Applied Geotechnical Engineering Consultants, Inc.

GEOTECHNICAL INVESTIGATION

UNDERGROUND PARKING STRUCTURE
AND RETAIL SHOPS

INTERSECTION OF MAIN STREET AND SWEDE ALLEY

PARK CITY, UTAH

PREPARED FOR:

PARK CITY MUNICIPAL CORPORATION
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ATTENTION: JONATHAN WEIDENHAMER

PROJECT NO. 1090605

OCTOBER 14, 2009

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EXECUTIVE SUMMARY

1. The subsurface materials encountered at the site consist of approximately 4 to 4½ inches of asphaltic concrete overlying approximately 4 to 5½ inches of base course. Fill was encountered below the base course and extends to depths of approximately 11 feet in Borings B-1 and B-3 and to a depth of approximately 7½ feet in Borings B-2C and B-2D. Poorly-graded gravel with clay and sand was encountered below the fill in Borings B-1, B-2C and B-2D. Clayey gravel was encountered below the fill in Borings B-3 and B-3A. The maximum depth investigated was approximately 23 feet.

   Practical auger refusal was encountered in the natural soil in Borings B-1, B-2D and B-3A at depths of approximately 23, 13 and 20½ feet, respectively. Practical auger refusal was encountered in the fill in Borings B-2, B-2A, B-2B and B-2C at depths ranging from 4½ to 6 feet.

2. Up to approximately 11 feet of existing fill was encountered in borings drilled at the site. Several borings encountered practical refusal in the fill at shallower depths. The practical refusal could be due to large rock, concrete or other conditions. The fill likely extends deeper in these areas and may extend deeper than was found in other borings.

3. The moisture content of the fill ranges from moist to very moist at depth. The fill was wet in some areas. The moisture content of the underlying soil is lower than the fill. Water was encountered in Boring B-2D at a depth of approximately 8 feet at the time of drilling. We anticipate that subsurface water is seeping down through the loose fill and along the interface between the fill and underlying natural soil in a perched condition.

4. The proposed parking structure and retail shops have not been designed. Building loads were not available at the time of our investigation. We have assumed the proposed structure will have column loads of up to 800 kips.

5. The proposed parking structure and retail shops may be supported on spread footings bearing on the undisturbed natural soil or on compacted structural fill extending down to the undisturbed natural soil.

   Footings bearing on the undisturbed natural soil or on compacted structural fill extending down to the natural soil may be designed using a net allowable bearing pressure of 3,500 pounds per square foot.

6. 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 a proposed parking structure and retail shops to be constructed in an existing parking lot near the intersection of Main Street and Swede Alley in Park City, Utah. The report presents the subsurface conditions encountered, laboratory test results and recommendations for foundation support. The study was conducted in general accordance with our proposal dated August 28, 2009.

Field exploration was conducted to obtain information on the subsurface soils. Samples obtained from the field investigation were tested in the laboratory to determine physical and engineering characteristics of the on-site soil. Information 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.

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 an existing asphalt-paved parking lot on the north side of the intersection of Main Street and Swede Alley in Park City, Utah.

The ground surface slopes gently to moderately down to the north. The elevation of the parking lot is approximately 3 to 6 feet lower than Main Street and at the same approximate elevation as Swede Alley.

Main Street, a two-lane, asphalt-paved road in good condition, extends along the west side of the site. Swede Alley, a narrow, two-lane, asphalt-paved road in good condition, extends along the south and east sides of the site. A two-story retail building is north of the site.

FIELD STUDY

The field study was conducted on September 14 and 15, 2009. Eight borings were drilled at the approximate locations indicated on Figure 1. The borings were drilled using 8-inch diameter, hollow-stem auger powered by a truck-mounted drill rig. The borings were logged and soil samples obtained by a field engineer from AGEC. Logs of the subsurface conditions encountered in the borings are graphically shown on Figures 2 and 3.

SUBSURFACE CONDITIONS

The subsurface materials encountered at the site consist of approximately 4 to 4½ inches of asphaltic concrete overlying approximately 4 to 5½ inches of base course. Fill was encountered below the base course and extends to depths of approximately 11 feet in Borings B-1 and B-3 and to a depth of approximately 7½ feet in Borings B-2C and B-2D. Poorly-graded gravel with clay and sand was encountered below the fill in Borings B-1, B-2C and B-2D. Clayey gravel was encountered below the fill in Borings B-3 and B-3A. The maximum depth investigated was approximately 23 feet.

Practical auger refusal was encountered in the natural soil in Borings B-1, B-2D and B-3A at depths of approximately 23, 13 and 20½ feet, respectively. Practical auger refusal was encountered in the fill in Borings B-2, B-2A, B-2B and B-2C at depths ranging from 4½ to 6 feet.

A description of various materials encountered in the borings follows:

Base Course - The base course ranges from poorly-graded gravel with sand to clayey or silty gravel with sand. It is moist and orange-brown to gray.

Fill - The fill ranges from poorly-graded gravel with sand to clayey gravel with sand. It contains some areas of clayey sand, frequent debris consisting of wood, metal, glass and a leather strap. Larger debris or rock is likely in the area of Borings B-2 through B-2D based on auger refusal in these borings. The fill is moist to very moist and wet in some areas near the interface between the fill and natural soil such as in Borings B-1 and B-2D. The fill is dark brown to gray.

Results of laboratory tests performed on a sample of the fill indicate it has a moisture content of 38 percent and a dry density of 76 pounds per cubic foot (pcf).

Clayey Gravel - The clayey gravel contains moderate amounts of sand and clay with occasional clayey sand with gravel layers. It is medium dense to very dense, wet decreasing to moist with depth and brown to orange-brown.

Results of laboratory tests performed on a sample of the clayey gravel with sand indicate that it has a natural moisture content of 18 percent and a natural dry density of 102 pcf.

Poorly-Graded Gravel with Clay and Sand - The poorly-graded gravel with clay and sand is medium dense to very dense, moist to wet and brown to orange-brown.

Results of laboratory tests performed on samples of the gravel indicate that it has natural moisture contents ranging from 9 to 12 percent and natural dry densities ranging from 121 to 122 pounds per cubic foot (pcf).

Results of the laboratory tests are summarized on Table I and are included on the Logs of the Borings.

SUBSURFACE WATER

The moisture content of the fill ranges from moist to very moist at depth. The fill was wet in some areas. The moisture content of the underlying soil is lower than the fill. Water was encountered in Boring B-2D at a depth of approximately 8 feet at the time of drilling. We anticipate that subsurface water is seeping down through the loose fill and along the interface between the fill and underlying natural soil in a perched condition.

PROPOSED CONSTRUCTION

The structure had not been designed at the time of our investigation. Based on an available conceptual plan, we understand that the structure will consist of two levels of underground parking. Access to the upper level of parking is planned to be from Swede Alley in the south portion of the property. Access to the lower level of parking is planned to be from Swede Alley in the north portion of the property.

Retail shops are planned to be constructed above the parking structure and are anticipated to consist of one to two-story buildings.

We have assumed that building loads will consist of column loads up to 800 kips and wall loads up to 5 kips per lineal foot.

A park with an amphitheater is planned for the south portion of the property.

If the proposed structure or building loads are significantly different from those described above, we should be notified so that we can reevaluate the recommendations given.

RECOMMENDATIONS

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

A. Site Grading

We estimate that excavation for the project will result in cuts of up to approximately 20 feet and less than 3 feet of fill.

1. Slopes

Temporary, unretained excavation slopes up to 20 feet in height in the natural gravel may be constructed at 1 horizontal to 1 vertical or flatter. Temporary, unretained excavation slopes up to 11 feet in height in the fill may be constructed at 1½ horizontal to 1 vertical or flatter. Steeper excavation slopes may be possible and should be evaluated on an individual basis.

Flatter excavation slopes will be needed if the excavation occurs during the wet times of the year, or if water is observed seeping from the slope.

An engineer from AGEC should observe excavation slopes.

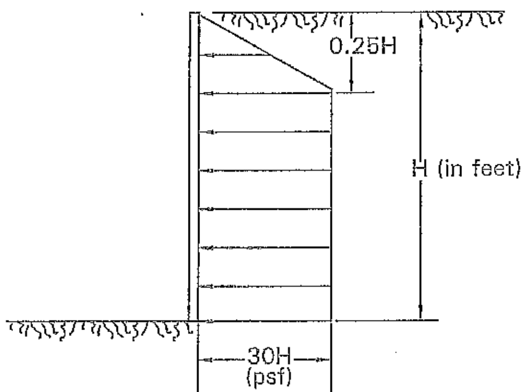
Permanent unretained fill slopes may be constructed at 2 horizontal to 1 vertical or flatter. Fill placed on slopes steeper than 5 horizontal to 1 vertical should be keyed into the slope with a key for every 2 feet of vertical rise.

2. Shoring

Due to the proximity of adjacent roadways and buildings, we anticipate shoring will be needed to maintain the stability of the excavation. We anticipate that shoring would consist of soldier piles and lagging. Consideration could also be given to providing internal supports or bracing the excavation from the inside. Soil nails or tie-back anchors may not be feasible due to the utilities underlying adjacent roadways.

Typically, the desire to have decreased movement will result in greater design lateral loads. If movement equivalent to 0.002 times the height of the excavation is tolerable, an active soil pressure of 40 pounds per cubic foot may be used in design.

The amount and location of movement in the shoring system depends on the type of shoring system used and the lateral pressure used in the design. If soil nails, tie-back anchors, or internal bracing is used, the lateral load should be calculated in accordance with the figure shown below:



Lateral Pressure Distribution
for Horizontal Ground Surface

If a cantilevered shoring system is used, such as soldier piles and lagging, the lateral pressure would increase linearly with depth.

Lateral loads used in design of the shoring should be increased due to sloping excavations above the top of the wall. This load will be dependent on the steepness of the slope and height of material above the shoring.

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

Particular care should be taken to prevent loss of material from below adjacent structures or facilities.

Observation of the installation of the shoring system should be made by the geotechnical engineer. This will include observation of soil nails or drilled piers and tie-back anchor installation.

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

3. <u>Subgrade Preparation</u>

Prior to placing grading fill, unsuitable fill, topsoil, organic material and other deleterious materials should be removed.

4. <u>Excavation</u>

Due to large debris that may be encountered in the fill and the dense to very dense natural soil, we recommend that heavy-duty excavation equipment be used for excavating. Greater difficulty can be expected in confined excavations such as for utilities.

Care should be taken not to disturb the natural soil to remain below the proposed structure.

5. 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 D1557.

Fill to Support	Compaction*
Foundations	≥ 95%
Concrete Flatwork	≥ 90%
Landscaping	≥ 85%
Retaining Wall Backfill	≥ 90%

*Local jurisdictions or utility companies may require a greater degree of compaction than indicated.

Base course should be compacted to at least 95% of the maximum dry density as determined by ASTM D1557.

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

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

6. Materials

Listed below are materials recommended for imported structural fill.

Fill to Support	Recommendation
Footings	Non-expansive granular soil Passing No. 200 sieve <35% Liquid Limit < 30% Maximum size 4 inches
Floor Slabs (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 natural gravel is suitable for use as fill below the proposed structure, as site grading fill or as utility trench backfill if the topsoil, organics, oversize material and other deleterious materials are removed or it may be used in landscaping areas.

The fill may be considered for use as structural fill or as utility trench backfill if it meets the recommendations given in the table above and if debris, oversize material, organics and other deleterious material are removed. The fill could also be considered for use in landscaping areas.

The natural gravel may require moisture conditioning (wetting or drying) prior to use as fill or backfill. The fill will likely require drying prior to use. Drying of the soil may not be practical during cold or wet times of the year.

7. Drainage

The ground surface surrounding the proposed structure should be sloped to drain away from the structure in all directions. Roof downspouts should discharge beyond the limits of backfill.

B. Foundations

1. Bearing Material

With the proposed construction and the subsurface conditions encountered, the proposed building may be supported on spread footings bearing on the undisturbed natural soil or on compacted structural fill which extends down to the natural soil. Structural fill placed below foundations should extend out away from the edge of the footings at least a distance equal to the depth of fill beneath the footings.

2. Bearing Pressure

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

Footings should have a width of at least 2 feet and a depth of embedment of at least 1 foot.

3. Settlement

We estimate that total and differential settlement will be less than ½ inch for footings supported on clayey gravel or structural fill overlying natural gravel. Care should be taken to minimize the disturbance of the natural soil to remain below footings so that settlement can be maintained within tolerable limits.

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

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 extending down to the undisturbed natural soil. Topsoil, organics, unsuitable fill, debris and other deleterious material should be removed from below proposed 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 concrete floor slabs for ease of construction and to promote even curing of the floor slab concrete.

D. Lateral Earth Pressures

1. Lateral Resistance for Footings

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 where foundations are supported on the natural gravel or on compacted structural fill extending down to the natural gravel.

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 below assume a horizontal ground surface adjacent the wall:

Slope Adjacent the Wall	Active	At-Rest	Passive
Fill	45 pcf	65 pcf	300 pcf
Natural Gravel	40 pcf	55 pcf	300 pcf

3. Seismic Conditions

Under seismic conditions, the equivalent fluid weight should be increased by 18 pcf for active and at-rest conditions and decreased by 18 pcf for the passive condition. This assumes a short period spectral response acceleration of 0.69g which represents a 2 percent probability of exceedance in a 50-year time period (IBC, 2006 and 2009).

4. <u>Safety Factors</u>

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. <u>Seismicity</u>

Listed below is a summary of the site parameters for the International Building Code 2006 and 2009:

a.	Site Class	C
b.	Short Period Spectral Response Acceleration, S_S	0.69g
c.	One Second Period Spectral Response Acceleration, S_1	0.25g

2. <u>Faulting</u>

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 15½ miles west of the site (Black and others, 2003).

3. <u>Liquefaction</u>

The site is located in an area mapped as having a "very low" liquefaction potential (Anderson and others, 1989).

Based on our understanding of the geology of the area and the subsurface conditions encountered, it is our professional opinion that liquefaction is not a hazard at the site.

F. Water Soluble Sulfates

One sample of the fill was tested for water soluble sulfate content. Test results indicate that there is less than 0.1 percent water soluble sulfate in the sample tested. Based on the tests results, previous experience in the area and published literature, the fill and natural soil at the site generally possess negligible sulfate attack potential on concrete. No special cement type is required for concrete placed in contact with the fill or natural soil. Other conditions may dictate the type of cement to be used for the project.

G. Subsurface Drains

Subsurface water was encountered near the interface of the fill and natural soil in Boring B-2D. Due to the water observed in the boring and with the potential for perched water conditions to develop during the wet times of the year, we recommend that a subsurface drain be provided around the below grade portion of the structure. The subsurface drain system should consist of at least the following items:

a. The subsurface drain system should consist of a perforated pipe installed in a gravel filled trench around the perimeter of the subgrade floor portion of the structure. The drain should extend up foundation walls high enough to intercept potential subsurface water (at least as high as the interface of the fill and natural soil). A geotextile drain could be considered for the portion of the drain which extends up the foundation walls.

b. 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.

c. 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 building.

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

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

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 borings drilled at the site and our experience in the area. Variations in the subsurface conditions may not become evident until subsurface 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 the recommendations given.

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.

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Reviewed by Scott D. Anderson, P.E.

BQC/dc

REFERENCES

Anderson, L., Keaton, J., Rice, J., 1989; Liquefaction Potential, Central Utah, Park City - Heber, U.S. Geological Survey, Contract Report 94-10.

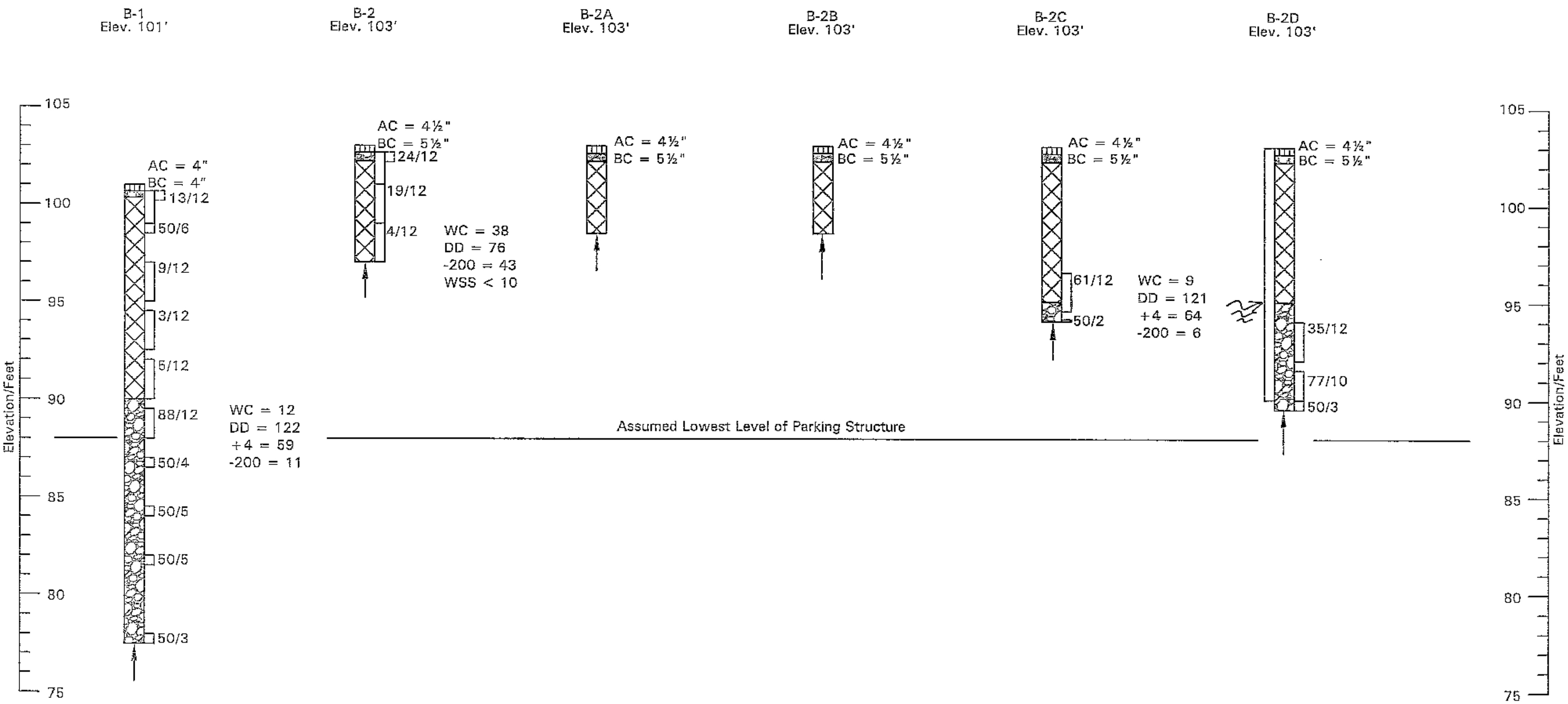
Black, B.D., Hecker, S., Hylland, M.D., Christenson, G.E., and McDonald, G.N., 2003; Quaternary fault and fold database and map of Utah;

International Building Code, 2006 and 2009; International Code Council, Inc. Falls Church, Virginia.

0 50 100 feet
Approximate Scale

UNDERGROUND PARKING STRUCTURE AND RETAIL SHOPS
INTERSECTION OF MAIN STREET AND SWEDE ALLEY
PARK CITY, UTAH

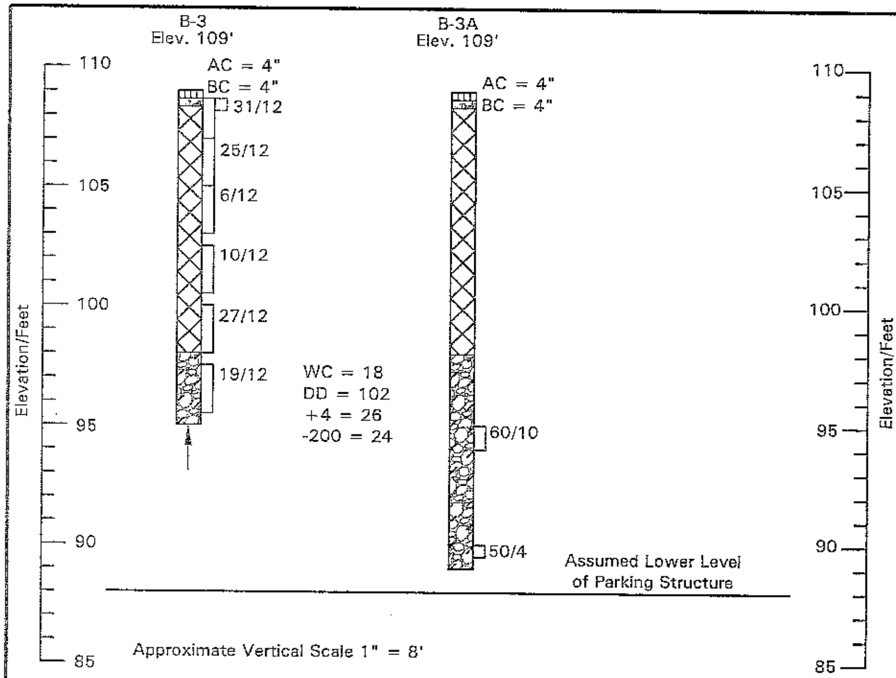
1090605	AGEC	Locations of Exploratory Borings	Figure 1



Approximate Vertical Scale 1" = 8'

See Figure 3 for Legend and Notes

1090605	AGES	Logs of Exploratory Borings	Figure 2



LEGEND:

- Asphaltic Concrete.
- Base Course; ranges from poorly graded gravel with sand to clayey or silty gravel with sand, moist, orange-brown to gray.
- Fill; ranges from poorly graded gravel with sand to clayey gravel with sand, some areas of clayey sand, frequent debris consisting of wood, metal, glass and leather strap, larger debris or rock likely in areas of Borings B-2 through B-2D based on auger refusal, moist to very moist, wet in some areas near the fill/natural soil interface such as Borings B-1 and B-2D, dark brown to gray.
- Clayey Gravel (GC); moderate amounts of sand and clay, occasional clayey sand with gravel layers, medium dense to very dense, wet to moist at depth, brown to orange-brown.
- Poorly Graded Gravel with Clay and Sand (GP-GC); decreasing amount of clay with depth, very dense, very moist to moist, brown to orange-brown.
- 10/12 California Drive sample taken. The symbol 10/12 indicates that 10 blows from a 140 pound automatic hammer falling 30 inches were required to drive the sampler 12 inches.
- Indicates disturbed sample taken.
- Indicates slotted 1 ½ inch PVC pipe installed in the boring to the depth shown.
- Indicates water seeping into boring at the approximate depth indicated.
- Indicates practical auger refusal.

NOTES:

1. Borings were drilled on September 14 and 15, 2009 with 8-inch diameter hollowstem auger.
2. Locations of borings were measured approximately by pacing from features shown on the site plan provided.
3. Elevations of borings were measured by automatic level and refer to the benchmark shown on Figure 1.
4. The boring 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 boring 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;
   WSS = Water Soluble Sulfates (ppm);
   AC = Asphaltic Concrete Thickness;
   BC = Base Course Thickness.

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.

TABLE I

SUMMARY OF LABORATORY TEST RESULTS

PROJECT NUMBER 1090605

SAMPLE LOCATION		MOISTURE CONTENT (%)	DRY DENSITY (PCF)	GRADATION			ATTERBERG LIMITS		UNCONFINED COMPRESSIV E STRENGTH (PSF)	WATER SOLUBLE SULFATE (PPM)	SAMPLE CLASSIFICATION
BORING	DEPTH (FEET)			GRAVEL (%)	SAND (%)	SILT/ CLAY (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)			
B-1	11½	12	122	59	30	11					Poorly Graded Gravel with Clay and Sand (GP-GC)
B-2	4	38	76			43				<10	Fill; Clayey Sand with Gravel
B-2C	6½	9	121	64	30	6					Poorly Graded Gravel with Clay and Sand (GP-GC)
B-3	11½	18	102	26	50	24					Clayey Sand with Gravel (SC)