AGEC
Applied GeoTech

PRELIMINARY GEOTECHNICAL STUDY

PROPOSED GATEWAY ESTATES SUBDIVISION

10700 EAST STATE ROUTE 39

WEBER COUNTY, UTAH

PREPARED FOR:

LOWE COMPANIES
6028 SOUTH RIDGELINE DRIVE, SUITE 203
OGDEN, UTAH 84405

ATTN: MATT LOWE

PROJECT NO. 1210067

MARCH 9, 2021

600 West Sandy Parkway • Sandy, Utah 84070 • (801) 566-6399 • www.agecinc.com

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EXECUTIVE SUMMARY

1. The subsurface materials encountered at the site consist of approximately ½ to 1½ feet of topsoil overlying clay and clayey gravel.

2. No subsurface water was encountered to the maximum depth investigated, approximately 11 feet.

3. There are landslide deposits in the west side of the property, which are not considered suitable for residential development without further geotechnical study. The area is shown on Figure 1.

4. High plastic clay was encountered in the area of landslide deposits and to a lesser amount in other test pits. The high plastic clay is moisture sensitive. It will expand when wetted and shrink when dried. Geotechnical studies are recommended for each individual house to be constructed on the property to determine what mitigation may be needed for the residences.

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5. The proposed residences to be constructed outside the landslide deposits may be supported on spread footings bearing on the undisturbed bedrock or on structural fill extending down to the bedrock and may be designed for a net allowable bearing pressure of 3,500 pounds per square foot. Spread footings may be suitable to support buildings in areas of lean clay and clayey gravel where the clay matrix is not high plastic clay. The individual geotechnical studies will help determine what foundation system is appropriate. Removal of high plastic clay or supporting buildings on deep foundations may be needed in some areas of the site.

6. The upper soil consists of clay or has a high clay content and may result in access difficulties for rubber-tired construction equipment when it is very moist to wet. Placement of 1 to 2 feet of granular fill may be needed to provide limited support for construction equipment when the upper soil is very moist to wet.

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

SCOPE

This report presents the results of a preliminary geotechnical study for the proposed Gateway Estates subdivision be constructed at approximately 10700 East State Route 39 west of Huntsville, 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 January 28, 2021. A geologic-hazards study was performed for the site and is presented in a separate report.

Field exploration was conducted to obtain information on the subsurface conditions. Information obtained from the field 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 site visit on February 10, 2021, there were no permanent structures or pavement on the site. The property consists of undeveloped land. There were several feet of snow on the ground.

The general topography of the site is presented on Figure 1. There is a drainage that extends generally north-south through the west central portion of the property, which fans out into an alluvial fan. There was some water in the drainage. There are other minor drainages on the east and west sides of the property, which are currently dry. Ridges with bedrock outcrops extend through much of the north half of the property and into parts of the south-central part of the property.

Vegetation consists of grass, brush and some patches of trees. Tree coverage is greatest in the central drainage.

There are similar properties to the north, east and west. State Route 39 borders the south side of the property. There are houses and camps south of the road.

FIELD STUDY

The field study was conducted on February 10, 11 and 16, 2021. Twelve test pits were excavated at the approximate locations indicated on Figure 1. The test pits were logged and samples obtained by a geologist from AGEC. The logs of the subsurface conditions encountered in the test pits are presented on Figures 2 and 3 with legend and notes on Figure 4.

The test pits were backfilled without significant compaction. The backfill should be removed and replaced with properly compacted fill where the backfill will support buildings, slabs or pavement.

SUBSURFACE CONDITIONS

The subsurface materials encountered at the site consist of approximately ½ to 1½ feet of topsoil overlying clay and clayey gravel.

A description of the soil and bedrock encountered in the test pits follows:

> Topsoil - The topsoil consists of sandy lean to fat clay with gravel and cobbles. It is moist, dark brown and contains organics.

Lean Clay with Sand - The clay contains some gravels and cobbles. It is very stiff, slightly moist and brown.

Laboratory tests on the clay indicate it has natural moisture contents of 5 to 7 percent. A hydrometer test indicates it has a clay fraction of 16 percent. Atterberg limit tests indicate it has liquid limits of 26 to 27 percent and a plasticity index of 9 percent.

Fat Clay - The clay contains a small to large amount of sand and gravel. It contains cobbles and boulders up to approximately 3 feet in size. It is very stiff, moist and brown.

Laboratory tests on the clay indicate it has natural moisture contents of 17 to 18 percent. Hydrometer tests indicate it has clay fractions of 28 to 41 percent. Atterberg limit tests indicate it has liquid limits of 54 to 72 percent and plasticity indexes of 35 to 50 percent.

Clayey Gravel with Sand - The gravel contains cobbles and boulders up to approximately 4 feet in size. It is medium dense to dense, slightly moist and brown.

Laboratory tests on the gravel indicate it has natural moisture contents of 7 to 16 percent. Hydrometer tests on the clay portion of the gravel samples indicate it has clay fractions of 33 to 46 percent. Atterberg limit tests on the clay portion of the gravel samples indicate it has liquid limits of 62 to 63 percent and a plasticity index of 47 percent.

Quartzite Bedrock - The bedrock is highly fractured, has clay infilled fractures and is very hard, slightly moist and brown.

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 in the test pits.

PROPOSED CONSTRUCTION

We have assumed the residences will be one- to three-story, wood-frame structures with the potential for a basements. We have assumed building loads to consist of wall loads up to 3 kips per lineal foot and column loads up to 30 kips.

We anticipate that roads extending into the development will have predominantly car traffic with occasional delivery and garbage-truck traffic.

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

RECOMMENDATIONS

High plastic clay was encountered in the area of landslide deposits and other areas of the site. The high plastic clay is moisture sensitive. It will expand when wetted and shrink when dried. Geotechnical studies are recommended for each individual house to be constructed on the property to determine what mitigation may be needed for the residences. The following are preliminary recommendations for the proposed development.

A. Site Grading

1. Subgrade Preparation

Prior to placing grading fill or base course, the topsoil, organics, unsuitable fill and other deleterious materials should be removed. In some cases, some or all of the high plastic clay may need to be removed from proposed building areas.

The upper soil consists of clay or has a high clay content and may result in access difficulties for rubber-tired construction equipment when it is very moist to wet. Placement of 1 to 2 feet of granular fill may be needed to provide limited support for construction equipment when the upper soil is very moist to wet.

2. Excavation

We anticipate that excavation at the site can be accomplished with heavy-duty excavation equipment. Difficult excavation can be expected where bedrock is encountered, particularly for confined excavations, such as for utilities. Jack hammering or other rock excavation methods may be needed for excavation into the bedrock.

3. Slopes

Temporary unretained excavation slopes may be constructed at 1 ½ horizontal to 1 vertical. For preliminary planning, permanent unretained cut and fill slopes may be considered at 4 horizontal to 1 vertical or flatter. Flatter slopes or retainage may be needed in some areas, particularly in areas of landslide deposits. Steeper slopes would be appropriate in areas of bedrock and gravel with low fines content. Additional study is recommended to evaluate stability of slopes. Slopes should be protected from erosion by revegetation or other methods. Surface drainage should be directed away from cut and fill slopes.

4. 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

Fill placed below the area of the proposed buildings should consist of granular soil as indicated above, though there may be instances where low-permeable fill is recommended. This would be determined with individual lot geotechnical studies. The on-site gravel meeting the above criteria exclusive of topsoil, organics, over-sized particles, debris and other deleterious materials may be used as structural fill. The natural gravel, lean clay and bedrock may be used as fill outside proposed building areas if the organics, debris and other deleterious materials are removed.

The moisture of the soil used as fill should be adjusted to within 2 percent of the optimum moisture content to facilitate compaction. Drying of the soil may not be practical during cold or wet times of the year.

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 D 1557.

Fill To Support	Compaction Criteria
Foundations	≥ 95%
Concrete Slabs	≥ 90%
Pavement	
Base Course	≥ 95%
Fill placed below Base Course	≥ 90%
Landscaping	≥ 85%
Retaining Wall Backfill	85 - 90%

Fill and pavement materials placed for the project should be frequently tested for compaction. Fill should be placed in thin enough lifts to allow for proper compaction.

6. 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

The proposed residences to be constructed outside the landslide deposits may be supported on spread footings bearing on the undisturbed bedrock or on structural fill extending down to the bedrock. Spread footings may be suitable to support buildings in areas of lean clay and clayey gravel where the clay matrix is not high plastic clay. The individual geotechnical studies will

help determine what foundation system is appropriate. Removal of high plastic clay or supporting buildings on deep foundations may be needed in some areas of the site. Structural fill placed below footings should extend out away from the edge of footings at least a distance equal to the depth of fill placed below footings.

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

2. Bearing Pressure

Spread footings bearing on the natural undisturbed bedrock or on compacted structural fill extending down to the bedrock may be designed for a net allowable bearing pressure of 3,500 pounds per square foot. Assuming the gravel for a particular residence does not have significant high plastic clay, footings bearing on the gravel or structural fill extending down to the gravel may also be designed for a net allowable bearing pressure of 3,500 pounds per square foot. Recommended allowable bearing pressures for other soil conditions would be evaluated as part of the lot-specific studies.

3. Minimum Footing Width and Embedment

Footings should have a width of at least 18 inches and a depth of embedment of at least 10 inches.

4. Settlement

We estimate that total and differential settlement for footings designed as indicated above to be less than ½ inch for footing bearing on bedrock or gravel as described above. Settlement estimates for other subsurface conditions can be provided from lot-specific studies.

5. Temporary Loading Conditions

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

6. Frost Depth

Exterior footings and footings beneath unheated areas should be placed at least 36 inches below grade for frost protection.

7. Foundation Base

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

8. 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 bedrock, and in some cases the gravel or on compacted structural fill. Slab support recommendation would be provided with lot-specific studies.

Expansive soil, topsoil, unsuitable fill, organics, debris and other deleterious materials should be removed from below proposed slabs.

2. Underslab Sand and/or Gravel

Consideration may be given to placing a 4-inch layer of free-draining sand and/or gravel (less than 5 percent passing the No. 200 sieve) below slabs to promote even curing of the slab concrete.

D. Lateral Earth Pressures

1. Lateral Resistance for Footings

Lateral resistance for footings placed on the bedrock, gravel or structural fill is controlled by sliding resistance between the footing and supporting material. A friction value of 0.45 may be used in design for ultimate lateral resistance for footings. A low friction value would be recommended for footings bearing on lean clay.

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 top and bottom 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

Additional recommendations can be provided for sloping backfill conditions.

3. Seismic Conditions

Under seismic conditions, the equivalent fluid weight should be increased by 24 pcf and 9 pcf for active and at-rest conditions, respectively, and decreased by 24 pcf for the passive condition. This assumes a peak horizontal ground acceleration of 0.41g for a seismic event having a 2 percent probability of exceedance in a 50-year period.

4. Safety Factors

The values recommended above for active and passive conditions assume mobilization of the soil to achieve the 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 that may be used with the 2018 International Building Code:

Description	Value[1]
Site Class	D[2]
S_s - MCE_R ground motion (period = 0.2s)	0.73g
S_1 - MCE_R ground motion (period = 1.0s)	0.25g
F_a - Site amplification factor at 0.2s	1.22
F_v - Site amplification factor at 1.0s	2.10
PGA - MCE_G peak ground acceleration	0.32g
PGA_M - Site modified peak ground acceleration	0.41g

[1]Values obtained from information provided by the Applied Technology Council at https://hazards.atcouncil.org

[2]Site Class C may be representative in areas of bedrock.

2. Faulting

There are no mapped active faults extending through the property. The closest mapped active fault is the Morgan Fault located approximately 12 miles to the south (Utah Geological Survey, 2021).

3. Liquefaction

Based on the subsurface conditions encountered and our understanding of geologic conditions in the area liquefaction is not considered a hazard at this site.

F. Subsurface Drains

If the lowest floor level of the residences extend below the natural ground surface, a perimeter drain system should be provided. 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 free-draining gravel filled trench around the perimeter of the below grade floor.

2. The flow line of the pipe should be placed at least 18 inches below the finished floor level or crawl space 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 away from the edge of the footing to avoid disturbing 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 clean-outs to allow access into the perimeter drain, should cleaning of the pipe be required in the future.

G. Water Soluble Sulfates

Based on the soil and bedrock conditions encountered and our experience in the area no special cement type is required for concrete placed in contact with the natural soil and bedrock. 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 as indicated in the Proposed Construction section of the report, the following pavement support recommendations are given:

1. Subgrade Support

   The upper natural soil at the site consists of a mixture of clay sand and gravel. A California Bearing Ratio (CBR) of 2½ percent was used for our analysis.

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 and 30 years for rigid pavement and methods presented by AASHTO, a flexible pavement section consisting of 3 inches of asphaltic concrete overlying 8 inches of high quality base course is recommended. Alternatively, a rigid pavement section consisting of at least 5 inches of Portland cement concrete may be used.

3. Pavement Material and Construction

a. Flexible Pavement (Asphaltic Concrete)

The pavement materials should meet the material 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 design assumes that a concrete shoulder or curb will be placed at the edge of the pavement and that the pavement will have aggregate interlock joints.

The pavement materials should meet the material specifications for the applicable jurisdiction. The pavement thicknesses indicated above assume that the concrete will have a 28-day compressive strength of 5,000 pounds per square inch. Concrete should be air entrained with approximately 6 percent air. The 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 the slab thickness.

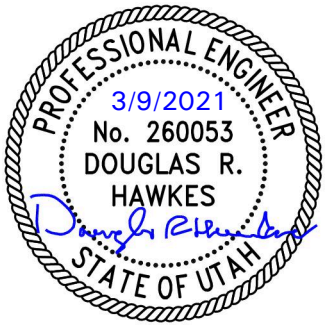
I. Preconstruction Meeting

A preconstruction meeting should be held 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.

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 preliminary design purposes. The conclusions and recommendations included in the report are based on the information obtained from the test pits excavated at the approximate locations indicated on Figure 1 and the results of the laboratory tests. 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 above, we should be notified to reevaluate the recommendations given.

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.



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

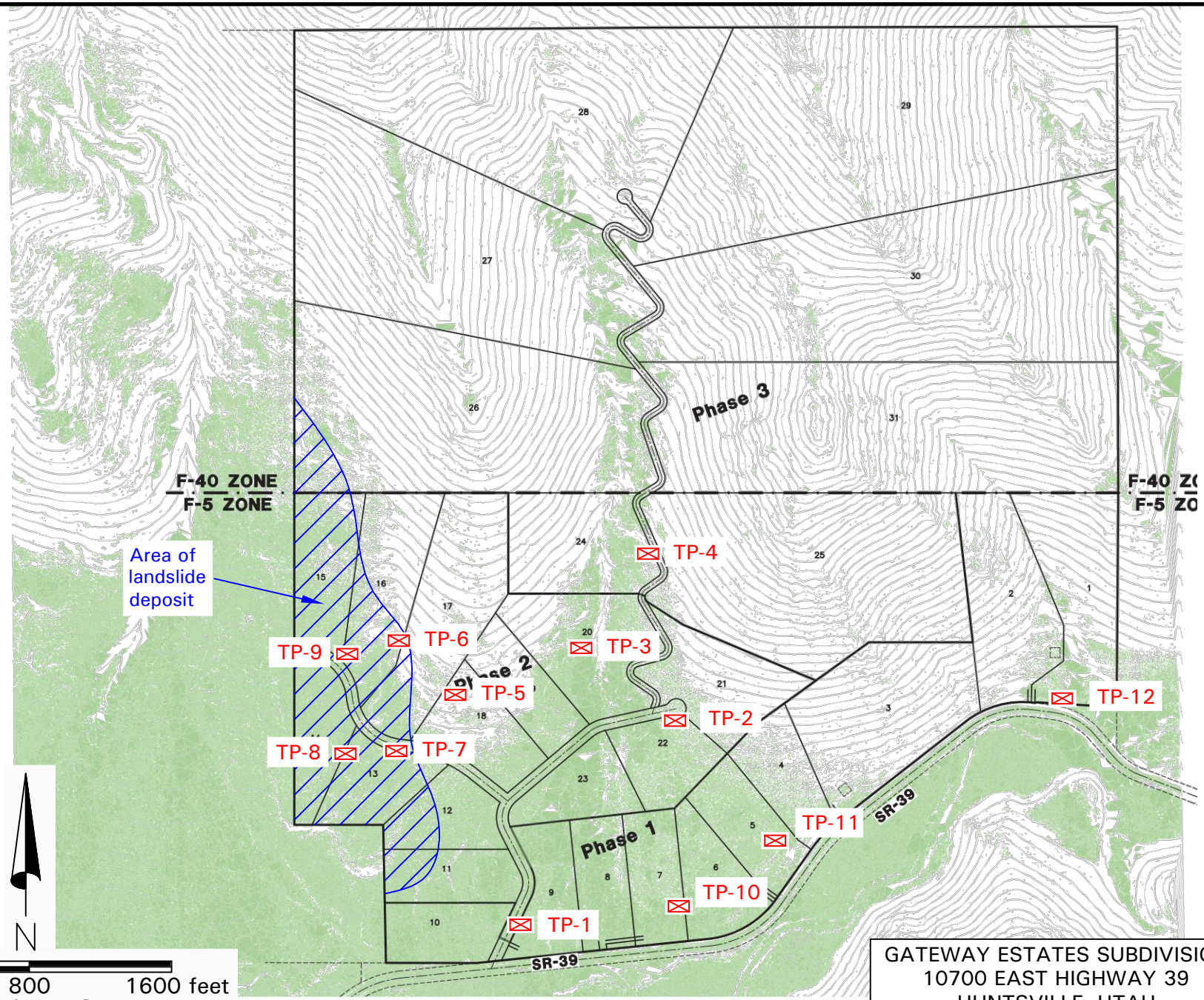
Reviewed by Jay R. McQuivey, P.E.

DRH/rs

REFERENCES

International Code Council, 2017; 2018 International Building Code, Falls Church, Virginia.

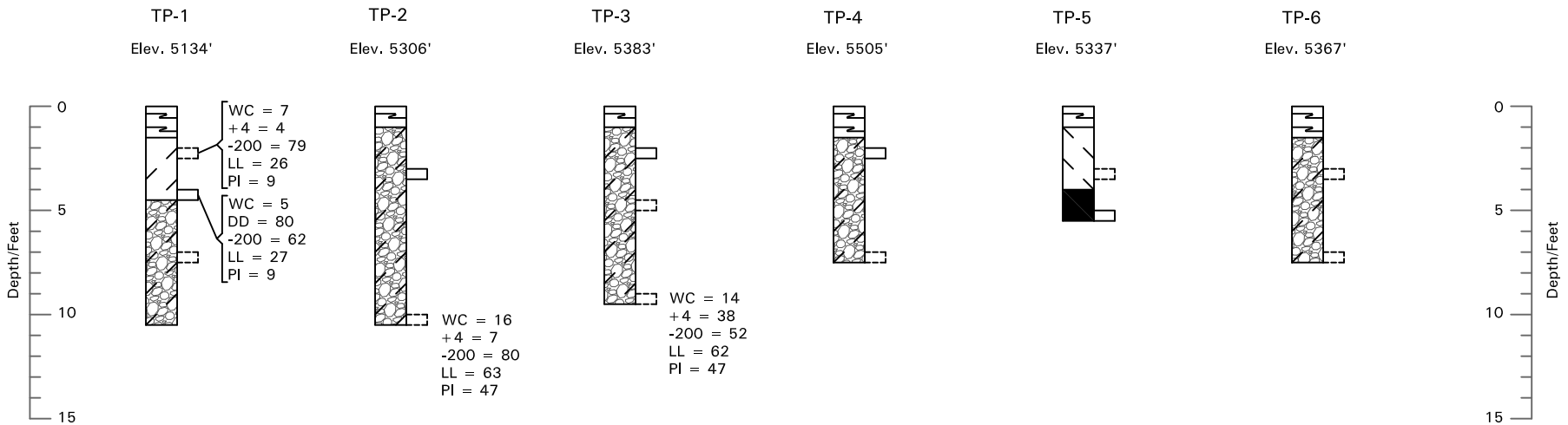
Utah Geological Survey, 2021; Utah Quaternary Fault and Fold Database, http://geology.utah.gov/resources/data-databases/qfaults/ accessed March 1, 2021.



Base Map from Reeve and Associates.

GATEWAY ESTATES SUBDIVISION
10700 EAST HIGHWAY 39
HUNTSVILLE, UTAH

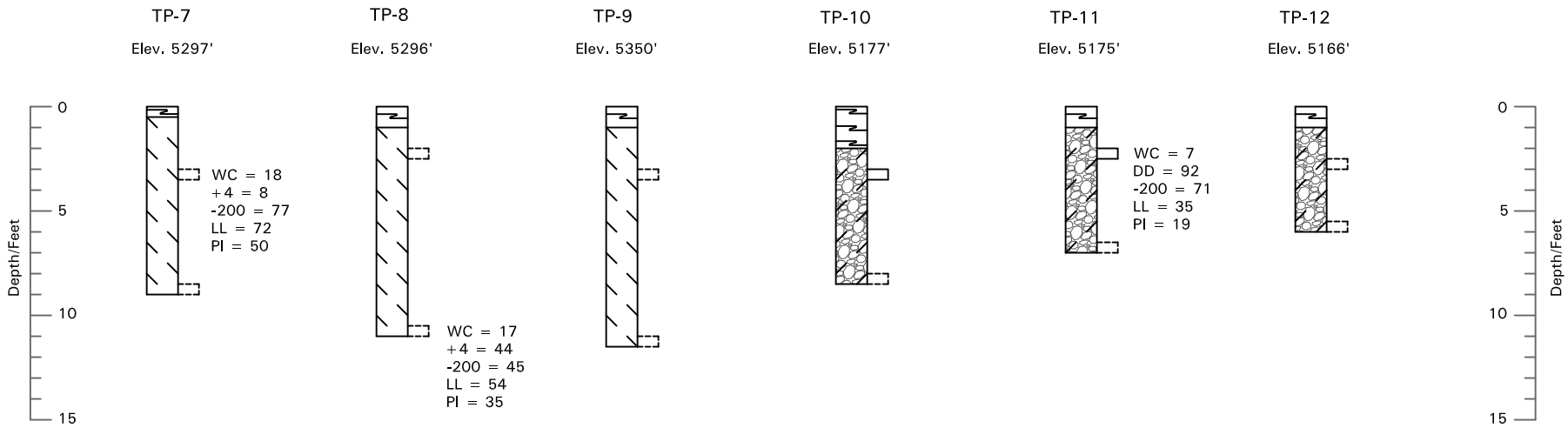
1210067	AGEC	Test Pit Locations	Figure 1



Approximate Vertical Scale 1" = 8'

See Figure 4 for Legend and Notes

1210067	AGEC	Test Pit Logs	Figure 2



Approximate Vertical Scale 1" = 8'

See Figure 4 for Legend and Notes

1210067	AGEC	Test Pit Logs	Figure 3

LEGEND:

Topsoil; sandy lean to fat clay with gravel and cobbles, moist, dark brown, organics.

Lean Clay with Sand (CL); some gravels and cobbles, very stiff, slightly moist, brown.

Fat Clay (CH); small to large amount of sand and gravel, some cobbles and boulders up to approximately 3 feet in size, very stiff, moist, brown.

Clayey Gravel with Sand (GC); cobbles, boulders up to approximately 4 feet in size, medium dense to dense, slightly moist, brown.

Quartzite Bedrock; highly weathered, clay infilled fractures, very hard, slightly moist, brown.

Indicates disturbed sample taken.

Indicates relatively undisturbed block sample taken.

NOTES:

1. The test pits were excavated on February 10, 11 and 16, 2021 with a tracked excavator.
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);
   +4 = Percent Retained on the No. 4 Sieve;
   -200 = Percent Passing the No. 200 Sieve;
   LL = Liquid Limit (%);
   PI = Plasticity Index (%).

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.

TABLE I
SUMMARY OF LABORATORY TEST RESULTS

PROJECT NUMBER: 1210067

SAMPLE LOCATION		NATURAL MOISTURE CONTENT (%)	NATURAL DRY DENSITY (PCF)	GRADATION		ATTERBERG LIMITS			CLAY FRACTION OF NO. 10 MATERIAL (%)	SAMPLE CLASSIFICATION
TEST PIT	DEPTH (FEET)			GRAVEL (%)	SAND (%)	SILT/ CLAY (%)	LIQUID LIMIT (%)	PLASTICITY INDEX		
TP-1	2	7		4	17	79	26	9	16	Lean Clay with Sand
	4	5	80			62	27	9		Sandy Lean Clay
TP-2	10	16		7	13	80	63	47	33	Fat Clay with Sand
TP-3	9	14		38	10	52	62	47	46	Gravelly Fat Clay
TP-7	3	18		8	15	77	72	50	41	Fat Clay with Sand
TP-8	10½	17		44	11	45	54	35	28	Clayey Gravel
TP-11	2	7	92			71	35	19		Lean Clay with Sand

Note that gravel samples are mostly from the clay matrix and thus the sample classification is not representative of the deposit.