendations given.

RECOMMENDATIONS

Based on the subsoil conditions encountered, laboratory test results and the proposed construction, the following recommendations are given:

A. Site Grading

Final site grading plans were not available at the time of our study. We anticipate that there will be small amounts of cut and fill for the project.

1. Subgrade Preparation

Prior to placing grading fill or base course, the topsoil, organics, debris and other deleterious material should be removed. Backfill and debris associated with demolition of the existing buildings should be removed.

The subgrade in proposed pavement areas should be proof-rolled to identify soft areas. Soft areas should be removed and replaced with granular borrow having less than 15 percent passing the No. 200 sieve and comprised mostly of gravel.

The subgrade consists of clay. Construction equipment access difficulties may be encountered when the subgrade is very moist to wet such as during periods of precipitation or snowmelt or where excavations extend to very moist soil. When the subgrade is very moist to wet, the subgrade should not be proof-rolled but cut to undisturbed natural soil below the topsoil and a sufficient thickness of granular fill placed to provide site access for construction equipment. Generally, 1 to 2 feet of granular fill will provide limited access for rubber-tired construction equipment above a very moist to wet clay subgrade. Consideration may be given to placing a support fabric between the natural soil and fill.

2. Excavation

Excavation at the site can be accomplished with typical excavation equipment. A flat cutting edge should be used on excavation equipment when excavating for foundations to reduce disturbance of the natural soil.

3. Compaction

Compaction of materials placed at the site should equal or exceed the minimum densities as indicated below when compared to the maximum dry density as determined by ASTM D-1557.

Fill To Support	Compaction
Foundations	≥ 95%
Concrete Flatwork and Pavement	≥ 90%
Landscaping	≥ 85%
Retaining Wall Backfill	85 - 90%

To facilitate the compaction process, the fill should be compacted at a moisture content within 2 percent of the optimum moisture content.

The base course should be compacted to at least 95 percent of the maximum dry density as determined by ASTM D-1557.

Fill and pavement materials placed for the project should be frequently tested for compaction.

4. Materials

Material placed as fill to support foundations should be non-expansive granular soil. The natural soil consists of clay and silty sand and is not recommended for use as structural fill. The natural clay and silty sand may be considered for use as fill in pavement areas or as utility trench backfill if the topsoil, organics, debris and other deleterious materials are removed or they may be used in landscape areas.

The natural soil is generally near or above the optimum moisture content and may require wetting or drying to facilitate proper compaction. Drying of the soil may not be practical during cold or wet periods of the year.

Listed below are materials recommended for imported structural fill.

Fill to Support	Recommendations
Footings	Non-expansive granular soil Passing No. 200 Sieve < 35% Liquid Limit < 30% Maximum size 4 inches
Floor Slab (Upper 4 inches)	Sand and/or Gravel Passing No. 200 Sieve < 5% Maximum size 2 inches
Slab Support	Non-expansive granular soil Passing No. 200 Sieve < 50% Liquid Limit < 30% Maximum size 6 inches

5. Drainage

The ground surface surrounding the proposed buildings should be sloped away from the buildings in all directions. Roof down spouts and drains should discharge beyond the limits of backfill.

The collection and diversion of drainage away from the pavement surface is important to the satisfactory performance of the pavement section. Proper drainage should be provided.

B. Foundations

1. Bearing Material

With the proposed construction and the subsurface conditions encountered, the proposed buildings may be supported on spread footings bearing on the natural undisturbed soil or on compacted structural fill. Compacted structural fill should extend down to the undisturbed natural soil and out away from the edge of the footings at least a distance equal to the depth of fill beneath footings. A support fabric may be placed between the natural soil and structural fill to facilitate construction.

Topsoil, organics, debris and other deleterious material should be removed from below proposed foundation areas.

2. Bearing Pressure

Spread footings bearing on the natural undisturbed soil or on compacted structural fill may be designed for a net allowable bearing pressure of 1,500 psf. Footings bearing on at least 2 feet of compacted structural fill may be designed using an allowable net bearing pressure of 2,500 psf. Footings should have a width of at least 1½ feet and a depth of embedment of at least 10 inches.

3. Temporary Loading Conditions

The allowable bearing pressure may be increased by one-half for temporary loading conditions such as wind or seismic loads.

4. Settlement

Based on the subsoil conditions encountered and the assumed building loads, we estimate total and differential settlement on the order of 1 inch and ¾ inch, respectively, for footings designed as indicated above.

5. Frost Depth

Exterior footings and footings beneath unheated areas should be placed at least 30 inches below grade for frost protection.

6. Foundation Base

The base of footing excavations should be cleared of loose or deleterious material prior to structural fill or concrete placement.

7. Construction Observation

A representative of the geotechnical engineer should observe footing excavations prior to structural fill or concrete placement.

C. Concrete Slab-on-Grade

1. Slab Support

Concrete slabs may be supported on the undisturbed natural soil or on compacted structural fill. Topsoil, organics, debris, unsuitable fill and other deleterious material should be removed from below proposed floor slabs.

2. Underslab Sand and/or Gravel

A 4-inch layer of free draining sand and/or gravel (less than 5 percent passing the No. 200 sieve) should be placed below the concrete slabs for ease of construction and to promote even curing of the slab concrete.

D. Lateral Earth Pressures

1. Lateral Resistance for Footings

Lateral resistance for footings placed on the undisturbed natural soil or on compacted structural fill is controlled by sliding resistance between the footing and the foundation soils. A friction value of 0.35 may be used in design for ultimate lateral resistance.

2. Subgrade Walls and Retaining Structures

The following equivalent fluid weights are given for design of subgrade walls and retaining structures. The active condition is where the wall moves away from the soil. The passive condition is where the wall moves into the soil and the at-rest condition is where the wall does not move. The values listed below assume a horizontal surface adjacent the wall.

Soil Type	Active	At-Rest	Passive
Clay and Silt	50 pcf	65 pcf	250 pcf
Sand and Gravel	40 pcf	55 pcf	300 pcf

3. Seismic Conditions

Under seismic conditions, the equivalent fluid weight should be increased by 29 pcf for active and at-rest conditions and decreased by 29 pcf for the passive condition. This assumes a short period spectral response acceleration of 1.23g which represents a 2 percent probability of exceedance in a 50-year period (IBC, 2003).

4. Safety Factors

The values recommended above assume mobilization of the soil to achieve the assumed soil strength. Conventional safety factors used for structural analysis for such items as overturning and sliding resistance should be used in design.

E. Subsurface Drains

No subsurface water was encountered in the test pits. However, a storm water detention pond is planned at the southeast end of the site.

If the lowest floor level of a house extends below grade and below the expected high water level of the detention pond, the subgrade floor portion of the residence should be protected with a perimeter drain system.

The perimeter drain system should consist of at least the following items:

1. The underdrain system should consist of a perforated pipe installed in a gravel filled trench around the perimeter of the subgrade floor portion of the building.

2. The flow line of the pipe should be placed at least 18 inches below the finished floor level and should slope to a sump or outlet where water can be removed by pumping or by gravity flow.

3. If placing the gravel and drain pipe requires excavation below the bearing level of the footing, the excavation for the drain pipe and gravel should have a slope no steeper than 1 horizontal to 1 vertical so as not to disturb the soil below the footing.

4. A filter fabric should be placed between the natural soil and the drain gravel. This will help reduce the potential for fine-grained material filling in the void spaces of the gravel.

5. The subgrade floor slab should have at least 6 inches of free-draining gravel placed below it and the underslab gravel should connect to the perimeter drain.

6. Consideration should be given to installing cleanouts to allow access into the perimeter drain should cleaning of the pipe be required in the future.

F. Seismicity and Liquefaction

The site is located in an area mapped as having a "very low" potential for liquefaction (Salt Lake County, 1995).

Subsurface soils encountered in the test pits are not susceptible to liquefaction. Liquefaction is not considered to be a hazard for the proposed structures.

The closest mapped fault trace to the site is the Wasatch Fault located approximately 5½ miles east of the site (Salt Lake County, 1995).

Listed below is a summary of the site parameters for the 2003 International Building Code.

a.	Site Class	D
b.	Short Period Spectral Response Acceleration, S_S	1.23g
c.	One Second Period Spectral Response Acceleration, S_1	0.48g

G. Water Soluble Sulfates

One sample of the natural soil was tested in the laboratory for water soluble sulfate content. Results of the test indicate there is less than 0.1 percent water soluble sulfate in the sample tested. Based on the results of the test and published literature, sulfate resistant cement is not needed for concrete placed in contact with the natural soil.

H. Pavement

Based on the subsoil conditions encountered, laboratory test results and the assumed traffic as indicated in the Proposed Construction section of the report, the following recommendations are given:

1. Subgrade Support

   The near surface soil consists of clay. We have assumed a California Bearing Ratio (CBR) value of 3 percent which represents a clay subgrade.

2. Pavement Thickness

   Based on the subsoil conditions, assumed traffic, a design life of 20 years for flexible pavement and 30 years for rigid pavement and methods presented by the Utah Department of Transportation, a pavement section consisting of 3 inches of asphaltic concrete overlying 6 inches of base course is calculated.

   Some granular borrow will be needed to facilitate construction when the subgrade consists of very moist to wet clay.

3. Pavement Materials and Construction

a. Flexible Pavement (Asphaltic Concrete)

The pavement materials should meet the specifications for the applicable jurisdiction. Other materials may be considered for use in the pavement section. The use of other materials may result in the need for different pavement material thicknesses.

b. Rigid Pavement (Portland Cement Concrete)

The pavement thickness assumes that the pavement will have aggregate interlock joints and that a concrete shoulder or curb will be provided.

Pavement materials should meet the specifications for the applicable jurisdiction. The pavement thicknesses indicated above assume that the concrete will have a 28-day compressive strength of 4,000 pounds per square inch. Concrete should be air entrained with approximately 6 percent air. Maximum allowable slump will depend on the method of placement but should not exceed 4 inches.

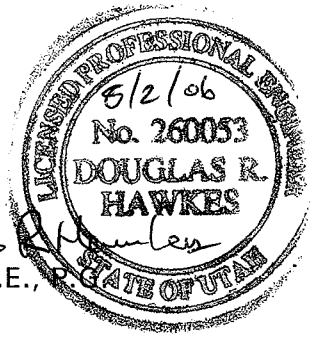
4. Jointing

Joints for concrete pavement should be laid out in a square or rectangular pattern. Joint spacings should not exceed 30 times the thickness of the slab. The joint spacings indicated should accommodate the contraction of the concrete and under these conditions steel reinforcing will not be required. The depth of joints should be approximately one-fourth of the slab thickness.

LIMITATIONS

This report has been prepared in accordance with generally accepted soil and foundation engineering practices in the area for the use of the client for design purposes. The conclusions and recommendations included within the report are based on the information obtained from the test pits excavated and the data obtained from laboratory testing. Variations in the subsurface conditions may not become evident until additional exploration or excavation is conducted. If the subsurface conditions or groundwater level is found to be significantly different from what is described above, we should be notified to reevaluate our recommendations.

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.



Douglas R. Hawkes, P.E.,

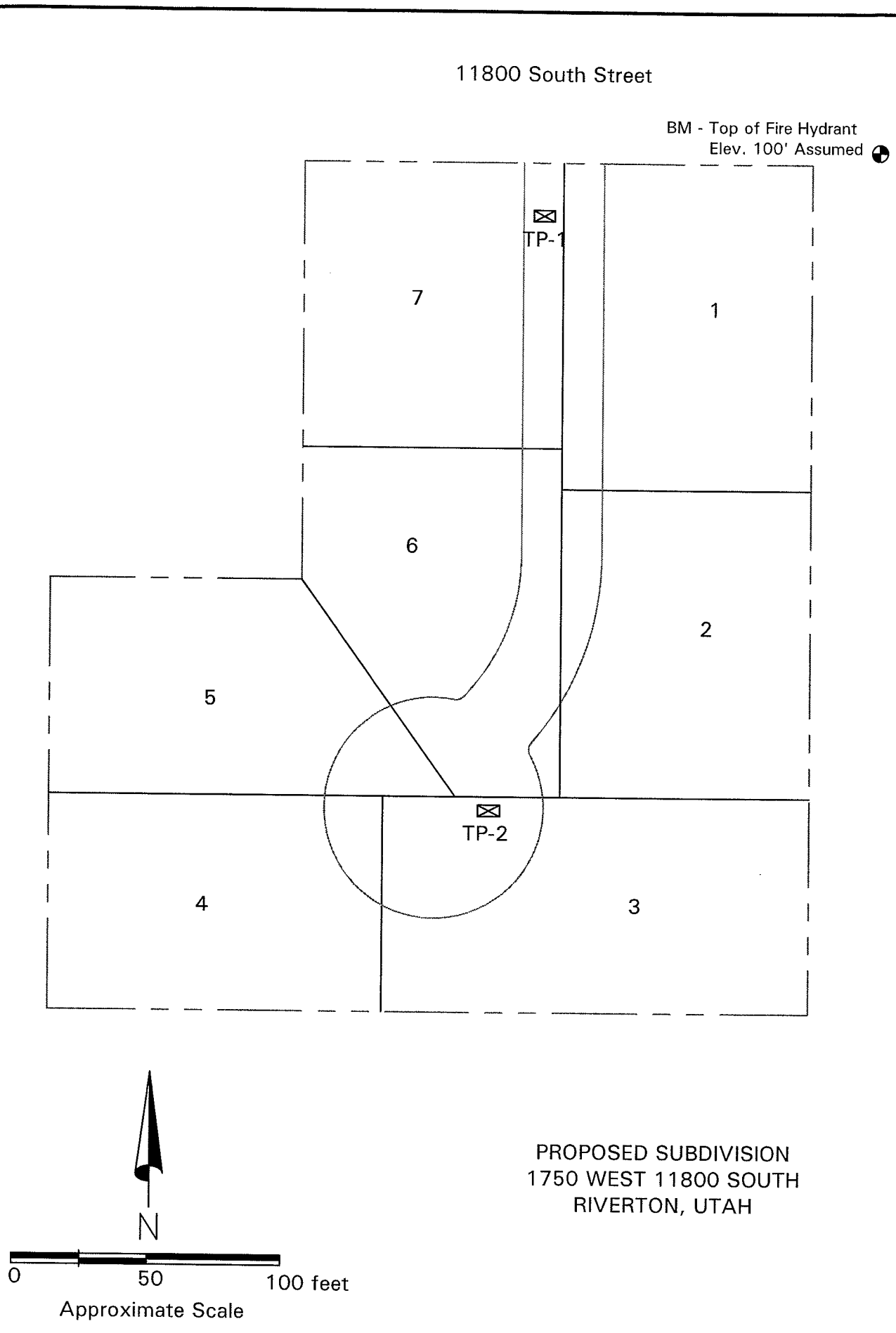
Reviewed by Jay R. McQuivey, P.E.

DRH/dc

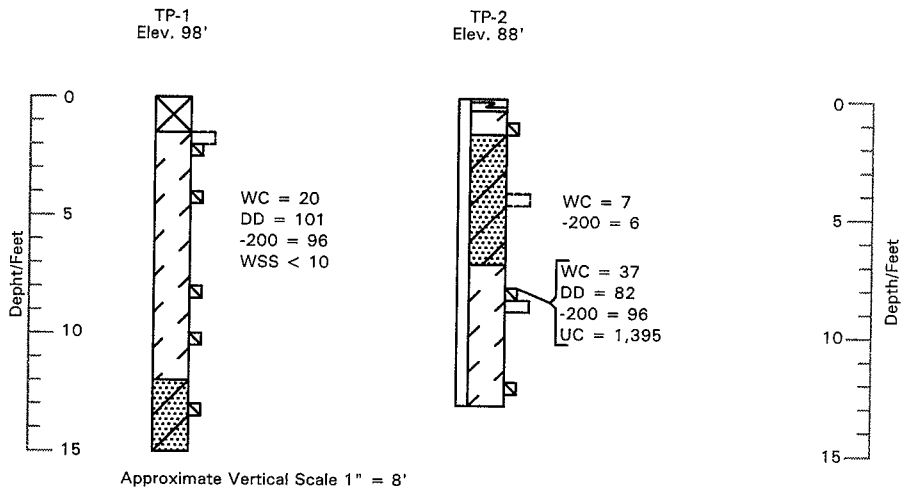
REFERENCES CITED

International Building Code, 2003; International Code Council, Inc., Falls Church, Virginia.

Salt Lake County, 1995, Surface Rupture and Liquefaction Potential Special Study Areas Map, Salt Lake County, Utah, adopted March 31, 1989, revised March 1995, Salt Lake County Public Works - Planning Division, 2001 South State Street, Salt Lake City, Utah.



1060752	AGEC	Locations of Test Pits	Figure 1



Approximate Vertical Scale 1" = 8'

LEGEND:

Fill; lean clay with sand, slightly moist, brown, some roots.

Topsoil; lean clay with sand, slightly moist, dark brown, roots, organics.

Lean Clay (CL); occasional sand and small gravel, medium stiff to very stiff, moist to very moist, brown to gray.

Silty Sand (SM); small to moderate amount of silt, medium dense, slightly moist, brown to gray.

Indicates relatively undisturbed hand drive sample taken.

Indicates disturbed sample taken.

Indicates relatively undisturbed block sample taken.

Indicates slotted 1½ inch PVC pipe installed in the test pit to the depth shown.

NOTES:

1. Test pits were excavated on July 21, 2006 with a rubber-tired backhoe.
2. Locations of test pits were measured approximately by pacing from features shown on the site plan provided.
3. Elevations of test pits were measured by hand level and refer to the bench mark shown on Figure 1.
4. The test pit locations and elevations should be considered accurate only to the degree implied by the method used.
5. The lines between the materials shown on the test pit logs represent the approximate boundaries between material types and the transitions may be gradual.
6. No subsurface water was encountered in the test pits at the time of excavation.
7. WC = Water Content (%);
   DD = Dry Density (pcf);
   -200 = Percent Passing No. 200 Sieve;
   UC = Unconfined Compressive Strength (psf);
   WSS = Water Soluble Sulfates (ppm).

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.

TABLE I

SUMMARY OF LABORATORY TEST RESULTS

PROJECT NUMBER 1060752

SAMPLE LOCATION		NATURAL MOISTURE CONTENT (%)	NATURAL DRY DENSITY (PCF)	GRADATION			ATTERBERG LIMITS		UNCONFINED COMPRESSIVE STRENGTH (PSF)	WATER SOLUBLE SULFATE (ppm)	SAMPLE CLASSIFICATION
TEST PIT	DEPTH (FEET)			GRAVEL (%)	SAND (%)	SILT/ CLAY (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)			
TP-1	4	20	101			96				<10	Lean Clay
TP-2	4	7				6					Poorly-graded Sand with Silt
	8	37	82			96			1,395		Lean Clay