AGEC

Applied GeoTech

GEOLOGIC-HAZARD AND GEOTECHNICAL STUDIES

PROPOSED RESIDENCE

1640 TOLIVER LANE

WEBER COUNTY, UTAH

PREPARED FOR:

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3866 W ELK VALLEY LANE
SOUTH JORDAN, UTAH 84009

PROJECT NO. 1200671

OCTOBER 8, 2020

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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 in all but Test Pit TP-2 where clayey gravel was encountered. Clayey gravel was encountered below the clay in Test Pits TP-1, TP-3 and TP-6 at depths of approximately 2½, 2 and 2 feet, respectively. Bedrock was encountered below the clay in Test Pits TP-4 and TP-5 at depths of approximately 4 and 3½ feet. Bedrock was encountered below the gravel in Test Pits TP-1, TP-2, TP-3 and TP-6 at depths of approximately 8, 6, 7 and 4 feet, respectively.

2. No subsurface water was encountered to the maximum depth investigated, approximately 12½ feet.

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3. The proposed residence may be supported on spread footings bearing on the undisturbed bedrock or on structural fill extending down to the undisturbed bedrock and may be designed for a net allowable bearing pressure of 3,500 pounds per square foot. The soil should be removed from below the proposed building area.

4. Surface fault rupture, tectonic subsidence, seismicity, landslide, liquefaction, debris flow, flooding, rockfall and snow avalanche are not potential hazards for the proposed building area. Seismic hazards will be mitigated through structural design.

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

SCOPE

This report presents the results of geologic-hazard and geotechnical studies for the proposed residence to be constructed at approximately 1640 Toliver Lane in Weber County, Utah. The report discusses geologic hazards, and presents the subsurface conditions encountered, laboratory test results and recommendations for foundations. The study was conducted in general accordance with our proposal dated September 8, 2020.

Aerial photographs, lidar data and geologic literature were reviewed, and a site reconnaissance performed to evaluate potential geologic hazards that may affect the proposed development of the site. Field exploration was conducted to obtain information on the subsurface conditions. Samples obtained from the field investigation were tested in the laboratory to determine physical and engineering characteristics of the on-site soil and bedrock. 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.

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

GEOLOGIC SETTING

Aerial photographs used in the geologic review were downloaded from the Utah Geological Survey website. Photograph Nos. AAJ-2B-28 and 29 with a date of August 10, 1946 and reported scale of 1 to 20,000 were used in our evaluation. Geologic maps reviewed for the study are by King and others (2008), Coogan and King (2000), Elliott and Harty (2010) and the Utah Fault and Fold database available at the Utah Geological Survey website.

The geology map for the area by King and others (2008) shows the site to be underlain by Norwood Tuff with colluvium and alluvium in the east drainage, and a mix of colluvial and landslide deposits for the rest of the property. A portion of the King and others (2008) map is presented on Figure 1. The Elliott and Harty (2010) landslide map does not show landslide deposits in the area of the property. The geology of the site based on site reconnaissance is presented on Figure 2.

SITE CONDITIONS

The building lot is currently undeveloped. The proposed building site is located on a ridge bordered on the east and west by drainages.

The ridge top is relatively flat at the south side of the property and slopes gently down to the north through the central and north portions of the property. The east flank of the ridge slopes down at approximately 2.5 horizontal to 1 vertical to the east drainage. The west flank of the ridge slopes down at approximately 1.8 horizontal to 1 vertical to the west drainage. The ground west of the west drainage slopes up to Toliver Lane at approximately 3.8 horizontal to 1 vertical. The slope of the ground east of the east drainage is up from the drainage at approximately 2.5 horizontal to 1 vertical.

Vegetation west of the west drainage consists of grass, brush and patches of trees. Much of the rest of the property is tree covered.

Toliver Lane is a gravel-surfaced road along the west edge of the property. There is undeveloped land on the surrounding properties.

FIELD STUDY

The field study was conducted on September 15, 2020. Six test pits were excavated with a tracked excavator at the approximate locations indicated on Figure 2. The test pits were logged and samples obtained by an engineer from AGEC. Logs of the test pits are presented on Figure 3 with legend and notes on Figure 4.

The test pits were backfilled without significant compaction. The backfill should be removed and replaced with compacted fill where it will be below proposed buildings, pavement, slabs or other settlement-sensitive features.

SUBSURFACE CONDITIONS

The subsurface materials encountered at the site consist of approximately ½ to 1½ feet of topsoil overlying clay in all but Test Pit TP-2 where clayey gravel was encountered. Clayey gravel was encountered below the clay in Test Pits TP-1, TP-3 and TP-6 at depths of approximately 2½, 2 and 2 feet, respectively. Bedrock was encountered below the clay in Test Pits TP-4 and TP-5 at depths of approximately 4 and 3½ feet. Bedrock was encountered below the gravel in Test Pits TP-1, TP-2, TP-3 and TP-6 at depths of approximately 8, 6, 7 and 4 feet, respectively.

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. It is slightly moist, dark brown and contains organics.

Fat Clay - The clay contains a small to large amount of sand and gravel. It is very stiff to hard, slightly moist to moist and brown to dark brown.

Laboratory tests performed on samples of the clay indicate it has natural moisture contents of 17 to 20 percent and a natural dry density of 103 pounds per cubic foot. Results of a direct shear test on a sample of clay remolded at a moisture content of 22 percent to a dry density of 103 pounds per cubic foot are presented on Figure 5.

Tuffaceous Claystone and Siltstone Bedrock - The bedrock is medium hard to hard, slightly moist and brown to grayish brown.

Results of the laboratory tests are presented on Table I and included on the test pit logs.

SUBSURFACE WATER

No subsurface water was encountered to the maximum depth investigated, approximately 12½ feet.

PROPOSED CONSTRUCTION

A single-family residence is planned for the site. The building will be a one to two-story, structure with potential for a walk-out basement and a sport court below the north end of the house. We have assumed building loads to consist of wall loads up to 3 kips per lineal foot and column loads up to 50 kips.

No grading plan was provided for our review. We understand that site grading will consist of removing the top of the ridge south of the proposed house and some cutting and filling from Toliver Lane to the house to provide access to the house. Some grading fill may be placed east of the house.

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

GEOLOGIC HAZARDS

Geologic hazards considered for this study are surface fault rupture, tectonic subsidence, seismicity, landslide, liquefaction, debris flow, flooding, rockfall and snow avalanche.

A. Surface fault rupture, tectonic subsidence and seismicity

The Utah fault and fold database shows no active faults extending near or through the site. The closest mapped surface trace of a Quaternary fault is the Ogden Valley Southwest margin fault located approximately 1.1 miles to the west. This fault is not considered to be active enough to be of concern. The Wasatch fault is the closest fault zone considered active and is approximately 6.7 miles to the west. Surface fault rupture and tectonic subsidence are not considered hazards at the site.

The property is located in the Intermountain seismic zone, which consists of an area of relatively high historical seismic activity. This seismic hazard is mitigated through structural design of the building and is discussed later in the report.

B. Landslide

Landslide deposits have been mapped for the area by King and others (2008) and by Coogan and King (2016). These maps show landslide deposits throughout most of the site. Based on aerial photograph and lidar review, there is geomorphic evidence of landslide deposits east of the east drainage. This portion of the property is not planned for development. No evidence of landslide deposits were found for the portion of the property west of the east drainage.

Test pits encountered 3½ to 8 feet of clay and gravel overlying predominantly siltstone bedrock, which is considered to be relatively stable for planned slopes at the site. The upper clay can be a concern for slope stability if placed with too steep of slopes. Recommendations for site grading are provided later in this report to provide relatively stable slope configurations.

It is our professional opinion that landslide is not a hazard for the area proposed for development if recommendations given for site grading are followed.

C. Liquefaction

The subsurface conditions at the site consist of soil with a high clay content overlying siltstone and claystone bedrock. These materials are not considered susceptible to liquefaction and thus liquefaction is not a potential hazard at the site.

D. Debris Flow and Flooding

The drainages at the site drain too small of an area and have a low enough gradient that debris flow would not develop in the drainages. The house is planned to be placed on a ridge above the drainages and thus flooding is not considered a potential hazard for the residence.

E. Rockfall

There are no sources of rock to result in rockfall events on this property.

F. Snow Avalanche

The site is not located in a known avalanche hazard zone. There are no potential sources for snow avalanche near the site.

SLOPE STABILITY EVALUATION

A slope stability evaluation was performed for proposed fill slopes. Stability is not a concern for the residence since it will be supported on siltstone bedrock. The strength selected for the site grading fill is based on the results of the direct shear test performed. A slope height of 25 feet was assumed in the analysis with a cohesion of 900 pounds per square foot for the end-of-construction condition and a friction angle of 23 degrees for the drained, long-term condition. A safety factor of at least 1.5 is attained for a slope of 3.5 horizontal to 1 vertical under static conditions and 1.0 under the seismic condition. The seismic condition is based on a peak ground acceleration of 0.46g representing a seismic event with a 2 percent probability of occurrence in 50 years and assuming an allowable deformation on the order of 9 inches.

RECOMMENDATIONS

A. Site Grading

1. Subgrade Preparation

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

2. Cut and Fill Slopes

   Temporary unretained excavation slopes may be constructed at 1 horizontal to 1 vertical or flatter. Permanent, unretained cut in soil and fill slopes consisting of the clay or clayey gravel may be constructed at a slope of 3.5 horizontal to 1 vertical or flatter. Steeper slopes may be considered on an individual basis, but would likely require the use of select fill for fill slopes, such as the broken down siltstone or imported sand and gravel. Permanent,

unretained cut slopes in bedrock may be constructed at a slope of 2 horizontal to 1 vertical or flatter.

Fill placed on slopes steeper than 5 horizontal to 1 vertical should be benched into the slope with a bench for every 4 feet of vertical rise. Fill should be placed in relatively horizontal lifts.

Good surface drainage should be provided up slope of cut and fill slopes to direct surface runoff away from the face of the slopes. The slopes should be protected from erosion by revegetation or other methods.

3. Excavation

We anticipate that excavation at the site can be accomplished with heavy-duty excavation equipment. Significant difficulty can be expected for confined excavations in the bedrock. Care should be taken not to disturb the bedrock to remain below the proposed building area.

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 areas of the proposed building should consist of granular soil as indicated above. The clay and bedrock are not recommended for use as fill below the proposed building area. The clay and bedrock could be considered for use as general site grading fill and as retaining wall and utility trench backfill outside the proposed building area if the organics, debris and other deleterious materials are removed and the bedrock is broken down to a suitable size for compaction.

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
Foundations	≥ 95%
Concrete Slabs	≥ 90%
Landscaping	≥ 85%
Retaining Wall Backfill	85 - 90%

The moisture of the soil should be adjusted to within 2 percent of optimum to facilitate compaction.

Each lift of fill placed for the project should be tested for compaction. Fill should be placed in thin enough lifts to allow for proper compaction.

6. Drainage

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

B. Foundations

1. Bearing Material

The proposed residence may be supported on spread footings bearing on the undisturbed bedrock or on compacted structural fill that extends down to the undisturbed bedrock. Structural fill placed below footings should extend out away from the edge of footings at least a distance equal to the depth of fill below footings.

The soil should be removed from below proposed foundation areas.

2. Bearing Pressure

Spread footings bearing on the undisturbed bedrock or on compacted structural fill may be designed for a net allowable bearing pressure of 3,500 pounds per square foot.

3. Settlement

We estimate that total and differential settlement will be less than ½ inch for footings designed as indicated above.

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. Minimum Footing Width and Embedment

Spread footings should have a minimum width of 1½ feet and a minimum depth of embedment of 10 inches.

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. The subgrade should not be scarified prior to structural fill 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 bedrock or on compacted structural fill that extends down to the undisturbed bedrock.

The soil should be removed from below the 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 bedrock or on compacted structural fill is controlled by sliding resistance between the footing and foundation

soils. A friction value of 0.45 may be used in design for ultimate lateral resistance.

2. Subgrade Walls and Retaining Structures

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

3. Seismic Conditions

Under seismic conditions, the equivalent fluid weight should be increased by 28 pcf and 13 pcf for active and at-rest conditions, respectively, and decreased by 28 pcf for the passive condition. This assumes a peak horizontal ground acceleration of 0.46g 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

Listed below is a summary of the site parameters for the 2018 International Building Code.

Description	Value[1]
Site Class	Default D[2]
S_s - MCE_R ground motion (period = 0.2s)	0.85g
S_1 - MCE_R ground motion (period = 1.0s)	0.30g
F_a - Site amplification factor at 0.2s	1.2
F_v - Site amplification factor at 1.0s	2.0
PGA - MCE_G peak ground acceleration	0.38g
PGA_M - Site modified peak ground acceleration	0.46g

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

[2]Site Class Default D is given based on the subsurface conditions encountered. Measurement of the shear wave velocity of the upper 100' of the subsurface may allow the use of Site Class C if the average velocity is high enough.

F. Water Soluble Sulfates

Based on testing of the soil and bedrock in the area, the natural soil and bedrock are expected possess a negligible sulfate attack potential on concrete. No special cement type is required for concrete placed in contact with the natural soil or bedrock. Other conditions may dictate the type of cement to be used in concrete for the project.

G. Subsurface Drain

We recommend that a subsurface drain be provided for the below-grade floor portion of the residence. 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 residence. A geosynthetic drain could be used as an alternative. The drain should extend up the foundation walls high enough (to within approximately 3 feet of the ground surface) to intercept potential subsurface water.

b. At least 6 inches of free-draining gravel should be placed below the floor slab of the residence. The gravel should connect the perimeter drainage pipe.

c. 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.

d. 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 1:1 (horizontal to vertical).

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

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

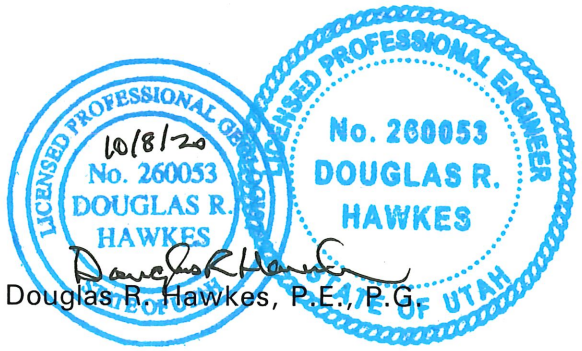
H. Preconstruction Meeting

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 geologic and geotechnical 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 and the data obtained from laboratory testing. Variations in the subsurface conditions may not become evident until additional exploration or excavation is conducted. If the 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/bw

REFERENCES

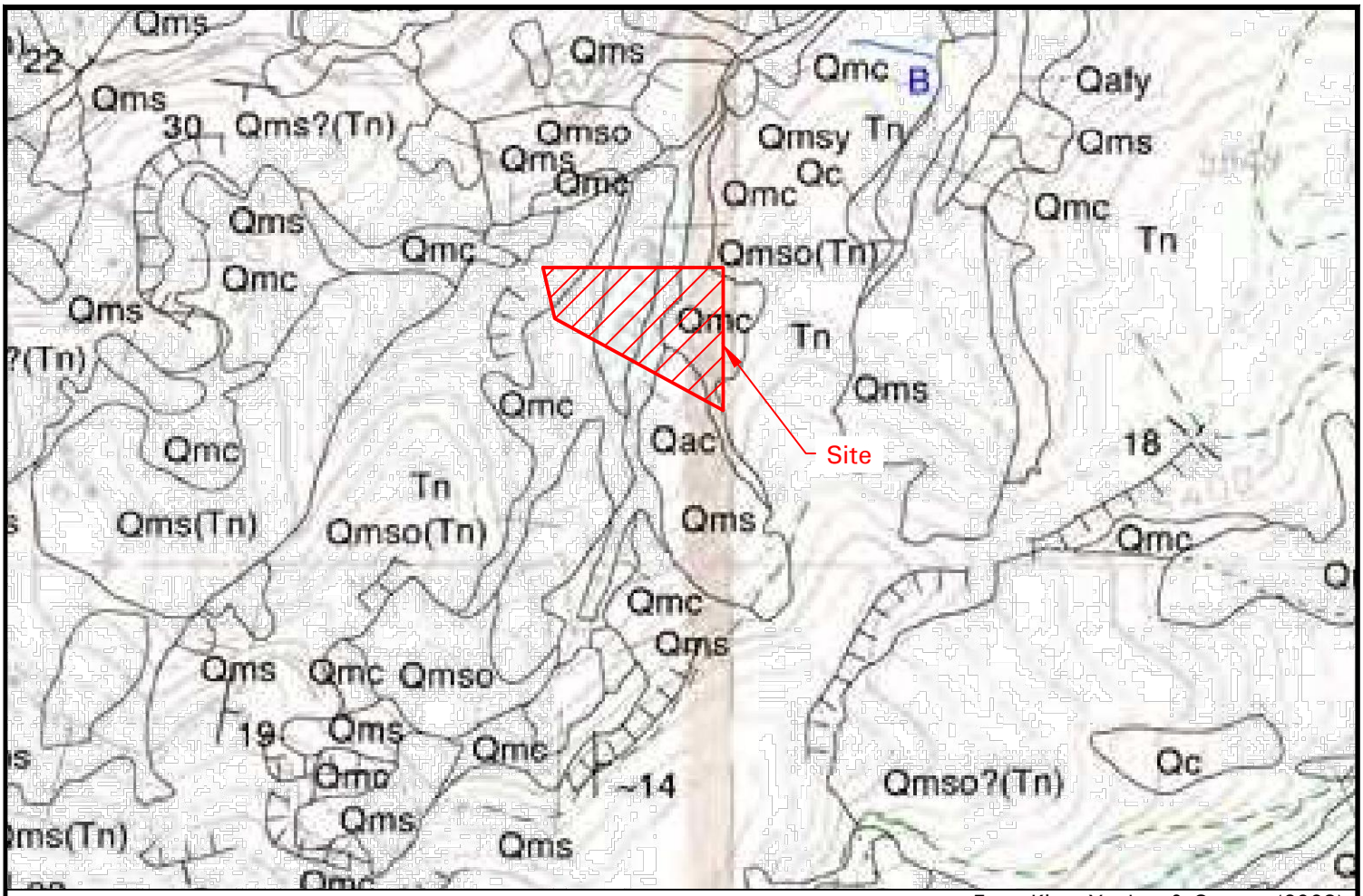
Coogan, J.C. and King, J.K.,2000; Progress report geologic map of the Ogden 30' X 60' quadrangle, Utah and Wyoming, Utah Geological Survey Open-file Map 380.

Elliott, A.H. and Harty, K.M., 2010; Landslide maps of Utah, Ogden 30' X 60' quadrangle, Utah Geological Survey Map 246DM, Plate 6.

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

King, J.K., Yonkee, W.A. and Coogan, J.C., 2008; Interim geologic map of the Snow Basin quadrangle and part of the Huntsville quadrangle, Davis, Morgan and Weber Counties, Utah, Utah Geological Survey Open-file Report 536.

Utah Geological Survey, 2020; Utah fault and fold database accessed on September 29, 2020 at geology.utah.gov/resources/data-databases/qfaults/.



From King, Yonkee & Coogan (2008)

EXPLANATION OF SYMBOLS AND GEOLOGIC UNITS IN AREA OF PROPOSED DEVELOPMENT

Qac	-	Quartenary alluvium and colluvium.
Qmc	-	Quartenary landslide and colluvial deposits.
Qms	-	Quartenary landslide deposits.
Qmso (Tn)	-	Quartenary landslide deposits and Tertiary Norwood Tuff.
Tn	-	Tertiary Norwood Tuff.
———		Geologic contact between units, dashed where approximate.

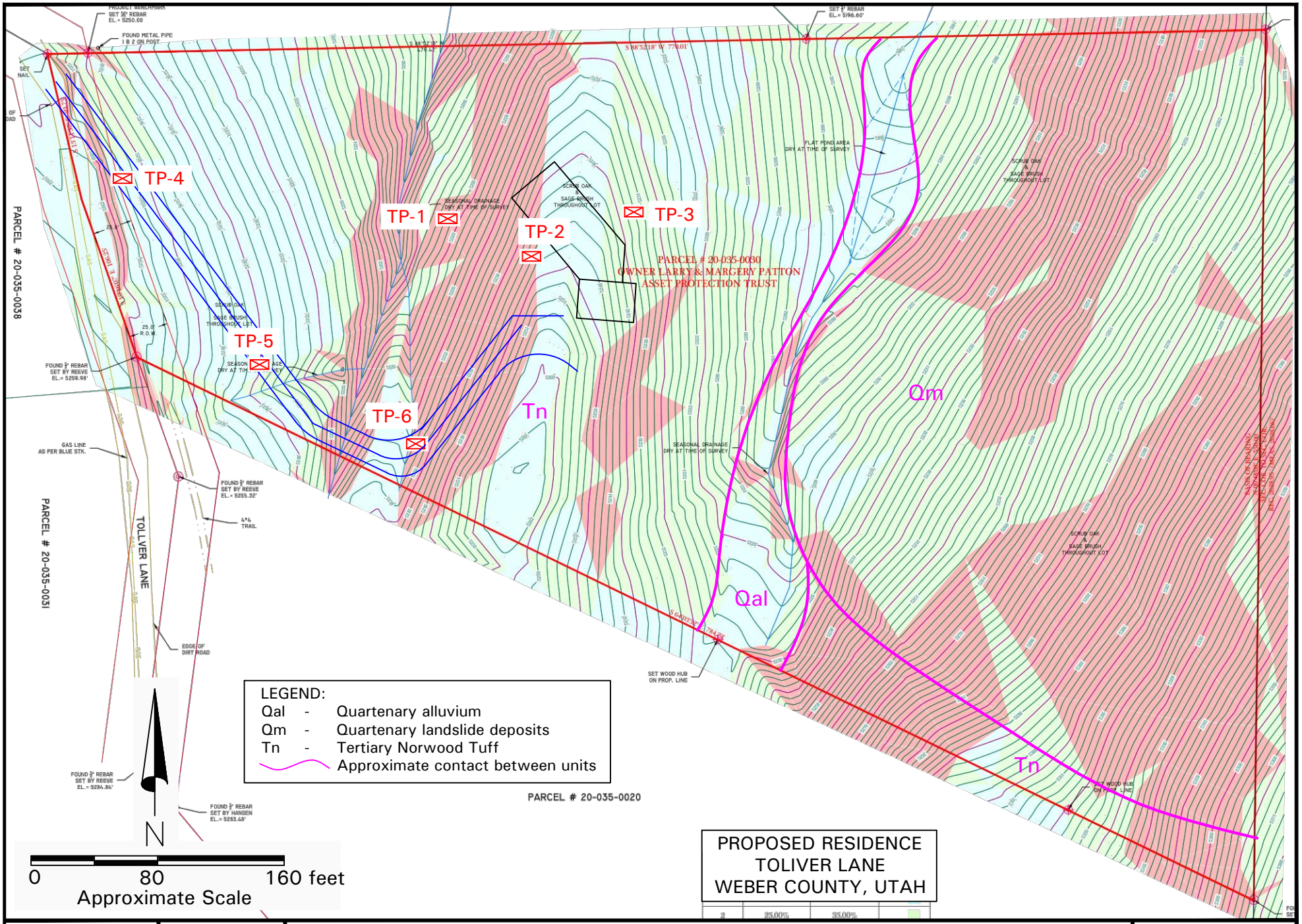
N

0 750 1500 feet

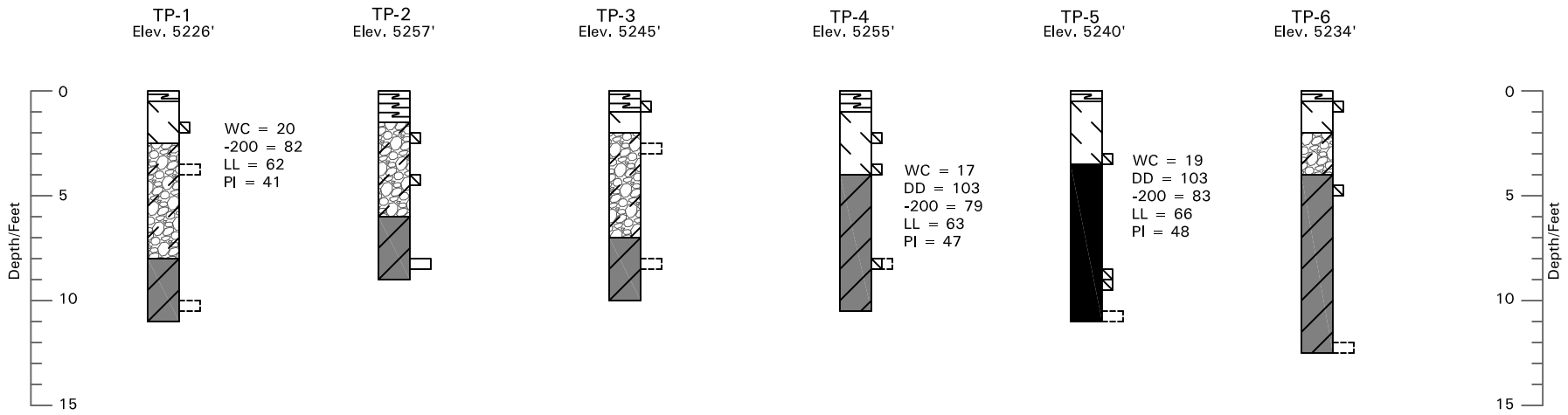
Approximate Scale

PROPOSED RESIDENCE
TOLIVER LANE
WEBER COUNTY, UTAH

1200671	AGEC	Regional Geology Map	Figure 1



1200671	AGEC	Test Pit Locations and Site Geology	Figure 2



Approximate Vertical Scale 1" = 8'

See Figure 4 for Legend and Notes

1200671	AGEC	Test Pit Logs	Figure 3

LEGEND:

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

Fat Clay (CH); small to large amount of sand and gravel, very stiff to hard, slightly moist to moist, brown to dark brown.

Clayey Gravel with Sand (GC); cobbles and boulders up to approximately 1½ feet in size, medium dense, slightly moist to moist, brown.

Tuffaceous Claystone; medium hard, slightly moist, brown.

Tuffaceous Siltstone; medium hard to hard, slightly moist, brown to grayish brown.

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 September 15, 2020 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);
   -200 = Percent Passing the No. 200 Sieve;
   LL = Liquid Limit (%);
   PI = Plasticity Index (%).

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TABLE I

SUMMARY OF LABORATORY TEST RESULTS

PROJECT NUMBER: 1200671

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	1½	20				82	62	41			Fat Clay with Sand
TP-4	3½	17	103			79	63	47			Fat Clay with Sand
TP-5	3	19	103			83	66	48			Fat Clay with Sand