REPORT
GEOLOGICAL STUDY
LOT 42R SUMMIT AT SKI LAKES NO.11
6763 EAST VIA CORTINA STREET
HUNTSVILLE, UTAH

Submitted To:

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Submitted By:

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Job No. 2206-01N-16

October 14, 2016
Job No. 2206-01N-16

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Attn: Mr. Wagstaff

Geological Study
Single-Family Home Development Lot
Lot 42R Summit at Ski Lake No. 11
6763 East Via Cortina
Huntsville, Weber County, Utah

1. INTODUCTION

In response to your request, GSH Geotechnical, Inc (GSH) has prepared this Geological Study for proposed residential lot referenced above. The single-family home development lot located at 6763 East Via Cortina, is a property of approximately 1.3 acres in area. The general location of the property is in the "Ski Lake" area of Huntsville in Weber County, Utah. The site location relative topographic and improved features as of 1998 is shown on Figure 1, Vicinity Map.

The general Summit at Ski Lake development area is located on the south side of Utah SR-39 between MP-16.6 and -17.4, and entirely within Section 24, T6N-R1E SLBM. The Summit at Ski Lake Phase 11 consists of four residential development lots roughly one-acre or greater in area, comprising a total area of approximately 5.7 acres as shown on Figure 1. Previous phases of the Summit at Ski Lake development are established to the north and generally down slope of the Phase 11 parcel. The Via Cortina access roadway loops around the lot 42 as shown on Figure 2, Aerial Coverage, thus allowing frontage on either the north or south sides of the property. Elevation rises approximately 105 feet from the north side of the lot to the south side of the lot.

It is our understanding that construction of a single-family home is planned for the subject property. Although design has not been finalized for this project, we expect the proposed structure to consist of reinforced concrete footings and basement foundation walls supporting 1 to 3 wood-framed levels above grade with some stone, brick, or stucco veneer, with maximum column and wall loads projected to be on the order of 10 to 20 kips and 1 to 3 kips per lineal foot, respectively. Aerial coverage of the site location is provided on Figure 2.

1.1 Weber County Natural Hazards Overlay Districts

Because the site is located on a sloping hill side area with slopes in the vicinity of the site identified as having "Landslide Potential" (Elliott and Harty, 2010), and "Expansive Soils" (Mulvey, 1992), Weber County (Planning Commission) is requesting that geotechnical andgeological studies be conducted to evaluate conformance of the proposed site development with the provisions included in the Weber County Code, Chapter 27, Natural Hazards Overlay District (Weber County, 2016). These hazards include, but are not limited to*: Surface-Fault Rupture, Landslide, Tectonic Subsidence, Rock Fall, Debris Flows, Liquefaction Areas, Flood, or other Hazardous Areas.*

To evaluate the proposed site development in compliance with the Weber County Nautural Hazards Overlay District requirements, GSH prepared a July 11, 2016 Work Plan to address the Natural Hazards Overlay District provisions. Our proposed work plan actions for the geological and geotechnical studies were as follows:

1) Work Plan and scope of work development and plan implementation;
2) A search and review of previous relevant documentation of site engineering and geologic studies and including UGS mapping (King, et al., 2008); and reports and studies prepared by others;
3) A field reconnaissance study including the geologic logging of a walk-in trench approximately 75 to 150 feet in length and as much as 12 feet in depth, two short walk-in test pits to a depth of up to 18 feet, and one geotechnical boring to penetrate as deep as 30 to 50 feet, at locations shown on Figure 2, Site Plan;
4) Development of a geological cross section to be used for geotechnical engineering slope stability analysis;
5) Site specific geological mapping and classification to identify critical geological units and exposure to proposed site improvements;
6) Slope analysis from LiDAR DEM geoprocessing identifying critical areas 30-percent or greater across the site and/or surficial features potentially affecting the proposed site improvements;
7) A laboratory geotechnical soils testing program of samples recovered from the test pits, trenches and borings for typical and critical geological units explored and identified in our subsurface evaluation. Laboratory testing program to include but not be limited to the moisture, density, gradation, Atterberg limits, consolidation, vane shear, and direct shear tests of representative soil samples; and
8) Preparation of summary report presenting results of our analysis and findings including:

- *A vicinity map showing the location of the property relative to site vicinity and topographic features.*
- *A geologic map showing the site specific surficial geology of the property and surrounding area.*
- *Aerial photography showing the site and nearby surficial geologic features.*
- *An assessment of potential geologic hazards in the vicinity of the site and the exposure of the site and proposed site improvements to hazards named in the*

ordinance including but not limited to: landsliding and recommendations for site specific slope stability analysis; surface fault rupture; alluvial fan processes including debris-flow; surface fault rupture hazards, strong earthquake ground motion, and liquefaction hazards; rockfall and avalanche hazards, flood hazards, and

- *Cross-sections of slopes depicting encountered geological conditions.*
- *Site development recommendations based upon our findings and professional experience.*
- *Following completion of the geologic study, a geotechnical study will be prepared for the subject property based on the findings of the geologic study and concurrent/subsequent geotechnical evaluations.*

2. INVESTIGATIONS

2.1 Literature Review

During the Work Plan development, existing previous reports and geological literature sources were reviewed. Specific to the site and immediate surrounding area, reports and mapping by KPS and Associates, Inc., 2001; King, et al., 2008; Applied GeoTech, 2013; and GSH Geotechnical Inc., 2015, 2016a and 2016b: and Coogan and King 2016 were reviewed. The KPS and Associates study involved a geotechnical evaluation and test pit excavations for a water tank constructed approximately 650 feet west of the Lot 42 site. The King, et al , 2008 document is an Open-file UGS geological mapping project of the Snow Basin and Huntsville, Utah quadrangles, which includes the location of the Lot 42 site. The 2013 Applied GeoTech study was a geotechnical evaluation conducted for surrounding Phases 12 and 13 of the Ski Lake development that included four test pit explorations. The 2015 GSH Geotechnical, Inc. study was a geological investigation conducted for the extension of the Via Cortina roadway, beginning approximately 200 feet west of the site. The 2015 GSH study included the geological logging of approximately 700 feet of vertical cut exposure made for the roadway extension, and four "walk-in" test pits. The 2016a GSH study included the geological and geotechnical study of the Lot 43, of the Summit at Ski Lake Phase 11, on the east side of Lot 42 Site, that included two exploration trenches and four test pit excavations. The 2016b GSH Study included the geological and geotechnical study of the Phase 13, of the Ski Lake development, on the west side of Lot 42 Site, that included five exploration trenches, four test pit excavations, and two geotechnical borings. The Coogan and King (2016) mapping is a reduced scale, 1:100,000 scale, UGS published mapping document that includes the Snow Basin and Huntsville, Utah quadrangles. Site specific geological mapping overlays developed from this review are included on Figure 3, Site Geology.

2.2 Field Program

GSH conducted field operations at the site on the dates July 13 and 28, 2016. The field program involved the drilling of one geotechnical boring, and the excavation and geological logging of one exploration trench and two test pits. The boring and excavations were logged to record and characterize subsurface/geologic and groundwater conditions for the site and the proposed residence construction. Trench 1 was located to evaluate the conditions beneath the proposed residence structure location, and the test pits and Boring 1 were located to observe conditions within the building lot, but away from the structure location. The locations of our trench, test pits, and boring are included on Figure 4, Site Evaluation. Trench 1 was 172.0 feet in length and extended to depths of 5.0 to 10.0 feet. The test pits consisted of walk-in excavations, 22.0 to 25.0 feet in length and extending to depths of 6.0 to 13.0 feet. The trenches and test pits were logged so as to illustrate the vertical and lateral characteristics and variations of soil and rock conditions underlying the proposed residence and across the site. The trenches and test pits were excavated using a 20-ton class excavator with a 36-inch bucket. In addition to the observations in the trenches and test pits, the general surface of the site and surrounding area was reconnoitered to assess geological and slope conditions, and feature location and elevation data were recorded using a hand-held GPS receiver device.

Our field program was conducted by Dr. Greg Schlenker PG of our geotechnical staff and Mr. Jed McFarlane, also of our geotechnical staff, visited the site to assist Dr. Schlenker, and to supervise the geotechnical drilling for the site.

The soils and geology in the test pits were classified and logged in the field based upon visual and textural examination, and interpretation of geologic site formation processes. These classifications have been supplemented by subsequent inspection and testing in our laboratory. Detailed graphical representations of the subsurface conditions encountered are presented on Figure 5 and Figure 6, Log of Trench 1, and Figure 7, Log of Test Pit 1 and Test Pit 2. The soil and rock units shown on the logs were classified according to Unified Soil Classification System (USCS), and were further classified on the basis of geological site formation processes.

Bulk and thin wall samples of representative soil layers encountered in the test pits were obtained and placed in sealable bags and/or were recovered undisturbed using driven sample tubes. The locations of the sample recovery locations are included on our trench and test pit logs. The results of our laboratory analysis and testing of the soils recovered from the test pits will be included in our concurrent geotechnical reports. Groundwater was not observed in any of the excavations or test pits during the dates of our field program.

The log of Boring 1 is shown on Figures 8, 9 and 10. The boring was completed using a CME 55 truck-mounted drill rig using hollow-stem auger methods. Soil and rock samples were recovered at 2.5-foot intervals using driven 2.42-inch inside diameter drive Dames & Moore sampler. The boring was also logged in accordance with the Unified Soil Classification System (USCS).

2.3 LiDAR - Slope Analysis

To asses slope conditions, interpret terrain, and develop site specific geologic cross section for the site, a LiDAR - Slope Analysis was performed for the site. Elevation data consisting of 2.0 meter LiDAR digital elevation data (DEM), for the site was obtained from Utah Automated Geographic Reference Center (AGRC). These data were geo-processed using the QGIS® GIS platform, and using the r.slope, r.shaded.relief and r.contour.level GRASS® (Geographic Resources Analysis Support System) modules, slope percentages, relief renderings and elevation contours for the site area were processed.

Figure 11, LiDAR Analysis, presents the results of our slope analysis efforts. Shown on Figure 11 is the 25-percent, and greater than 30-percent slope gradients in the vicinity of the site. The shaded relief rendering on Figure 11 provides a visual basis for landform interpretation, and the contour elevation data shown on Figure 11 is used to develop the cross section shown on Figure 12, Slope Cross Section *A-A'*. The critical gradient for slope development considerations according to the Weber County Section 108-14-3 (Weber County Code, 2015), includes slopes greater that 25-percent. The Geologic Slope Cross Section shown on Figure 12 will be used for slope stability analysis in our geotechnical reporting.

3. SITE CONDITIONS

The site conditions and site geology were interpreted through an integrated compilation of data including a review of literature and mapping from previous studies conducted in the area (Sorensen and Crittenden, 1979; Currey and Oviatt, 1985; Bryant, 1988; King et al., 2008; and Coogan and King, 2016) including a review of earlier evaluations discussed previously in the Literature Review Section of this report, photogeologic analyses of 2014 and 2012 imagery shown on Figure 2 and Figure 4, and historical stereoscopic imagery flown in 1946, GIS analyses of elevation and geoprocessed LiDAR terrain data as discussed in the previous section (LiDAR-Slope Analysis) and shown on Figure 11, field reconnaissance of the general site area, and the interpretation of the trench and test pits excavated on the site as part of our field program. Seismic hazards information was developed from United States Geologic Survey (USGS) databases (Peterson, et al., 2008).

3.1 Geologic Setting

The site is located on the eastern flank of Mount Ogden, which western flank comprises the Wasatch Front. The Wasatch Front is marked by the Wasatch fault, which is 7.0 miles west of the site, and provides the basis of division between the Middle Rocky Mountain Physiographic on the east and the Basin and Range Physiographic Province on the west. The Basin and Range Physiographic Province is characterized by approximately north-south trending valleys and mountain ranges that have been formed by extensional tectonics and displacement along normal faults, and extends from the Wasatch Range on the east to the Sierra Nevada Range on the west (Hunt, 1967).

The Middle Rocky Mountain province covers parts of Utah, Colorado, Wyoming, Idaho, and Montana. The geology of the province is an assemblage of sedimentary, igneous, and metamorphic rocks that have been folded, faulted, and uplifted. Mountain building (tectonic) activity commenced about 30 million years ago (Cretaceous time) and continues to the present. The province is characterized by mountainous terrain with deep canyons and broad intervening basins, with temperate semi-arid to mesic climatic conditions (Hunt, 1967).

The surficial geology of the site vicinity is the result of the uplift and exposure of older pre-Cambrian rocks which forms the crest of Mount Ogden east of the site. This exposure was the result of movement along high-angle faults during late Tertiary and Quaternary age (Bryant, 1988).

Bounding the east foothill flank of Mount Ogden are mid Tertiary units of the Norwood Formation that ramp along the base of the mountains south and west of the Ogden Valley floor. The Norwood Formation is described as "light-gray to light brown, altered tuff (claystone), tuffaceous siltstone, sandstone, and conglomerate" derived from volcanic ash deposition (King, et al., 2008), and has been measured to be as much as 7000 feet thick in the vicinity of the site. The claystone, siltstone and sandstone occurrences of the formation are primarily a result of lacustrine (lake processes) redeposition of the volcanic ash. The site location is largely underlain by Norwood Formation lacustrine rock units which beds appear to slope gently down to the northeast across the site (King et. al, 2008). The existing surface of the site and vicinity appears to have been modified by Quaternary age erosion, and localized late-Quaternary stream, lacustrine (Currey and Oviatt, 1985), residual soil weathering and development, and mass movement processes (King, et al., 2008).

3.2 Surface Conditions

Surface vegetation consists of open areas of grasses, weeds and sage brush with clustered wooded areas of scrub oak, alder and maple tree cover. The topography of the site consists of a north facing hillslope with slopes on the property generally facing downward toward the north toward Ogden Valley.

Topographically the site is located on base foothills on the northeast side of Mount Ogden, and overlooks Ogden Valley and the South Fork of the Ogden River floodplain, which is inundated by Pineview Reservoir waters, to the north of the site. The site, as shown on Figure 2 is bordered on the north, east and west by vacant undeveloped properties, and on the south by the Via Cortina roadway and open space land uses.

3.3 Subsurface Conditions

The natural rock and soils observed in the trenches, test pits and boring and illustrated on Figures 5, 6, 7, 8, 9 and 10, generally consisted, from surface to depth of the following sequence:

On the surface the soils consisted of dark brown, medium stiff, dry, clayey silt (ML) top soil sequences roughly 1.0 feet in thickness. Beneath the top soil, brown, very stiff, slightly moist, clays (CL) with a trace of sand, with vertical cracks, consisting of soil B-horizon vertisol sequences, extending as much as 3.0 to 6.0 feet in depth were observed. Below the vertisol sequences the soils in the test pits consisted of very stiff light brown clays (CL) interpreted to be residual -weathered exposures of Norwood Formation Tuff (King, 2008). In Test Pit 2, the materials encountered below the vertisol sequences consisted of claystone (CS) and sandstone (SS) rock layers, slightly to moderately weathered, moderately soft to hard, laminated to moderately bedded exposures of Norwood Formation rock. The soils in Boring 1 consisted of stiff silty clays (CL) with a trace sand, becoming hard below about 10.0 feet. Very dense silty sand (SM) was encountered from 22.0 feet to the 50.0 foot depth of the boring.

Groundwater was not observed in any of the excavations or borings during our field program.

3.4 Site Engineering Geology

Figure 3, Site Geology shows the location of the site relative to GIS overlays including geological mapping prepared by King et al. (2008). A summary of the geological mapping of the Site vicinity is provided as follows:

The **Qmc** deposits are landslide and slump, and colluvial deposits, undivided Holocene and Pleistocene in age (0 to 30,000 ybp -years before present), consisting of poorly sorted to unsorted clay- to boulder-sized material. These mapped units include smaller landslide slopes and slopes comprised of slopewash and soil-creep deposits.

The **Qms**, **Qmsy** and **Qmso?** deposits include landslide and colluvial deposits associated with failed or moving slopes, Holocene and Pleistocene in age (0 to 30,000 ybp), consisting of poorly sorted to unsorted clay- to boulder-sized material. These units include slides, slumps, and locally flows and floods. **Qmso?** deposits are likely Pleistocene in age (>30,000), and were emplaced before Lake Bonneville transgression 15,000 ybp (Currey and Oviatt, 1985). The **Qmsy** deposits are believed to be Holocene in age, having moved since the regression of Lake Bonneville 14,000 ybp (Currey and Oviatt, 1985).

Shorelines attributed to levels of ancient Lake Bonneville which inundated parts of Ogden Valley 15,000 to 19,000 years ago, are shown on Figure 3. The shorelines are useful benchmarks for determining the ages of the **Qmso?-Qmsy** deposits (Currey and Oviatt, 1985).

The **Qms/Tn** areas consist of thin landslide and colluvial deposits that have moved during the past 30,000 years (late-Quaternary), over Norwood Formation (**Tn**) rocks formed 20 to 30 million years ago.

The **Qmc, Qms, Qmsy** and **Qmso?** classified areas should be considered exposed to landslide and slope-creep hazards. On Figure 3 the nearest exposure of these deposits to the site are **Qmc** deposits shown to occur within steep sloping areas only a few feet southwest of the site boundary.

The **Qlf/Tn** mapped areas consist of thin Lake Bonneville deposits 15,000 to 19,000 ybp in age, over Norwood Formation (**Tn**) rocks formed 20 to 30 million years ago. The Lake Bonneville deposits **(Qlf),** undivided (upper Pleistocene) consist of silt, clay, and sand.

Areas mapped as **Qms?Tn** include apparent thin landslide and colluvial deposits associated with failed or moving slopes, Holocene and Pleistocene in age (0 to 30,000 ybp), over Norwood Formation (**Tn**) rocks formed 20 to 30 million years ago.

The Norwood Formation, **Tn,** is a lower Oligocene and upper Eocene (20 to 30 million years ago) ash deposit that originated from regional volcanic activity. The Norwood Formation typically consists of light-gray to light-brown altered tuff (claystone), altered tuffaceous siltstone and sandstone, and conglomerate.

4. DISCUSSIONS AND RECOMMENDATIONS

4.1 Summary of Findings

4.1.1 Subsurface Observations: The geology exposed by trenches and test pits were generally found to consist of surficial, upper 1.0 feet of pedogenic soil A horizons, and B horizon vertisol sequences that extended in depth (thickness) as much as 6.0 feet. At depth residual -weathered soil and weathered rock sequences consisting of hard clays, claystones and sandstones were observed extending to the depths penetrated by our excavations and borings.

4.1.2 Expansive soils. Vertical cracking associated with vertisol development was observed to extend from 3.0 to 6.0 feet below the surface in the trench and the two test pits excavated for this study. The vertical cracking demonstrated by these soils is a result of naturally high expansive clay content within these soils (Graham and Southard, 1982). The presence or absence of the vertisol soils should be evaluated where structural loads are to be placed during future development.

4.1.3 Sloping Surfaces. The surface of site slopes developed from our LiDAR analysis range from level to over 100-percent as shown on Figure 11, LiDAR Analysis. For the Lot 42 site area the slope gradient averaged 28.2-percent, for the general vicinity of the Summit at Ski Lake Phase 11 area the slope gradient averaged 24.4-percent. As previously discussed in the LiDAR-Slope Analysis section of this report, the critical gradient for slope development considerations according to the Weber County Code is 25-percent. Areas on and in the vicinity of the site exceeding 25-percent are shown on Figure 11.

4.1.4 Site Engineering Geology and Mapping. The engineering geology mapping of the site presented on Figure 3 reveals two issues pertinent to site development planning. These issues include: (1) **Landslide and slump deposits** (**Qms** and **Qmsy)** - the presence and proximity of landslide and slump deposits **Qms** and **Qmsy** deposits to the Lot 42 property; (2) **Norwood Formation (Tn)** - the presence of Norwood Formation **Tn** deposits underlying much of the area comprising the development lot and site vicinity. These issues are addressed in order importance below:

1. **Landslide and slump deposits:** Presence of mass-movement landslide and slump deposits, **Qms** and **Qmsy**, is based upon mapping prepared by King et al. (2008) and our own previous investigations (GSH, 2016a). Although no landslide and slump deposits, (**Qms** and **Qmsy)** are shown to occur on the property, the close proximity of these deposits to the site should be disclosed. It is our opinion that if the proposed construction should avoid the very northwestern part of the development lot where **Qms** deposits are mapped within a few feet of the site boundary.

2. **Norwood Formation (Tn):** The Norwood Formation has a notoriety of poor stability performance and geotechnically challenging soils throughout Northern Utah (Mulvey,

1992). Furthermore, we have observed an apparent genetic relationship with the occurrence of the Norwood Formation (and Norwood "Tuff") and surficial vertisol soils, which are subject seasonal shrink-swell processes (Graham and Southard, 1982). Based upon our past experience with areas underlain by Norwood Formation rock and soil, we believe that appropriate geological/geotechnical studies should be conducted before structural improvements are made in those areas. Vertisol soil layers inherent to expansive soils were observed in the trench and the two test pits to as much as 6.0 feet below the surface.

4.1.5 Geoseismic Setting: Strong ground motion originating from the Wasatch fault or other near-by seismic sources is capable of impacting the site. The Wasatch fault zone is considered active and capable of generating earthquakes as large as magnitude 7.3 (Arabasz et al., 1992). Utah municipalities have adopted the International Building Code (IBC) 2015. The IBC 2015 code determines the seismic hazard for a site based upon 2008 mapping of bedrock accelerations prepared by the United States Geologic Survey (USGS) and the soil site class (Peterson, et al., 2008). The USGS values are presented on maps incorporated into the IBC code and are also available based on latitude and longitude coordinates (grid points).

Based on probabilistic estimates (Peterson, et al., 2008) queried for the site, the expected peak horizontal ground acceleration on rock from a large earthquake with a ten-percent probability of exceedance in 50 years is as high as 0.16*g*, and for a two-percent probability of exceedance in 50 years is as high as 0.33*g* for the Site.

The a ten-percent probability of exceedance in 50 years event has a return period of 475 years, and the 0.16*g* acceleration for this event corresponds "strong" perceived shaking with "light" potential damage based on instrument intensity correlations (Wald et al., 1999).

The two-percent probability of exceedance in 50 years event has a return period of 2475 years, and the 0.33*g* acceleration for this event corresponds "very strong" perceived shaking with "moderate" potential damage based on instrument intensity correlations (Wald et al., 1999).

Future ground accelerations greater than these are possible but will have a lower probability of occurrence.

4.1.6 Active Earthquake Faults: The nearest active (Holocene) earthquake fault to the site is the Weber segment of the Wasatch fault zone (UT2351E) which is located 7.0 miles west of the site, thus fault rupture hazards are not considered present on the site (Black et al., 2004). The Ogden Valley southwestern margin faults (UT2375) are located much closer to the site, approximately 1.0 mile to the southwest, however the most recent movement along this fault is estimated to be pre-Holocene (>15,000 ybp), and presently is not considered an active risk (Black, et al., 1999).

4.1.7 Liquefaction Potential Hazards: In conjunction with the ground shaking potential of large magnitude seismic events as discussed previously, certain soil units may also possess a potential for liquefaction during a large magnitude event. Liquefaction is a phenomenon whereby loose, saturated, granular soil units lose a significant portion of their shear strength due to excess pore water pressure buildup resulting from dynamic loading, such as that caused by an earthquake. Among other effects, liquefaction can result in densification of such deposits causing settlements of overlying layers after an earthquake as excess pore water pressures are dissipated. Horizontally continuous liquefied layers may also have a potential to spread laterally where sufficient slope or free-face conditions exist. The primary factors affecting liquefaction potential of a soil deposit are: (1) magnitude and duration of seismic ground motions; (2) soil type and consistency; and (3) occurrence and depth to groundwater.

Liquefaction commonly occurs in saturated non-cohesive soils such as alluvium, and no areas in the vicinity of the site appear to have characteristics susceptible to liquefaction processes.

4.1.8 Alluvial Fan Deposits: Alluvial fan deposits indicative of processes including flash flooding and debris flow hazard do not occur on the site. The nearest active alluvial fan deposits to the site, mapped as **Qafy** by King, et al. (2008), are located on a small fan surface (<4.0 acres in area) approximately 2,000 feet southwest of the site, and do not appear to represent a potential impact the site.

4.1.9 Flooding Hazards: No significant water ways pass in the vicinity of the site and flood insurance rate mapping by Federal Emergency Management Agency for the site vicinity has not been prepared at this time (FEMA, 2015).

4.1.10 Rockfall and Avalanche Hazards: The site is over two miles from steep slope areas where such hazards may originate.

4.1.11 Radon Exposure: Radon is a naturally occurring radioactive gas that has no smell, taste, or color, and comes from the natural decay of uranium that is found in nearly all rock and soil. Radon and has been found occur in the Ogden Valley area, and can be a hazard in buildings because the gas collects in enclosed spaces. Indoor testing following construction to detect and determine radon hazard exposure should be conducted to determine if radon reduction measures are necessary for new construction. Radon-hazard potential mapping has been prepared for most of Ogden Valley by the Utah Geological Survey, and the radon-hazard potential for the Lot 42 location appears to be mapped as "Moderate" by the UGS study (Solomon, 1996). For new structures radon-resistant construction techniques as provided by the EPA (EPA 2016) should be considered.

4.2 Conclusions

Based upon our geological studies herein, we believe that the Lot 42R Summit at Ski Lake No. 11 is suitable for development, provided that **Qms** soils identified near the northwestern side of the site are avoided.

The site has been shown to be underlain by Norwood Formation deposits and expansive vertisol soils were observed in all of the excavations made for this study. Areas where these soils are present should be evaluated prior to the placement of structural loads. Evaluation of the expansive potential of the site soils is planned as part of the concurrent geotechnical study.

Although not addressed by the Weber County ordinances, we recommend that radon exposure be evaluated to determine if radon reduction measures are necessary for the new construction. It is our understanding that new construction in Ogden Valley area often includes radon remedial measures as part of final design.

CLOSURE

If you have any questions or would like to discuss the results of this study further, please feel free to contact us at (801) 393 2012.

Respectfully submitted,

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Encl.	Figure	1,	Vicinity Map
	Figure	2,	Aerial Coverage
	Figures	3,	Site Geology
	Figure	4,	Site Evaluation
	Figure	5,	Log of Trench 1 STA 00 to 110 North
	Figure	6,	Log of Trench 1 STA 110 to 170 North
	Figure	7,	Log of Test Pit 1 and Test Pit 2
	Figure	8,	Boring Log B-1, 0 to 25 feet
	Figure	9,	Boring Log B-1, 25 to 50 feet
	Figure	10,	Boring Log B-1, 50 to 51 feet
	Figure	11,	LiDAR Analysis
	Figure	12,	Slope Cross Section *A-A′*

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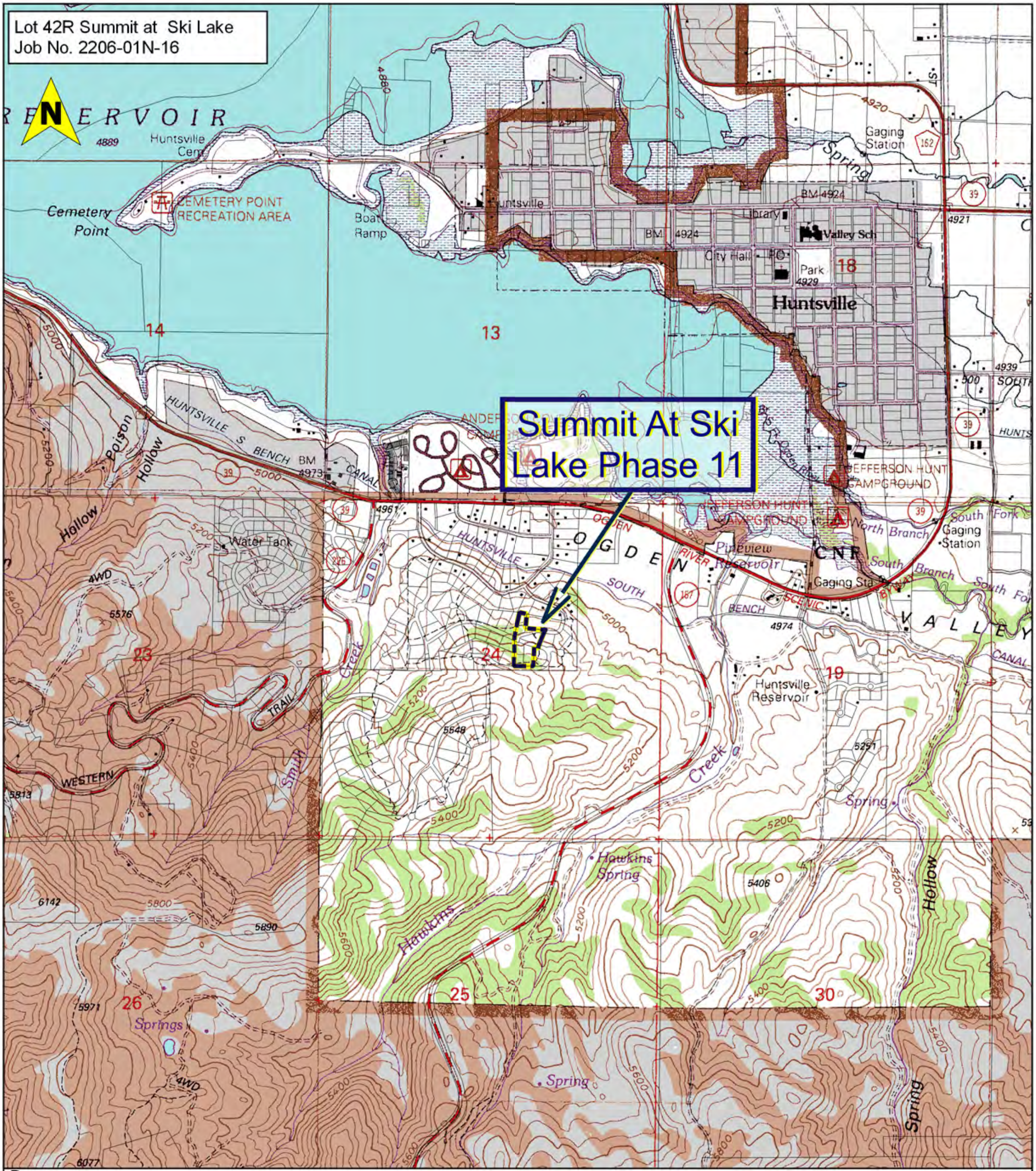


Base:
1998 7.5 Minute USGS Toporgraphic Maps Titled
Snowbasin, Utah, and Huntsville, Utah.

0 1000 2000 3000 4000 ft

1:24,000

FIGURE 1
VICINITY MAP

GSH

Base:
2012 6-inch Color HRO Orthoimagery,
from Utah AGRC; http://gis.utah.gov/

0 200 400 ft
1:2,400

FIGURE 2
AERIAL COVERAGE

GSH

EXPLANATION

Geology after King, et al., 2008

- Qmc - Landslide and slump, and colluvial deposits
- Qmsy - Younger landslide and slump deposits (younger-Holocene)
- Qms - Landslide and slump deposits
- Qmso? Older landslide and slump deposits (older-Pleistocene)
- Qlf/Tn - Lacustrine Lake Bonneville deposits over Norwood Formation
- Qms?(Tn) - Landslide and slump deosits over Norwood Formation
- Tn - Norwood Formation

Lake Bonneville Shorelines after King et al., 2008

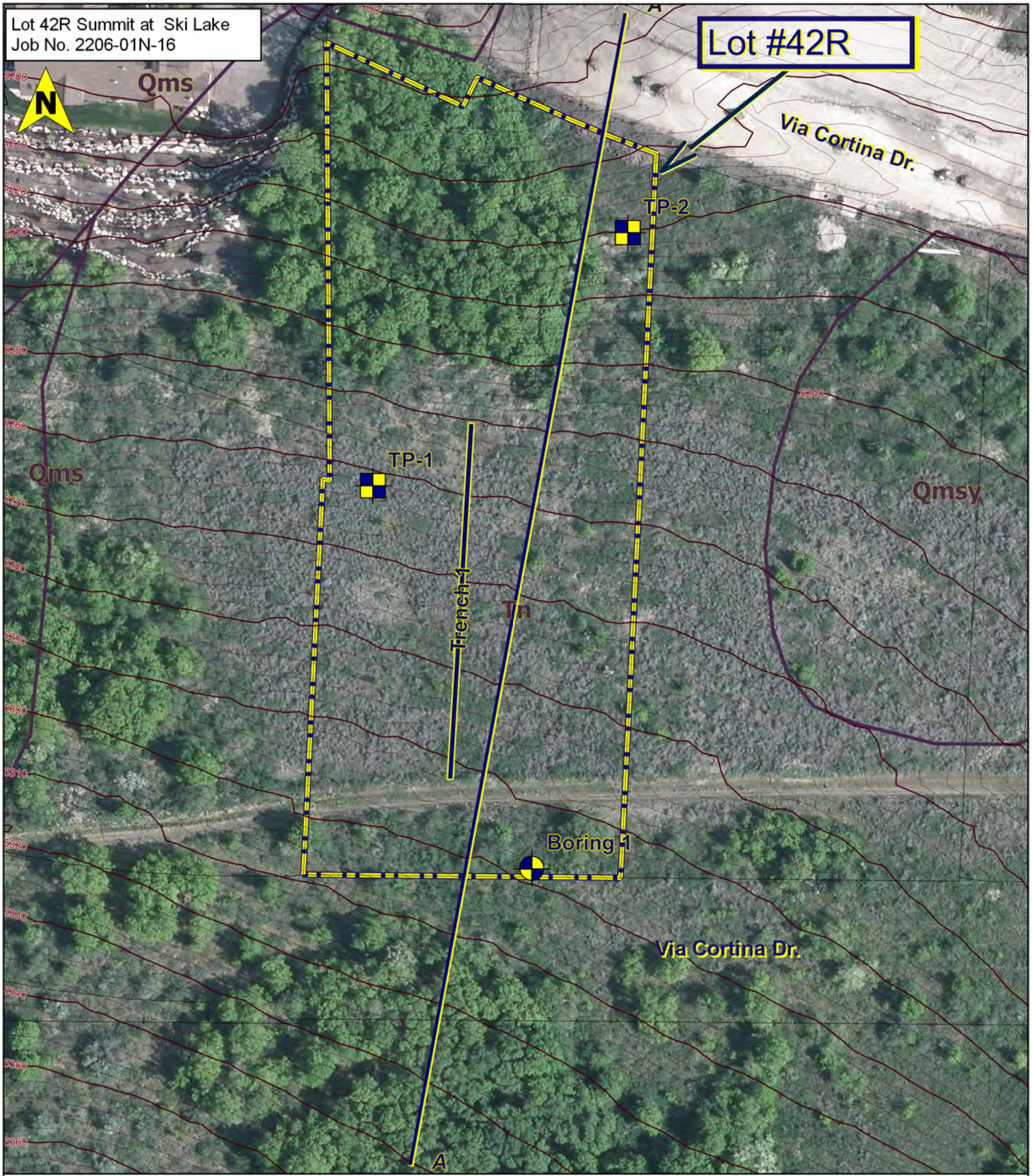
- Lake Bonneville Transgressional
- Lake Bonneville Transgressional Approximate
- Lake Bonnevile
- Lake Bonneville Approximate

Base:
2012 6-inch Color HRO Orthoimagery,
from Utah AGRC; http://gis.utah.gov/
Geology:
King et al., 2008
Elevation:
2006 2.0m Geoprocessed LiDAR
from Utah AGRC; http://gis.utah.gov/

0 200 400 ft
1:2,400

FIGURE 3
SITE GEOLOGY

GSH



Base:
2012 6-inch Color HRO Orthoimagery,
from Utah AGRC; http://gis.utah.gov/
Elevation:
2006 2.0m Geoprocessed LiDAR
from Utah AGRC; http://gis.utah.gov/

0 60 120 ft

1:720

FIGURE 2
SITE PLAN

GSH

Lot 42R Summit at Ski
Job No. 2206-01N-16

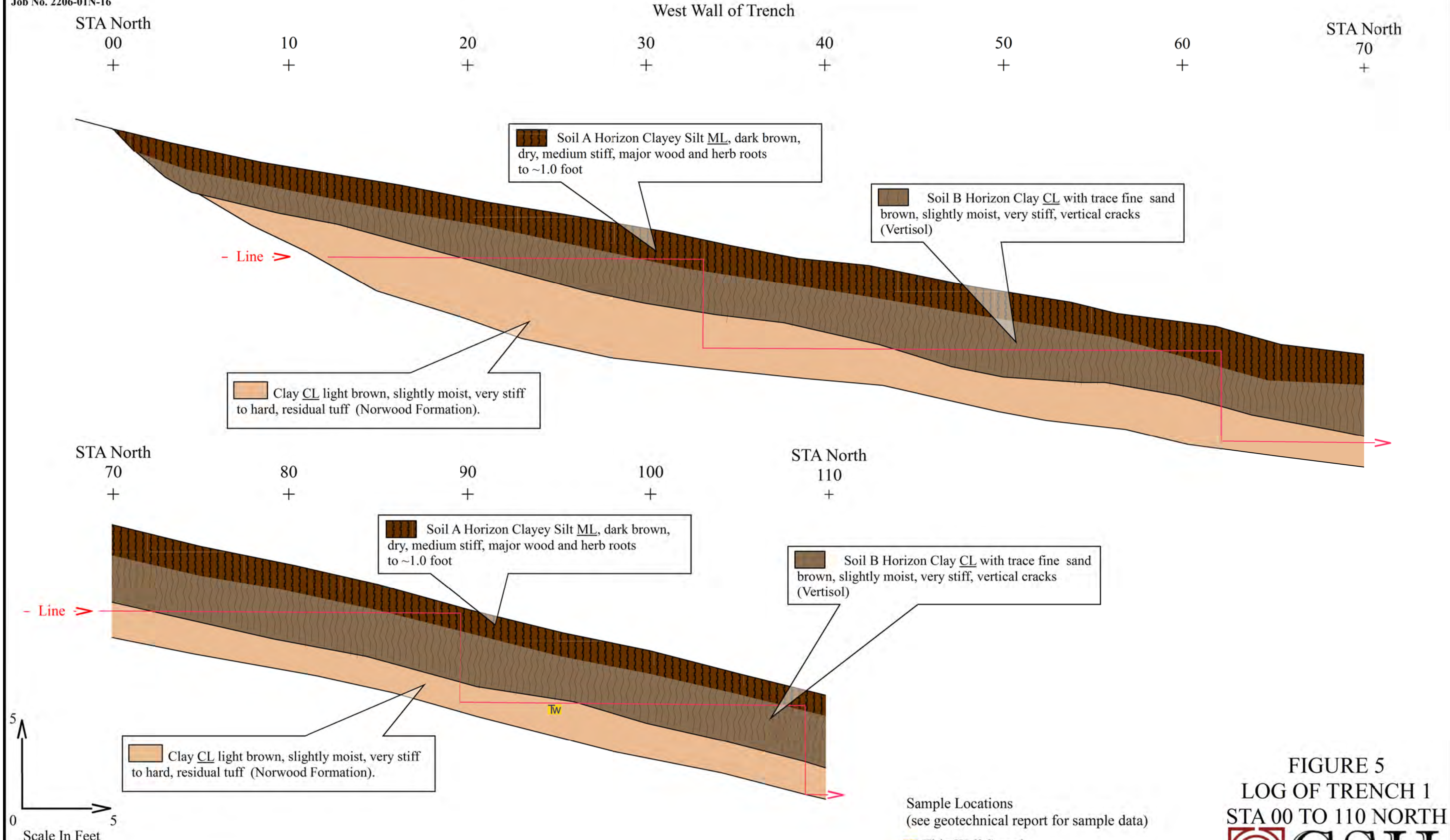
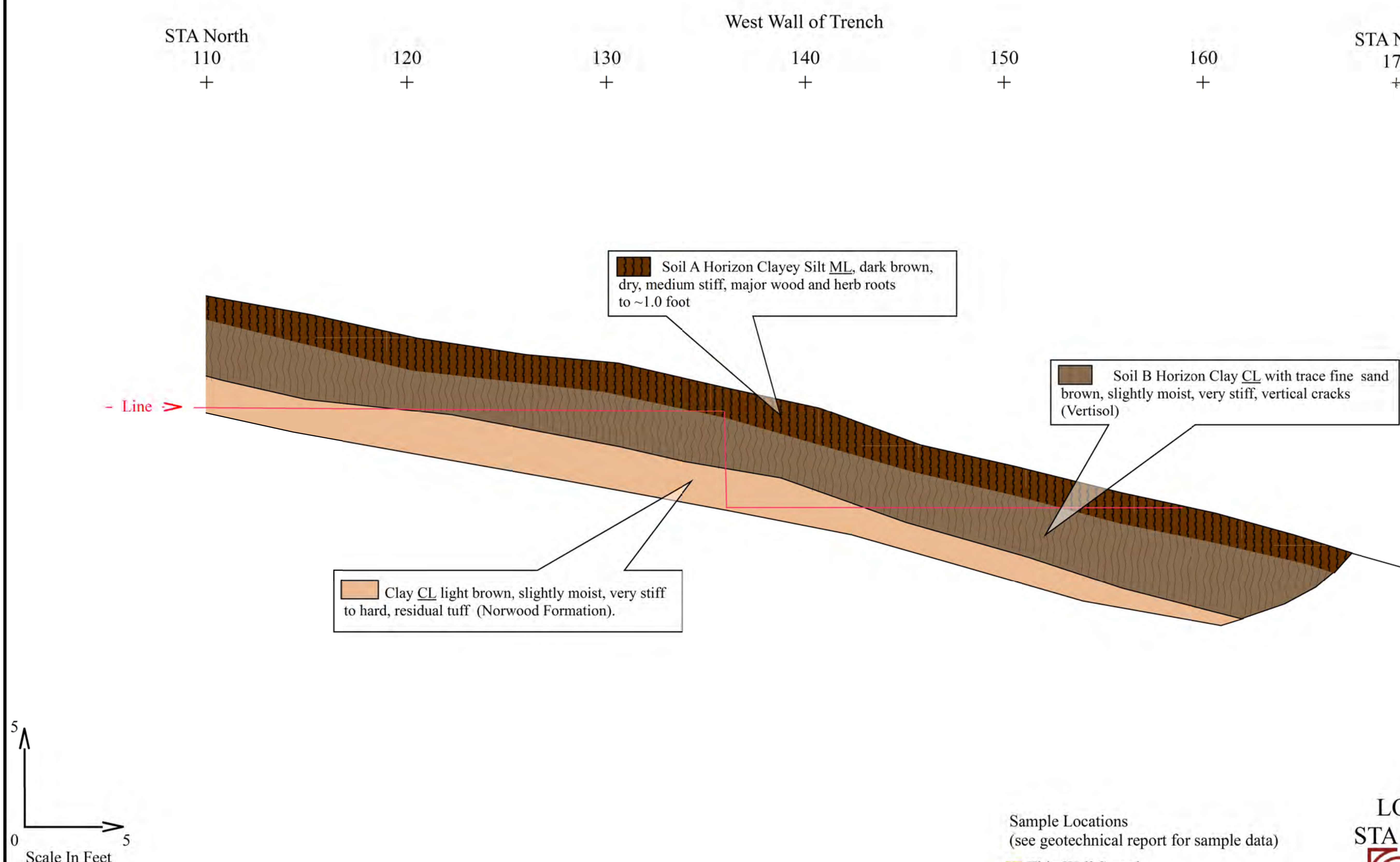


FIGURE 5
LOG OF TRENCH 1
STA 00 TO 110 NORTH

GSH

ANALYSIS BY: GCS | CHECKED BY AH | DATE 9/28/16

Lot 42R Summit at Ski
Job No. 2206-01N-16



Sample Locations
(see geotechnical report for sample data)

TW Thin Wall Sample

B Bulk Sample

FIGURE 6
LOG OF TRENCH 1
STA 110 TO 170 NORTH

GSH

ANALYSIS BY: GCS | CHECKED BY AH | DATE 9/28/16

Lot 42R Summit at Ski
Job No. 2206-01N-16

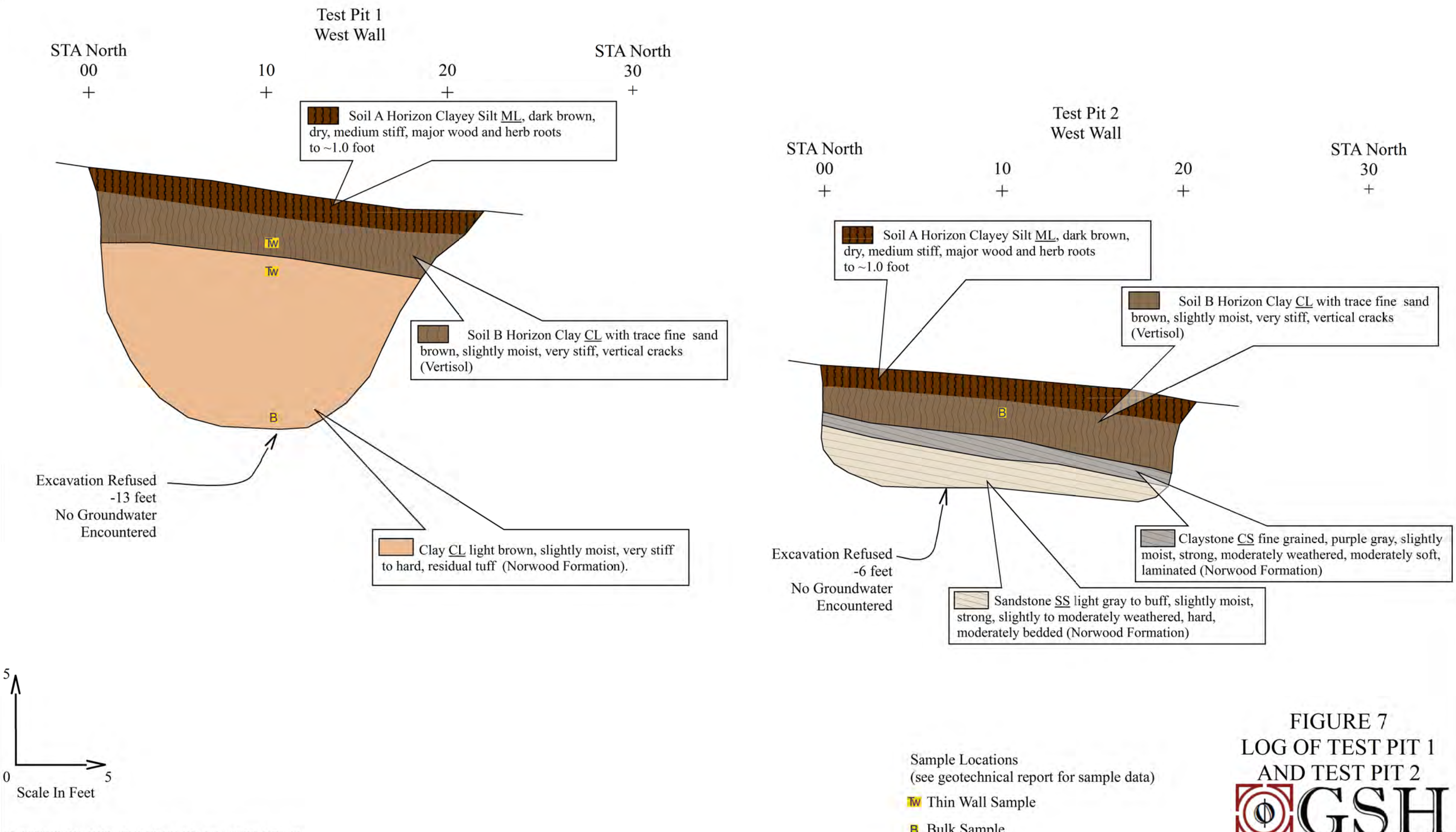


FIGURE 7
LOG OF TEST PIT 1
AND TEST PIT 2

GSH

ANALYSIS BY: GCS | CHECKED BY AH | DATE 9/28/16

GSH

BORING LOG

BORING: B-1

CLIENT: Craig Wagstaff	PROJECT NUMBER: 2206-01N-16
PROJECT: Lot 42R Summit at Ski Lake No.11	DATE STARTED: 7/13/16 DATE FINISHED: 7/13/16
LOCATION: 6763 East Viacortina Street, Huntsville, Weber County, Utah	GSH FIELD REP.: JM
DRILLING METHOD/EQUIPMENT: 3-3/4" ID Hollow-Stem Auger	HAMMER: Automatic WEIGHT: 140 lbs DROP: 30"
GROUNDWATER DEPTH: Not Encountered (7/13/16)	ELEVATION: ---

WATER LEVEL	USCS	DESCRIPTION	DEPTH (FT.)	BLOW COUNT	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
		Ground Surface	0								
	CL FILL	SILTY CLAY, FILL with trace fine to medium sand; trace organics; dark brown									slightly moist stiff
				15		15	82				
			5	20		23	93				moist
	CL	SILTY CLAY with trace fine to medium sand; brown									moist stiff
				15		25	91				
	CL	CLAYSTONE/SILTSTONE with some fine to mediun sand; light brown									moist hard
			10	84		38	77				
				50+					NP	NP	
			15	50+		32	83				
				50+							
			20	50+					50	24	
	SM	SILTY FINE TO MEDIUM SAND/WEATHERED SANDSTONE brown									moist very dense
				89							
	SP	FINE TO MEDIUM SAND	25								

See Subsurface Conditions section in the report for additional information.

FIGURE 8

GSH	BORING LOG Page: 2 of 3	BORING: B-1

CLIENT: Craig Wagstaff PROJECT NUMBER: 2206-01N-16

PROJECT: Lot 42R Summit at Ski Lake No.11 DATE STARTED: 7/13/16 DATE FINISHED: 7/13/16

WATER LEVEL	USCS	DESCRIPTION	DEPTH (FT.)	BLOW COUNT	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
	SP	FINE TO MEDIUM SAND with trace silt; yellowish-brown	25	79	X	14		94			moist dense
	CL	CLAY with trace fine sand; brown		50+	X						moist hard
	SM	SILTY FINE SAND/WEATHERED SANDSTONE brown	30	50+	X						moist dense
				50+	X						
	SP	FINE TO MEDIUM SAND/WEATHERED SANDSTONE with trace silt; brown	35	88	X	22	101	18			moist very dense
	SM	SILTY FINE TO MEDIUM SAND/WEATHERED SANDSTONE brown		50+	X						moist very dense
			40	50+	X	18		23			
				50+	X						
			45	50+	X	26	88				
	SM	FINE TO COARSE SILTY SAND/WEATHERED SANDSTONE brown		76	X						moist very dense
	SM	SILTY FINE TO MEDIUM SAND/WEATHERED SANDSTONE yellowish-brown	50	85	X	21	95				moist very dense
		End of Exploration at 51.5'									

See Subsurface Conditions section in the report for additional information.

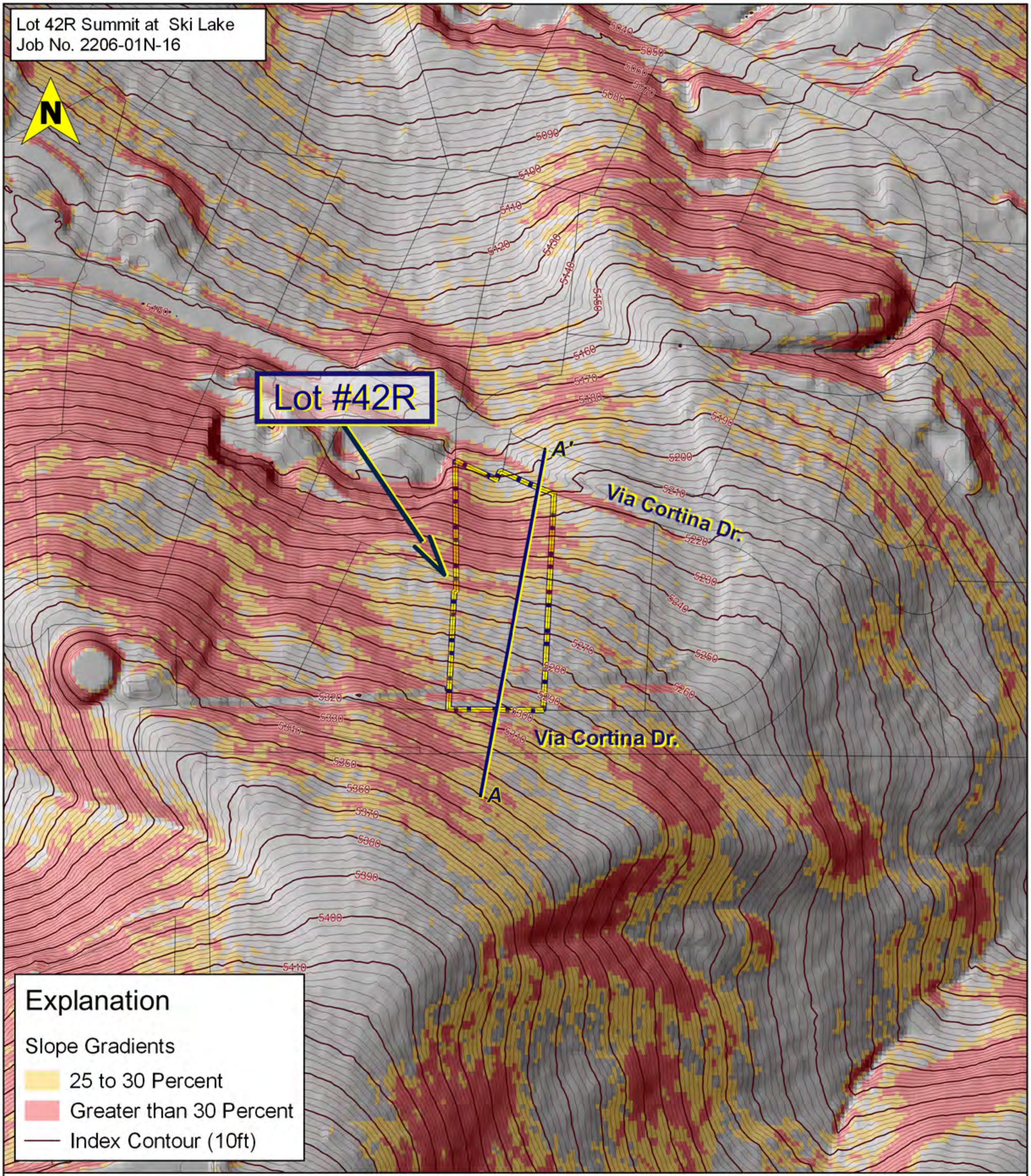
BORING LOG

BORING: B-1

CLIENT: Craig Wagstaff	PROJECT NUMBER: 2206-01N-16	
PROJECT: Lot 42R Summit at Ski Lake No.11	DATE STARTED: 7/13/16	DATE FINISHED: 7/13/16

WATER LEVEL	USCS	DESCRIPTION	DEPTH (FT.)	BLOW COUNT	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
		No groundwater encountered at time of drilling Installed 1.25" diameter slotted PVC pipe to 50.0'	52								
			55								
			60								
			65								
			70								
			75								

See Subsurface Conditions section in the report for additional information.



Base:
2006 2.0m Geoprocessed LiDAR
from Utah AGRC; http://gis.utah.gov/

0 200 400 ft
1:2,400

FIGURE 11
LiDAR ANALYSIS

GSH

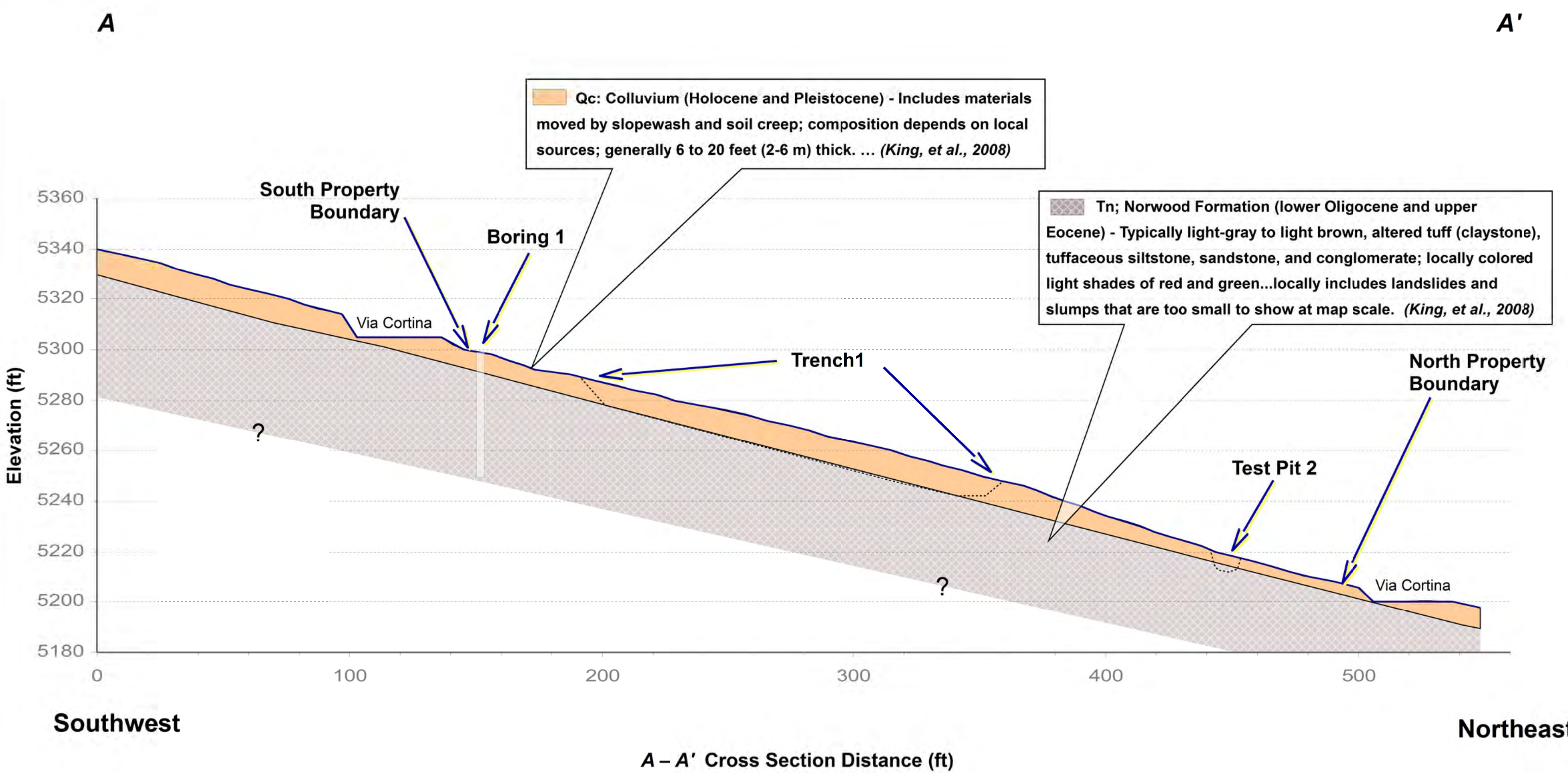


FIGURE 12
GEOLOGIC SLOPE
CROSS SECTION *A-A'*

GSH

ANALYSIS BY: GCS | CHECKED BY AH | DATE 9/28/16

* From Section Shown On Figure 4 and Figure 11