Applied Geotechnical Engineering Consultants, Inc.

GEOTECHNICAL INVESTIGATION

RIDGE PARK SUBDIVISION

11800 SOUTH 1300 WEST

RIVERTON, UTAH

PREPARED FOR:

SUDWEEKS CONSTRUCTION
9137 SOUTH MONROE, SUITE B
SANDY, UTAH 84070

ATTENTION: BRIAN SUDWEEKS

PROJECT NO. 1040177

MARCH 23, 2004

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EXECUTIVE SUMMARY

1. The subsurface materials encountered at the site consist of approximately ½ foot of topsoil in Test Pit TP-1 and ½ foot of fill in Test Pit TP-2 overlying clay. The clay extends the full depth of Test Pit TP-2. Interlayered clay and silty sand was encountered below the clay in Test Pit TP-1 at a depth of approximately 10 feet and extends the full depth investigated, approximately 15½ feet.

2. Subsurface water was encountered at depths of approximately 11 and 13½ feet in Test Pits TP-1 and TP-2, respectively, based on measurements taken 9 days after excavation of the test pits.

3. The site is suitable for the proposed construction. Houses may be supported on spread footings bearing on the undisturbed natural soil or compacted structural fill extending down to the natural soil and may be designed for a net allowable bearing pressure of 2,000 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 3,500 pounds per square foot.

4. The upper natural soil consists predominantly of clay and 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. Placement of 1 to 2 feet of granular fill will provide limited support 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 Ridge Park Subdivision to be located at approximately 11800 South 1300 West 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 March 2, 2004.

Field exploration was conducted to obtain information of 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 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, garage and shed in the south/central portion of the property. The house is a two-story, wood frame, slab-on-grade structure. The garage is a single-story, masonry structure with a slab-on-grade floor.

There is landscaping and large trees around the house. There is an asphalt-paved driveway that extends from 1300 West Street to the north side of the house.

The ground surface at the site is relatively flat and slopes gently down toward the northeast.

There are houses to the north, south and west of the site. The houses are one to two-story with partial-depth basements or slab-on-grade. The east edge of the property is bordered by 1300 West Street which is a two-lane, asphalt-paved road in fair condition. There is a subdivision east of the road.

FIELD STUDY

The field study was conducted on March 10, 2004. 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 a representative 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 footings, floor slabs or pavement.

SUBSURFACE CONDITIONS

The subsurface materials encountered at the site consist of approximately ½ foot of topsoil in Test Pit TP-1 and ½ foot of fill in Test Pit TP-2 overlying clay. The clay extends the full depth of Test Pit TP-2. Interlayered clay and silty sand was encountered below the clay in Test Pit TP-1 at a depth of approximately 10 feet and extends the full depth investigated, approximately 15½ feet.

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

> Fill - The fill consists of silty sand which is moist, dark brown and contains roots and organics.

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

Clay - The clay contains occasional sand layers. It is stiff to very stiff, very moist to wet and brown to grayish brown.

Laboratory tests performed on samples of the clay indicate that it has natural moisture contents ranging from 21 to 22 percent and natural dry densities ranging from 100 to 101 pounds per cubic foot (pcf). Results of a consolidation test indicate that the clay will compress a small to moderate amount with the addition of light to moderate loads. Results of the consolidation test are presented on Figure 3. An unconfined compressive strength of 2,335 pounds per square foot (psf) was measured for a sample of the clay.

Interlayered Clay and Silty Sand - The interlayered soil contains silt layers. It is stiff to very stiff, medium dense, very moist to wet and grayish brown.

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

SUBSURFACE WATER

Subsurface water was encountered at depths of 11 and 13½ feet in Test Pits TP-1 and TP-2, respectively, based on measurements taken 9 days after excavation of the test pits. Fluctuations in the water level can be expected over time. An evaluation of such fluctuations is beyond the scope of this report. Generally, water levels are highest in the spring and summer and lowest in the fall and winter.

PROPOSED CONSTRUCTION

We understand that the property will be subdivided for residential construction. We anticipate that the proposed residences will be one to three-story, wood frame structures with a potential for basements. We have assumed maximum wall loads of 3 kips per lineal foot and maximum column loads of 25 kips.

We understand that a dead ended road will extend into the property. We have assumed that traffic will be relatively light and infrequent with no significant truck traffic.

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, the laboratory test results, our understanding of the proposed construction and our experience in the area, the following recommendations are given:

A. Site Grading

Final site grading plans were not available at the time of our investigation. We anticipate there will be no significant changes in grade at the site.

1. <u>Subgrade Preparation</u>
   Prior to placing site grading fill or base course, the topsoil, organics, unsuitable fill and other deleterious materials should be removed.

The subgrade in proposed pavement areas and areas to receive site grading fill should be scarified to a depth of approximately 8 inches, the moisture adjusted to within 2 percent of the optimum moisture content and the subgrade compacted to at least 90 percent of the maximum dry density as determined by ASTM D-1557. The subgrade should then be proof-rolled to identify soft areas. Soft areas should be removed and replaced with granular fill containing less than 15 percent passing the No. 200 sieve.

If construction occurs when the upper soil is very moist to wet, the subgrade should not be scarified, but cut to undisturbed natural soil below the topsoil and a sufficient thickness of granular fill placed to provide support for construction equipment. Placement of 1 to 2 feet of gravel will provide limited support for construction equipment when the upper soil is very moist to wet.

2. Excavation

Excavation may be accomplished with typical excavation equipment. Excavations which extend below the water level should be dewatered during excavation and backfill.

3. Materials

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

The on-site soil is not suitable for use as fill below buildings. It may be used as fill below pavement areas, as utility trench backfill and as retaining wall backfill if the topsoil, organics and other deleterious materials are removed or it may be used in landscaping areas. The sand and clay at depth is very moist to wet and will require drying prior to use as fill or backfill. Drying of the soil may not be practical during cold or wet times of the year.

Free-draining gravel should be used as fill and backfill below the original water level.

4. 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, fill should be compacted at a moisture content within 2 percent of the optimum moisture content.

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 during construction for compaction.

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 structures may be supported on spread footings bearing on the undisturbed natural soil or on compacted structural fill extending down to the undisturbed natural soil. Structural fill placed below foundations should extend out away from the edge of the footings a distance equal to the depth of fill beneath footings.

The topsoil, organics, unsuitable fill and other deleterious material should be removed from below the proposed foundation areas.

2. Bearing Pressure

Footings bearing on the undisturbed natural soil or on compacted structural fill may be designed for an allowable net bearing pressure of 2,000 psf. Footings bearing on at least 2 feet of compacted structural fill may be designed for a net allowable bearing pressure of 3,500 psf. Footings should have a minimum width of 18 inches and a minimum depth of embedment of 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

We estimate that total and differential settlement will be on the order of 1 and ¾ of an inch, respectively.

Disturbance of soil below the foundations can result in greater settlement. Care should be taken to minimize disturbance of the soil to remain below foundations so that settlement can be maintained within tolerable limits.

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 Slabs-on-Grade

1. Slab Support

Concrete slabs may be supported on the undisturbed natural soil or on compacted structural fill extending down to the undisturbed natural soil.

The topsoil, organics, unsuitable fill and other deleterious material should be removed from below floor slab areas.

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. Subsurface Drains

If the lowest floor level of a structure extends below the original ground surface and within 4 feet of the water level, the subgrade floor portion 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 pipes 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 drainpipe requires excavation below the bearing level of the footing, the excavation for the drainpipe and gravel should have a slope no steeper than 1:1 (horizontal to 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 grain 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 pipes be required in the future.

E. Lateral Earth Pressures

1. <u>Lateral Resistance for Footings</u>

   Lateral resistance for spread footings placed on the natural soil or on compacted structural fill is controlled by sliding resistance between the footing and the foundation soils. A friction value of 0.45 may be used in design for ultimate lateral resistance for footings.

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 26 pcf for active and at-rest conditions and decreased by 26 pcf for the passive condition. This assumes a short period spectral response acceleration of 1.25g which represents a 2 percent probability of exceedance in a 50-year period (IBC 2000).

4. Safety Factors

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

F. Seismicity, Faulting and Liquefaction

1. Seismicity

Listed below is a summary of the site parameters for the 2000 International Building Code.

a.	Site Class	D
b.	Short Period Spectral Response Acceleration, S_S	1.25g
c.	One Second Period Spectral Response Acceleration, S_1	0.51g

2. Faulting

There are no mapped active faults extending through the project site. The nearest mapped fault which is considered active is the Wasatch Fault located approximately 5 miles east of the site (Salt Lake County, 1995).

3. Liquefaction

The Salt Lake County Liquefaction Hazard Map indicates that the site is located in an area mapped as having a "very low" liquefaction potential (Salt Lake County, 1995). Research indicates that the soil type most susceptible to liquefaction during a large magnitude earthquake is loose, clean sand. In order for liquefaction to occur, the soil must be saturated. The liquefaction potential for soil tends to decrease with an increase in fines content and density.

The subsurface soil encountered at the site consists primarily of clay with some sand layers. The sand layers are relatively thin and cannot be evaluated for liquefaction potential. Investigation to greater depth would be needed to evaluate the liquefaction potential. Such a study is beyond the scope of this report. The stiff upper soil which is not susceptible to liquefaction would reduce the surface effect if the deeper soil were to liquefy.

G. Water Soluble Sulfates

One sample of the natural soil was tested in the laboratory for water soluble sulfate content. The test results 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, the natural soil possesses negligible sulfate attack potential on concrete. The concentration of water soluble sulfates present in the soil at the site indicates that sulfate resistant cement is not needed for concrete placed in contact with the soil. Other conditions may dictate the type of cement to be used in concrete for the project.

H. Pavement

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

1. Subgrade Support
   The near surface soil consists of clay. A California Bearing Ratio (CBR) value of 3 percent was used in the analysis which assumes a clay subgrade.

2. Pavement Thickness
   Based on the subsoil conditions, assumed traffic as described in the Proposed Construction section of the report, 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 may be used. A rigid pavement section consisting of 5 inches of Portland cement concrete placed on a prepared subgrade may be used.

   Some gravel may be needed when the upper soil is very moist to wet as discussed in the Site Grading section of the report.

3. Pavement Materials and Construction

a. Flexible Pavement (Asphaltic Concrete)

The pavement materials should meet the Utah Department of Transportation specifications for gradation and quality. 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 Utah Department of Transportation Specifications. The pavement thickness indicated above assumes 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 at the approximate locations indicated on Figure 1, the data obtained from laboratory testing and our experience in the area. Variations in the subsurface conditions may not become evident until additional exploration or excavation is conducted. If the proposed construction, subsurface conditions or groundwater level is found to be significantly different from what is described in this report, we should be notified to reevaluate the recommendations given.

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.

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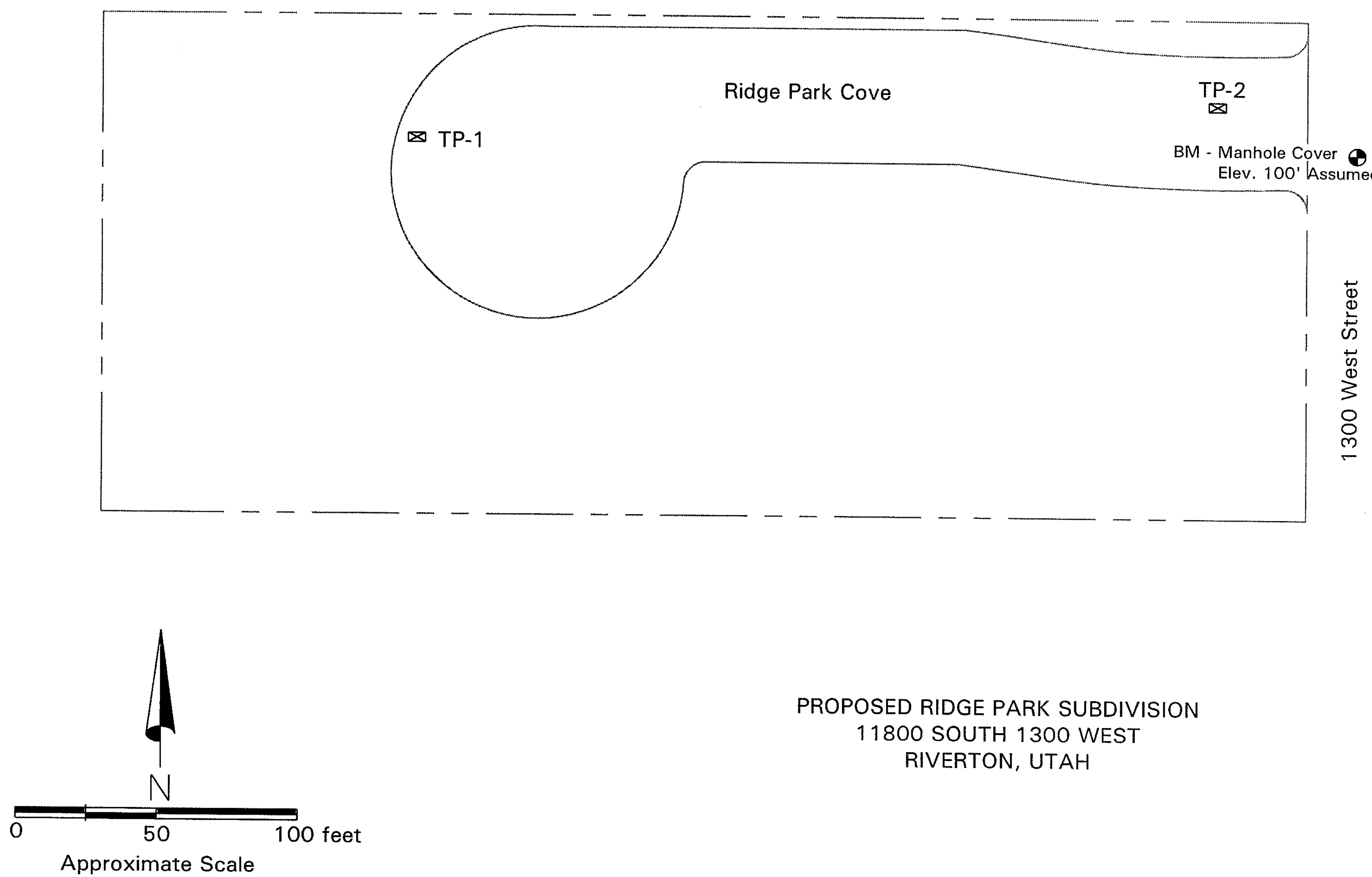
DRH/dc

REFERENCES CITED

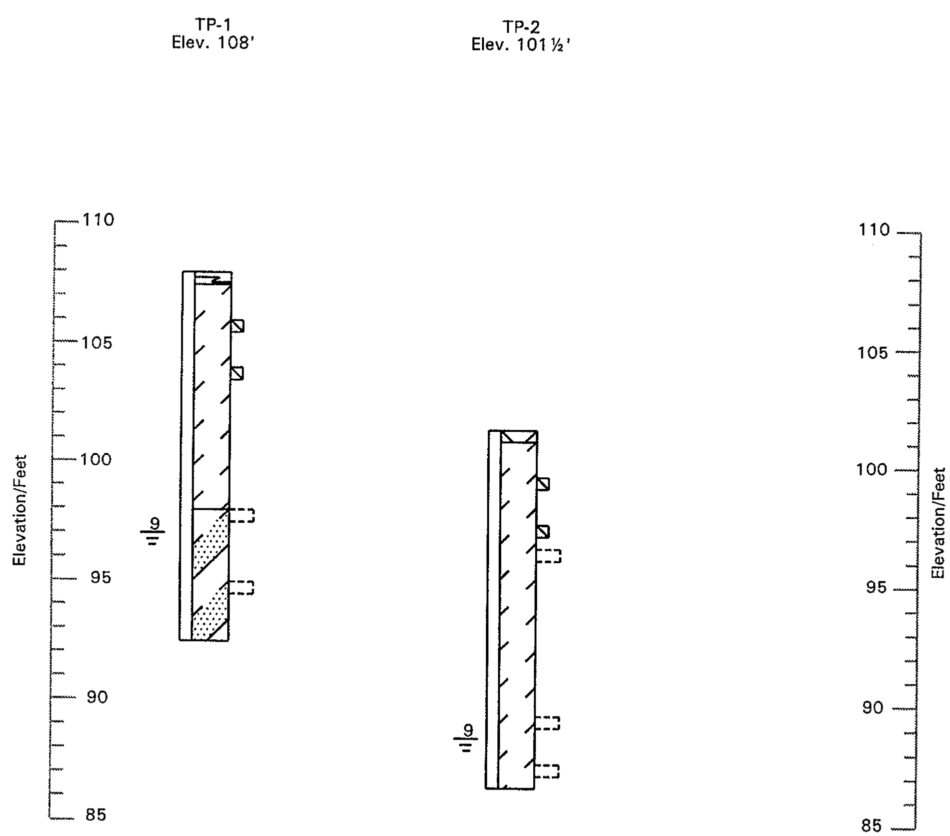
International Building Code, 2000; International Code Council, Inc., Falls Church, Virginia.

Salt Lake County Planning Department, 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 Department, 2001 South State Street, Salt Lake City, Utah.



PROPOSED RIDGE PARK SUBDIVISION
11800 SOUTH 1300 WEST
RIVERTON, UTAH

1040177	AGEC	Locations of Test Pits	Figure 1



LEGEND:

Fill; silty sand, moist, dark brown, roots, organics.

Topsoil; lean clay, moist, dark brown, roots, organics.

Lean Clay (CL); occasional sand layers, stiff to very stiff, very moist to wet, brown to grayish brown.

Interlayered Lean Clay and Silty Sand (CL/SM); som silt layers, stiff to very stiff, very moist to wet, brown to grayish brown.

Indicates relatively undisturbed hand drive sample taken.

Indicates disturbed sample taken.

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

0 Indicates the depth to free water and the number of days after excavating the measurement was taken.

NOTES:

1. Test pits were excavated on March 10, 2004 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. Water level readings shown on the logs were made at the time and under the conditions indicated. Fluctuations in the water level may occur with time.
7. WC = Water Content (%);
   DD = Dry Density (pcf);
   +4 = Percent Retained on No. 4 Sieve;
   -200 = Percent Passing No. 200 Sieve;
   LL = Liquid Limit (%);
   PI = Plasticity Index (%);
   UC = Unconfined Compressive Strength (psf);
   WSS = Water Soluble Sulfates (ppm).

Approximate Vertical Scale 1" = 8'

1040177	AGEC	Logs, Legend and Notes of Test Pits	Figure 2

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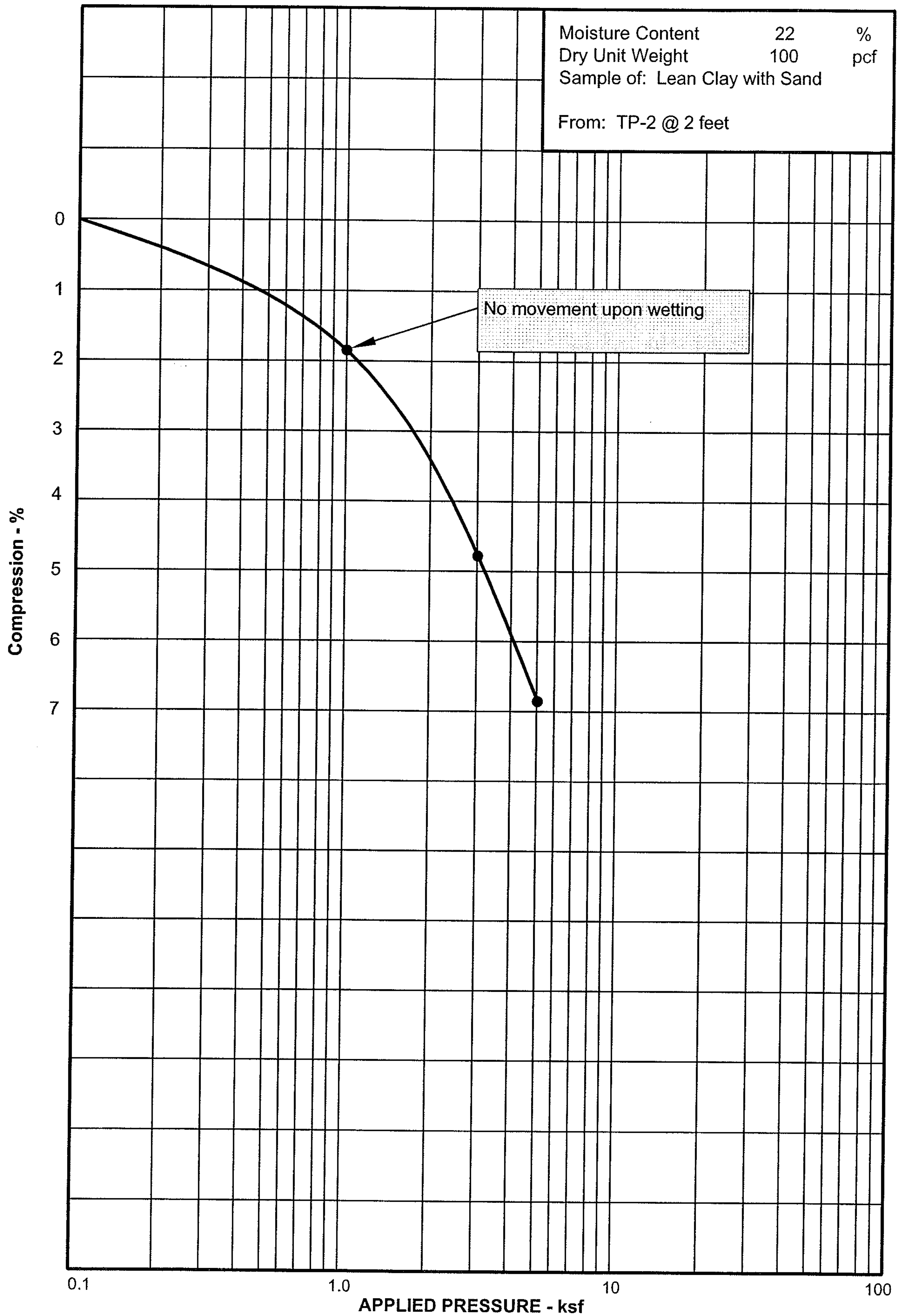

Project No. 1040177 | CONSOLIDATION TEST RESULTS | Figure 3

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TABLE I

SUMMARY OF LABORATORY TEST RESULTS

PROJECT NUMBER 1040177

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	2	21	101			92			2,335		Lean Clay
	4									500	Lean Clay
TP-2	2	22	100			80					Lean Clay with Sand