AGEC

Applied GeoTech

GEOTECHNICAL INVESTIGATION

PROPOSED KING'S CROWN DEVELOPMENT

APPROXIMATELY 1400 LOWELL AVENUE

PARK CITY, UTAH

PREPARED FOR:

RORY MURPHY
2590 SIDEWINDER DRIVE
PARK CITY, UTAH 84060

PROJECT NO. 1161003

DECEMBER 15, 2016

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EXECUTIVE SUMMARY

1. Approximately 1½ to 2 feet of topsoil was encountered in the upper portion of the test pits excavated at the site. Layers of gravel and clay were encountered below the topsoil and extend to depths ranging from approximately 5 to 13½ feet below the existing ground surface. Quartzite bedrock was encountered below the clay and gravel.

2. No subsurface water was encountered in the test pits at the time of excavation to the maximum depth investigated.

3. Practical excavation equipment refusal was encountered in bedrock in the test pits at depths ranging from approximately 10 to 13½ feet below the existing ground surface. Excavation difficulties can be expected in the bedrock. Light blasting, jack hammering and other rock excavation methods will likely be needed to facilitate excavation into the bedrock.

4. The proposed structures may be supported on spread footings bearing on the undisturbed bedrock or on compacted structural fill extending down to the undisturbed bedrock.

   Footings bearing on the undisturbed natural gravel extending down to bedrock or compacted structural fill extending down to the undisturbed bedrock or gravel/bedrock may be designed using an allowable net bearing pressure of 3,500 pounds per square foot. Footings bearing entirely on bedrock may be designed using an allowable net bearing pressure of 5,000 pounds per square foot.

   Where a footing would bear partially on structural fill and partially on bedrock, the footing should be extended down to bear entirely on bedrock or at least 2 feet of structural fill provided below the footing.

5. We anticipate that shoring will be needed for portions of the foundation excavations which are near adjacent structures and utilities and where there is not enough horizontal distance to provide for a stable excavation slope. Recommendations for shoring design are presented in the report.

6. Construction access difficulties can be expected in areas where the subgrade consists of very moist to wet clay. Placement of approximately 1½ to 2½ feet of granular fill or excavation down to granular soil or bedrock will generally improve site conditions for construction access in areas where the subgrade consists of very moist to wet clay.

7. Geotechnical information related to foundations, subgrade preparation, compaction and materials is included in the report.

SCOPE

This report presents the results of a geotechnical investigation for the proposed King's Crown development to be located at approximately 1400 Lowell Avenue in Park City, Utah. The report presents the subsurface conditions encountered, laboratory test results and recommendations for foundation support and pavement. The study was conducted in general accordance with our proposal dated November 15, 2016.

Field exploration was conducted to obtain information on the subsurface conditions. Samples obtained from 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 assumed subsurface conditions. Design parameters and a discussion of geotechnical engineering considerations related to construction are included in the report.

SITE CONDITIONS

The site consists of vacant, undeveloped property along the southwest side of Lowell Avenue. There are no permanent structures or pavements on the site.

The ground surface at the site slopes gently down to the northeast. The ground surface adjacent the west side of Lowell Avenue slopes down to the pavement at approximately 2 horizontal to 1 vertical or flatter. Other areas of the site slope down to the northeast at approximately 3 horizontal to 1 vertical and flatter.

Vegetation at the site consists primarily of trees, shrubs and grass.

Lowell Avenue borders the northeast edge of the property. There are residential buildings northeast of Lowell Avenue and northwest and southeast of the site. The buildings are single-family and multi-family structures. The buildings range from one to three-story, wood-frame, slab-on-grade structures. The area to the south and west consists of undeveloped hillside and ski runs for the Park City Mountain Resort.

ANTICIPATED SUBSURFACE CONDITIONS

Approximately 1½ to 2 feet of topsoil was encountered in the upper portion of the test pits excavated at the site. Layers of gravel and clay were encountered below the topsoil and extend to depths ranging from approximately 5 to 13½ feet below the existing ground surface. Quartzite bedrock was encountered below the clay and gravel.

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

> Topsoil - The topsoil consists of sandy lean clay with some gravel. It is moist, dark brown and contains roots and organics.
>
> Lean Clay - The clay contains small amounts of sand. It is moist, very stiff and brown.
>
> Fat Clay - The clay contains small to moderate amounts of sand and occasional small gravel. The clay is moist, stiff to very stiff and brown to reddish brown.
>
> Laboratory tests conducted on a sample of the fat clay indicate that it has a natural moisture content of 22 percent and a natural dry density of 95 pounds per cubic foot (pcf).

Consolidation tests were conducted on samples of the clay tested at the sampled moisture content and an air-dried moisture content. The results of the consolidation tests indicate that the clay expanded approximately 1 percent when wetted at a confining pressure of 1,000 psf. The results of the consolidation tests are presented on Figure 3.

Poorly Graded Gravel with Clay and Sand - The gravel contains small to moderate amounts of clay and sand and some cobbles up to approximately 6 inches in size. It is dense to very dense, slightly moist to moist and brown to reddish brown.

Bedrock - The bedrock consists of quartzite of the Weber Sandstone. The bedrock is hard to very hard, slightly moist and gray.

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

SUBSURFACE WATER

No subsurface water was encountered in the test pits at the time of excavation to the maximum depth investigated.

PROPOSED CONSTRUCTION

The proposed construction is planned to consist of 21 "old town" building lots along the west side of Lowell Avenue. The residences plan for the "old town" lots will likely consist of one to three-story, wood-frame, slab-on-grade structures.

Three condominium buildings are planned to be constructed southwest of the "old town" building lots (see Figure1). The condominium buildings will likely consist of three-story, wood-frame, slab-on-grade structures.

We have assumed building loads for the structures will consist of wall loads of up to 3 kips per lineal foot and column loads of up to 50 kips based on typical residential construction in the area.

Traffic for pavement areas is assumed to consist primarily of light passenger vehicles, occasional light delivery trucks and two garbage trucks per week.

Site grading plans were not provided for our review. However, we anticipate that the proposed structures will be cut into the adjacent hillside. We have assumed site grading will consist of cuts and fills on the order of 10 feet.

RECOMMENDATIONS

Based on the subsurface conditions encountered, laboratory test results and our understanding of the proposed construction, the following recommendations are given:

A. Site Grading

1. Excavation Slopes

   Temporary, unretained excavation slopes up to 10 feet in height in the natural gravel may be constructed at 1½ horizontal to 1 vertical or flatter. Temporary, unretained excavation slopes up to 10 feet in height in the clay may be excavated at approximately 1 horizontal to 1 vertical or flatter. Steeper excavation slopes may be considered for excavations in bedrock depending on the orientation of discontinuities in the bedrock. Excavation slopes should be evaluated at the time of construction.

Permanent unretained cut and fill slopes in soil may be constructed at 2 horizontal to 1 vertical or flatter. Steeper slopes may be suitable for areas of bedrock and can be evaluated at the time of construction.

Grading should be planned to direct surface runoff away from cut and fill slopes. Permanent cut and fill slopes should be protected from erosion by revegetation or other methods.

2. Shoring

Shoring may be needed to maintain the stability of the excavation slopes constructed steeper than recommended and near existing buildings. We anticipate that shoring would consist of soldier piles with timber lagging or soil nails with a shotcrete face.

The retaining system should be designed to retain the load of the soil, along with surcharge and other loading conditions located above and adjacent to the excavation, such as adjacent residences, traffic, roadways or other loads.

Lateral pressures due to surcharge loading of adjacent buildings and equipment should also be considered in addition to the earth pressures discussed. The recommended lateral loads resulting from surcharge loading to be used in design can be provided once the expected surcharge loading conditions have been provided.

Observation of the installation of the shoring system should be made by the geotechnical engineer. This will include observation of soil nails, soldier piles and timber lagging placement.

Details and calculations of proposed shoring and excavation should be submitted to the geotechnical engineer for review prior to commencement of the excavation.

3. Subgrade Preparation

Prior to placing grading fill or base course, the topsoil, organics, unsuitable fill and other deleterious materials should be removed.

Construction equipment access difficulties can be expected for rubber-tired construction equipment when the subgrade consists of very moist to wet clay, such as may occur in the winter or spring. Placement of 1½ to 2 feet of granular fill or excavation down to granular soil will provide equipment access for rubber construction equipment above a very moist to wet clay subgrade.

4. Fill Placement

Fill should be placed in horizontal lifts with relatively uniform thickness. Fill placed in areas of slopes steeper than 5 horizontal to 1 vertical should be benched into the hillside with a bench for every 2 feet of vertical rise, The fill should be placed and compacted in thin enough lifts to allow for proper compaction. The lift thickness will depend on the soil type, placement and compaction methods and type of equipment used. Typically, granular fill densified with moderate to large "riding type" compaction equipment, is placed in approximately 12-inch or less loose lifts. Fill placed in confined areas, or where hand-held/remote-controlled compaction equipment is used, should be placed in loose lifts of less than 6 inches.

5. Materials

Materials used as fill for the project are anticipated to consist of imported fill and the on-site soil. Recommendations for these materials are shown below.

a. Imported Fill

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

b. On-site Fill

The gravel and bedrock that are broken down to a suitable size for compaction may be used as fill below proposed buildings, pavement and as general site grading fill if the organics, debris, over-sized particles and other deleterious materials are removed. The clay is not recommended for use as fill below buildings and pavement but may be used in landscape areas.

c. Moisture Conditioning

The moisture content of the soil should be adj usted to within 2 percent of optimum to facilitate compaction. This will likely require moisture conditioning (wetting or drying) depending on whether the moisture of the soil is above or below the optimum moisture content at the time of construction. Drying of the soil may not be practical during cold or wet times of the year.

6. Compaction

The following table presents the compaction criteria for the areas of fill placement.

Fill to Support	Granular Soil (ASTM D 1557)
Foundations	≥95%
Concrete Slabs and Pavement	≥90%
Landscaping	≥85%
Retaining Wall Backfill	85% to 90%

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. Full-time testing and observation should be provided due to the thickness of fill to be placed at the site.

7. Drainage

The ground surface surrounding the proposed buildings should be sloped away from the buildings in all directions. Roof down spouts 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 undisturbed gravel, bedrock or on compacted structural fill extending to undisturbed bedrock. Foundations that would bear partially on structural fill and partially on bedrock should be extended down to bear entirely on bedrock or provided with at least 2 feet of compacted structural fill. Structural fill placed below foundations should extend out away from the edge of footings at least a distance equal to the depth of fill placed beneath footings.

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

2. Bearing Pressure

Footings bearing on the undisturbed natural gravel extending down to bedrock or structural fill extending down to bedrock or gravel over bedrock may be designed using an allowable net bearing pressure of 3,500 psf. Foundations bearing entirely on undisturbed bedrock may be designed using an allowable net bearing pressure of 5,000 psf.

Footings should have a minimum width of 1½ feet and a minimum depth of embedment of 1 foot.

3. Settlement

We estimate that total settlement will be less than ¾ inch for foundations designed and constructed as described above. Differential settlement is estimated to be on the order of ½ inch or less.

4. Temporary Loading Conditions

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

5. Frost Depth

Exterior footings and footings beneath unheated areas should be placed at least 40 inches below grade for frost protection.

6. Foundation Base

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

7. Construction Observation and Testing

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

Fill placed for the project should be frequently tested for compaction during construction.

C. Concrete Slab-on-Grade

1. Slab Support

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

The clay, topsoil, organic materials, unsuitable fill and other deleterious material should be removed from below proposed 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 floor slab for ease of construction and to promote even curing of the floor slab concrete.

3. Vapor Barrier

A vapor barrier should be placed under the concrete floor if the floor will receive an impermeable floor covering. The barrier will reduce the potential for water vapor passing from below the slab to the floor covering.

D. Lateral Earth Pressures

1. Lateral Resistance for Footings

Lateral resistance for spread footings placed on the natural soil/bedrock 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. Foundation 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 assume a horizontal surface adjacent each side of the wall.

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

3. Seismic Conditions

Under seismic conditions, the equivalent fluid weight should be increased by 18 pcf for the active conditions and 3 pcf for the at-rest condition. The equivalent fluid weight should be decreased by 18 pcf for the passive condition. This assumes a peak horizontal ground acceleration of 0.28g which represents a 2 percent probability of exceedance in a 50-year period (IBC, 2015).

4. Safety Factors

The values recommended above for active and passive pressures 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. Seismicity, Faulting and Liquefaction

1. Seismicity

Listed below is a summary of the site parameters for the 2015 International Building Code.

a.	Site Class	C
b.	Short Period Spectral Response Acceleration, S_S	0.62g
c.	One Second Period Spectral Response Acceleration, S_1	0.21g

Note: Site Class B may be used for buildings supported entirely on bedrock.

2. Faulting

There are no mapped active faults extending through the subject property. The closest mapped fault considered active is the Wasatch fault located approximately 18 miles west of the site.

3. Liquefaction

The area proposed for construction is mapped as having a "very low" potential for liquefaction (Anderson and others, 1989). Based on our understanding of geologic conditions in the area, it is our professional opinion that liquefaction is not a hazard at the site.

F. 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 natural soil. Other conditions may dictate the type of cement to be used for the project.

G. Pavement

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

1. Subgrade Support

We have assumed a California Bearing Ratio (CBR) value of 3 percent which assumes a clay subgrade.

2. Pavement Thickness

Based on the subsoil conditions, the assumed traffic conditions presented in the Proposed Construction section of this report, a design life of 20 years for flexible and 30 years for rigid pavement and methods presented by the Utah Department of Transportation, a flexible pavement section consisting of 3 inches of asphaltic concrete overlying 8 inches of base course is calculated.

Alternatively, a rigid pavement section consisting of 5 inches of Portland cement concrete may be used.

Thicker pavement sections are recommended for areas of concentrated traffic or heavy vehicles such as near entry ways or adjacent trash enclosures. A concrete approach slab consisting of 6½ inches of Portland cement concrete overlying 4 inches of base course is recommended for trash enclosures.

Approximately 1½ to 2 feet of granular borrow or excavation down to granular material may be needed to provide equipment access and to facilitate construction of pavement when the upper soil consists of very moist to wet, fine-grained soil.

3. Pavement Materials and Construction

a. Flexible Pavement (Asphaltic Concrete)

Pavement materials should meet the specifications for the applicable jurisdiction. 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 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.

H. Additional Services

It is important that AGEC be involved during design and construction of the development. There are several items where we can provide value, help the design of the geotechnical aspects of the project be more efficient and help reduce the risk to the design team and the owner.

We recommend that at least the following additional services be provided:

1. Attend a preconstruction meeting with representatives of the owner, project architect, geotechnical engineer, general contractor, earthwork contractor and other members of the design team to review construction plans, specifications, methods and schedule.

2. Review construction plans for the project to verify our recommendations have been incorporated in the design.

3. Observe excavations for the proposed building foundations.

4. Provide testing and inspections during construction. Typical items include concrete testing, inspection of reinforcement, and observation of fill placement and compaction.

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 the site plan, the data obtained from laboratory testing and our previous experience at the site. Variations in the subsurface conditions may not become evident until additional 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.

LICENSED PROFESSIONAL ENGINEER
12/16/16
No. 264456
CHRISTOPHER J. BECKMAN
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Christopher J. Beckman, P.E.

Reviewed by Douglas R. Hawkes, P.E., P.G.

CJB/rs

REFERENCES

Anderson, L.R., Keaton, J.R., and Rice, J.D., 1994; Liquefaction potential map for central Utah, Utah Geological Survey, Contract Report 94-10.

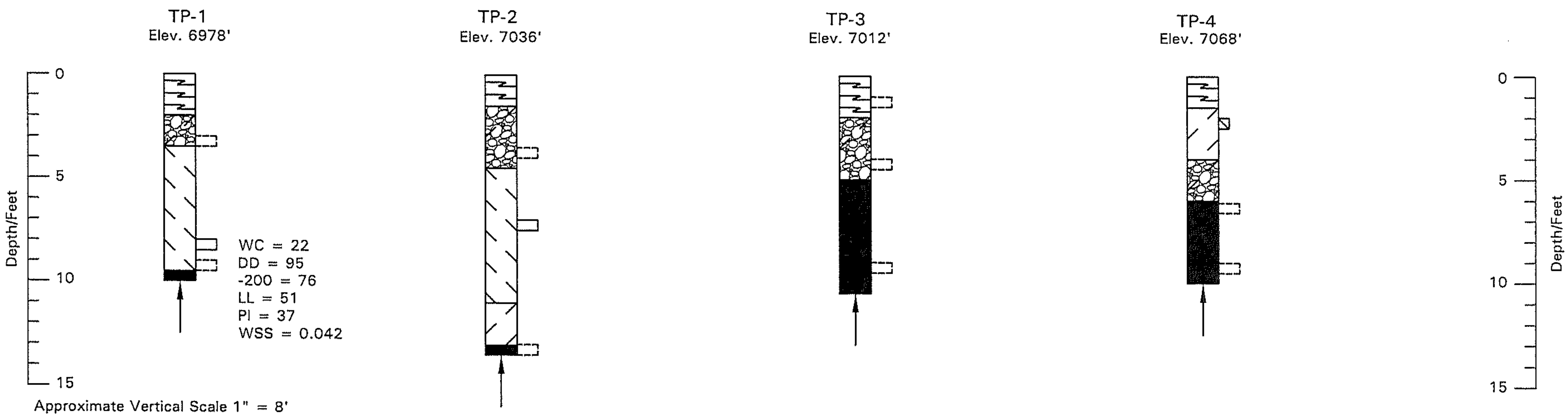
Black, B.D., DuRoss, C.B., Hylland, M.D., McDonald, G.N., and Hecker, S., compilers, 2004, Fault number 2351f, Wasatch fault zone, Salt Lake City section, in Quaternary fault and fold database of the United States: U.S. Geological Survey website, hhtps://earthquakes.usgs.gov/hazards/qfaults , accessed 12/12/2016 04:14 PM.

International Building Code, 2015; International Code Council, Inc., Falls Church, Virginia.

NOTE: Site Plan provided by the Client

KING'S CROWN DEVELOPMENT
APPROXIMATELY 1400 LOWELL AVENUE
PARK CITY, UTAH

1161003	AGEC	Test Pit Locations	Figure 1



Approximate Vertical Scale 1" = 8'

LEGEND:

- Topsoil; sandy lean clay, some gravel, moist, dark brown, roots and organics.
- Lean Clay (CL); small amounts of sand, moist, very stiff, brown.
- Fat Clay (CH); small to moderate amounts of sand, occasional gravel, moist, stiff to very stiff, brown to reddish brown.
- Poorly-graded Gravel with Clay and Sand (GP-GC); small to moderate amounts of clay and sand, some cobbles up to approximately 6 inches in size, dense to very dense, slightly moist to moist, brown to reddish brown.
- Quartzite bedrock; hard to very hard, slightly moist, gray.
- Indicates relatively undisturbed hand drive sample taken.
- Indicates disturbed sample taken.
- Indicates relatively undisturbed block sample taken.

NOTES:

1. The test pits were excavated on November 21 and 22, 2016 with a trackhoe.
2. Locations of the test pits were measured approximately by pacing from features shown on the site plan provided.
3. Elevations of the test pits were determined by interpolating between contours shown on the site plan provided.
4. The test pit locations and elevations should be considered accurate only to the degree implied by the method used.
5. The lines between materials shown on the logs represent the approximate boundaries between material types and the transitions may be gradual.
6. No free water was encountered in the test pits at the time of excavation.
7. WC = Water Content (%);
   DD = Dry Density (pcf);
   -200 = Percent Passing the No. 200 Sieve;
   LL = Liquid Limit (%);
   PI = Plasticity Index (%);
   WSS = Water Soluble Sulfates (%).

1161003	AGEC	Test Pit Logs, Legend and Notes	Figure 2

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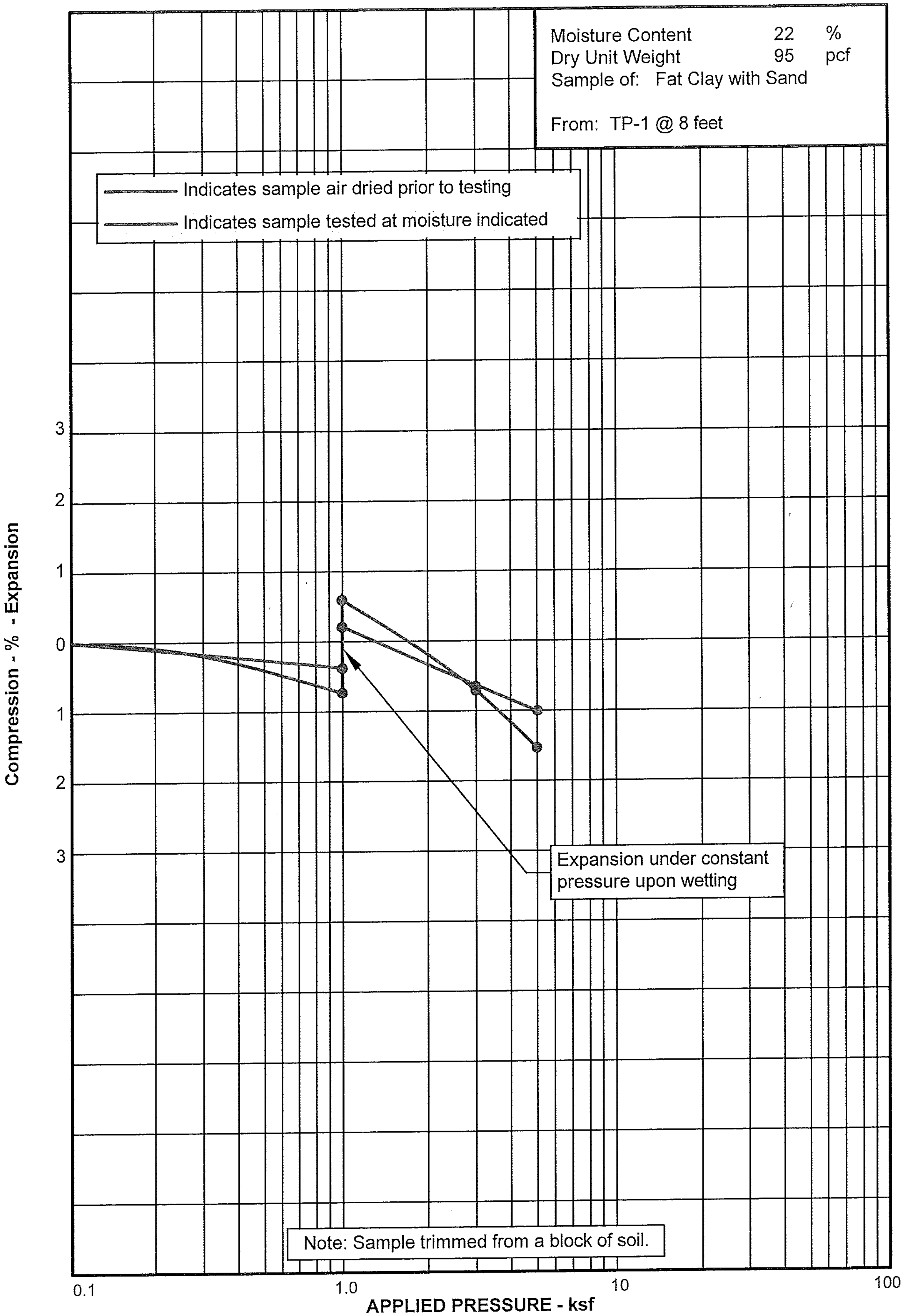

Project No. 1161003 **CONSOLIDATION TEST RESULTS** **Figure 3**

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TABLE I

SUMMARY OF LABORATORY TEST RESULTS

PROJECT NUMBER 1161003

SAMPLE LOCATION		NATURAL MOISTURE CONTENT (%)	NATURAL DRY DENSITY (PCF)	GRADATION			ATTERBERG LIMITS		UNCONFINED COMPRESSIVE STRENGTH (PSF)	WATER SOLUBLE SULFATE (%)	SAMPLE CLASSIFICATION
TEST PIT	DEPTH (FEET)			GRAVEL (%)	SAND (%)	SILT/ CLAY (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)			
TP-1	8	22	95			76	51	37		0.042	Fat Clay with Sand