GCS Geoscience

Report Professional Geologist Site Reconnaissance and Review
Snowbasin Modular Structure
Former Hill Haus Lodge Location, Snowbasin Resort
Huntsville, Weber County, Utah

For:

Snowbasin Resort
3925 East Snowbasin Road
Huntsville, Utah
84317

By:

GCS Geoscience
554 South 7700 East Street
Huntsville, Utah 84317

October 23, 2019
GCS File No: 2019.39

GCS Geoscience

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Snowbasin Resort
3925 East Snowbasin Road
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Attention: Mr. Chris Westover

Subject: **Report**
Professional Geologist Site Reconnaissance and Review
Snowbasin Modular Structure
Former Hill Haus Lodge Location, Snowbasin Resort
Huntsville, Weber County, Utah

INTRODUCTION

In response to your request, GCS Geoscience (GCS) has prepared this Professional Geologist site reconnaissance review report for the above referenced site. The site consists of an approximately 3000 square-foot construction pad located on the Snowbasin Property (Parcel #:20-043-0005) in Weber County, Utah, as shown on attached Figure 1, Vicinity Map. Figure 2, Aerial Coverage provides aerial coverage of the site and detail of the current (2014) layout of the site vicinity, and the proposed location of the modular structure pad.

The site is the former location of the Hill Haus Lodge (41.2191º N., 111.8534º E.), a wood-frame lodge structure that was recently razed to accommodate the proposed new construction. The site is located near the SR-226 entrance to the Earl's Lodge parking for the resort, as shown on Figure 2. The property parcel is zoned by Weber County as Recreation Resort Zone DRR-1 land-use zone. According to the Weber County Code of Ordinances the purpose of the DRR-1 land-use zone…*is to provide flexible development standards to resorts that are dedicated to preserving open space and creating extraordinary recreational resort experiences while promoting the goals and objectives of the Ogden Valley general plan…Resorts within an approved destination and recreation resort zone shall, by and large, enhance and diversify quality public recreational opportunities, contribute to the surrounding community's well-being and overall, instill a sense of stewardship for the land.*

It is our understanding that Snowbasin Resort intends to construct a concrete pad, and place a modular dwelling structure on the pad at the former Hill Haus Lodge location. We expect that the proposed construction will primarily consist of preparing the surface and placing the concrete pad; and that the modular structure will be transported to the

site as components for final on-site assembly on the pad. Projected site grading is anticipated to consist primarily of cutting into the existing ground to construct the pad, with very little fill projected for the site.

Because the proposed site appears to be located in part on a hillslope area in the vicinity of mapped landslide hazards, marginal soils, Quaternary faults and FEMA floodplain areas, Weber County is requesting that a geological site reconnaissance be performed to assess whether all or parts of the site are exposed to the hazards that are included in the Weber County Code, Section 108-22 Natural Hazard Areas. These hazards include, but are not limited to: Surface-Fault Ruptures, Landslide, Tectonic Subsidence, Rock Fall, Debris Flows, Liquefaction Areas, Flood, or other Hazardous Areas.

The purpose of this **Professional Geologist Site Reconnaissance Review** is to evaluate if the proposed development is outside or within areas identified as Natural Hazards Overlay District, and if within a hazard area, to recommend appropriate additional studies that comply with the purpose and intent of the Weber County Natural Hazards Area guidelines and standards in order to be "cleared" for building permit issuance by the county, as outlined by the Weber County Development Process packet as provided by the Weber County Building Inspection Department.

The objectives and scope of this study were discussed and presented to Mr. Chris Westover of Snowbasin Resort, in our (GCS) Proposal-Agreement dated October 18, 2019, and the Proposal-Agreement was signed by Mr. Davey Ratchford (**Client**), General Manager of Snowbasin Resort, that same day.

Literature and Resource Review

To evaluate the potential exposure of sites to geological hazards that impact sites or site improvements, Weber County has compiled a series of Geographic Information Systems (GIS) data mapping layers of geological hazard related information. These data may be queried on-line using the Weber County Geo-Gizmo web server application at:

http://www.co.weber.ut.us/gis/maps/gizmo/.

Using the Geo-Gizmo application, under the Engineering Layers category, is listed geological hazard related layers that may be toggled on and off to determine potential hazards exposure to sites in the county. These mapping layers include the following categories; *Quake Epicenters, FEMA Flood Zone Line, FEMA Base Flood Elevation, Wasatch Faults, Landslide Scarps, Geologic Faults, Faults, Quaternary Faults, FEMA Flood Zone, FEMA LOMR, Engineering Problems; Liquefaction Potential, Landslide, FEMA Letters of Map Change, and FEMA Flood Zones.* These layers have been compiled from the respective agencies including the Federal Emergency Management Agency (FEMA), the Utah Geological Survey (UGS), and the U.S. Geological Survey (USGS). These mapping layers consist of regional compilation hazards data but are not

compiled at scales that are necessarily applicable for site specific usage and planning. When hazard layer data on the Geo-Gizmo are found to interact with Permit Applicant site improvement locations, Weber County Engineers and Planners will request that the Permit Applicant have a Professional Geologist Site Reconnaissance Review, such as presented herein, conducted for the site.

In addition to the Geo-Gizmo site screening, the Weber County Engineers and Planners rely on recently published UGS geological mapping (Coogan and King, 2016), that includes much of Weber County for determining if a site is located upon a potentially hazardous geological mapping unit, thus requiring a geological reconnaissance. This interactive "Weber County Geologic Map" may be viewed on-line at:

https://weber.maps.arcgis.com/apps/webappviewer/index.html?id=bd557ebafc0e4ed58471342bb03fdac5

Our preliminary review of the Geo-Gizmo indicated that the proposed modular structure site (Site) was near "*landslide*" hazard units that are mapped nearby according the UGS landslide database (Elliott and Harty, 2010), however the location did not show exposure to any of the other aforementioned hazard layer areas, Including; *Quaternary Faults* (USGS and UGS, 2006), and *FEMA Flood Zone* (FEMA, 2015).

The Weber County Geologic Map shows the site is underlain by *high-level alluvial-fan deposits over Tertiary strata, undivided* rocks (**QTaf/Ts**), a geologic unit that has been determined by Weber County as requiring hazard studies.

Our site-specific review consisted of a GIS data integration effort that included:

1. Reviews of previous mapping and literature pertaining to site and regional geology including and Sorensen and Crittenden (1979), Mulvey (1992), USGS and UGS (2016), Elliott and Harty (2010), King and others (2008), and Coogan and King (2016).

2. An analysis of vertical and stereoscopic aerial photography for the site including a 1947 1:20,000 stereoscopic sequence, 2012 5.0-inch digital HRO coverage, and 2014 1.0 meter digital NAIP coverage of the site.

3. A GIS analysis using the QGIS® GIS platform to geoprocess and analyze 2016 2.0-meter LiDAR digital elevation data made available for the site by the Utah Automated Geographic Reference Center (AGRC). The GIS analysis included using the QGIS® platform Geospatial Data Abstraction Library (GDAL, 2013) Contour; the GRASS® (Geographic Resources Analysis Support System, 2013) r.slope and r.shaded.relief modules.

For the best site-specific documentation for this review we relied on geologic mapping by Coogan and King (2016), which provided the most up to date rendering of geological mapping for the site location. Mapping by King and others (2008) was also used to

support this review. The geological mapping for this review is provided on Figure 3, Geologic Mapping. Topographic, slope, and elevation data for this review was supported through the aforementioned LiDAR analysis which is presented on Figure 4, LiDAR Analysis.

REVIEW FINDINGS

The site is located on the eastern flank of Mount Ogden which western flank comprises the Wasatch Front. 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 Wasatch Formation and the Norwood Formation that ramp along the transition of the mountains to the foothills on the east. The Wasatch Formation is described as red to brownish-red sandstone, siltstone, mudstone, and conglomerate, and the Norwood Formation is described as "light-gray to light brown, altered tuff (claystone), tuffaceous siltstone, sandstone, and conglomerate" derived from volcanic ash deposition, and has been measured to be as much as 7000 feet thick in the vicinity of the site (King and others 2008). The existing surface of the site and vicinity appears to have been modified by Quaternary age erosion, residual soil weathering and development, and mass movement processes (King and others 2008; Coogan and King (2016).

Topographically the Site is located on base foothills on the east side of Mount Ogden, and overlooks Ogden Valley which is located to the northeast. As shown on Figure 2 the Site consists of an area of approximately 3000 square-feet in size that has currently been cleared and graded for development. The topography of the site vicinity consists of a foothill ridge with about 200 feet of total local vertical relief, with elevations locally ranging between 5212 feet and 5296 feet (msl). The Site, as shown on Figure 2, (2014 imagery) is surrounded by wooded undeveloped ground.

Site Geology

Figure 3 shows the location of the site relative to GIS overlays including geological mapping layers prepared by Coogan and King (2016). A summary of the geological mapping of the site vicinity is provided as follows:

Qac - Alluvium and colluvium (Holocene and Pleistocene) - Includes stream and fan alluvium, colluvium, and locally mass-movement deposits...

Qmsy - Younger landslide and slump deposits (Holocene) - Poorly sorted clay- to boulder-sized material…

Qms - Landslide and slump deposits (Holocene and Pleistocene) - Poorly sorted clay- to boulder-sized material…

Qmg - Mass-movement and glacial deposits, undivided (Holocene and Pleistocene) – Unsorted and unstratified clay, silt, sand, and gravel; mapped where glacial deposits lack typical moraine morphology…

Qms(QTaf) – Block landslide deposits (Holocene and Pleistocene) – comprised of QTaf materials...

Qms(Tn/Tw) – Block landslide deposits (Holocene and Pleistocene) – comprised of Tn and/or Tw materials...

QTaf/Ts – QTaf - High-level alluvial-fan deposits (lower Pleistocene and/or Pliocene) – Gravel, sand, silt, and clay above other stream-terrace and alluvial-fan deposits / over **Ts** Tertiary strata, undivided including **Tw** Wasatch Formation and/or **Tn** Norwood Formation…

QTaf/Tw – QTaf - High-level alluvial-fan deposits (lower Pleistocene and/or Pliocene) – Gravel, sand, silt, and clay above other stream-terrace and alluvial-fan deposits / over **Tw** Wasatch Formation…

Tn - Norwood Formation (lower Oligocene and upper Eocene) – Typically light-gray to light-brown altered tuff (claystone), altered tuffaceous siltstone and sandstone, and conglomerate…

Tw - Wasatch Formation (Eocene and upper Paleocene) – Typically red to brownish-red sandstone, siltstone, mudstone, and conglomerate with minor gray limestone and marlstone locally; conglomerate clasts mainly rounded Neoproterozic and Paleozoic sedimentary rocks, typically Neoproterozoic and Cambrian quartzite…

The Site is shown on Figure 3 to be located upon **QTaf -** High-level alluvial-fan deposits, projected to overlie bedrock deposits described as **Ts** Tertiary strata, undivided that would include **Tw** Wasatch Formation and/or **Tn** Norwood Formation rocks. The Norwood Formation (**Tn**) bedrock has a notoriety of poor stability performance (particularly with steep slopes), and geotechnically challenging soils throughout the area, and such is the partly the reason for this evaluation.

Geologic/Natural Hazards

In addition to the review and location query we searched for nearby or proximal classifications or conditions that could possibly present hazardous conditions to the site. A summary of this search is provided as follows:

1. **Landsliding:** The nearest active landslide units are mapped as **Qmsy** deposits by Coogan and King (2016), and are located approximately 880 feet to the east of the Site as shown on Figure 3, and should not potentially impact the proposed use of the site. Active landsiding on a SR226 road cut approximately 1300 feet

south of the Site was also observed during our October 2019 visit. The road cut f feature should also not potentially impact the proposed use of the Site.

2. **Alluvial fan debris flow processes** including flash flooding and debris flow hazard: The nearest potential debris flow process deposits to the site are mapped as **Qafy** by Coogan and King (2016), and occur approximately 2700 feet west of the site. These deposits that occur at the head of Wheeler Creek are not shown on the Figure 3 scene, and do not appear to be a potential impact to the Site.

3. **Surface fault rupture hazards, strong earthquake ground motion, tectonic subsidence and liquefaction:**

   Surface fault rupture hazards: The nearest active (Holocene) earthquake fault to the site is the Weber segment of the Wasatch fault zone (UT2351E) which is located 3.7 miles west of the Site, thus fault rupture hazards are not considered present on the Site (Black and others, 2004). The Ogden Valley southwestern margin faults (UT2375) are located much closer to the site, approximately 900 feet to the northwest, 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 and others, 1999).

   Strong earthquake ground motion: 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 and others, 1992). Based on probabilistic estimates (Peterson and others, 2014) 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 0.17*g,* and for a two-percent probability of exceedance in 50 years is as high as 0.38*g* for the site.

   The a ten-percent probability of exceedance in 50 years event has a return period of 475 years, and the 0.17*g* acceleration for this event corresponds "strong" perceived shaking with "light" potential damage based on instrument intensity correlations. The two-percent probability of exceedance in 50 years event has a return period of 2475 years, and the 0.38*g* acceleration for this event corresponds "very strong" perceived shaking with "moderate" potential damage based on instrument intensity correlations (Wald and others, 1999).

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

   Tectonic Subsidence is surface tilting subsidence that occurs along the boundaries of normal faults in response to surface-faulting earthquakes (Keaton,

1986). Because the Site is not located in near proximity to active earthquake faults, tectonic subsidence hazards are not considered a risk to the site.

Liquefaction potential hazards: In conjunction with strong earthquake ground motion 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 potential hazards have not been studied or mapped for the Snowbasin area, as has occurred in other parts of northern Utah (Anderson and others, 1994). Liquefaction commonly occurs in saturated non-cohesive soils such as alluvium, which is not found on the Site, consequently the conditions susceptible to liquefaction do not appear to be present at the site.

4. **Rockfall and avalanche hazards**: The Site is over a mile from steep slope areas where such hazards may originate.

5. **Flooding:** 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 for this area at this time (FEMA, 2015). Local sheet flow, slope wash, and seasonally perched soil water typical of sloping areas should be anticipated for the site, and site improvements.

6. **Sloping surfaces:** The site vicinity slopes developed from our LiDAR analysis range from level to well over 50-percent as shown on Figure 4, LiDAR Analysis. As shown on Figure 4, the ground surrounding the Site slopes moderately to the northeast and average slopes of 15.4 percent are calculated for the ground surrounding the Site.

   The threshold gradient for slope development considerations and hillside review according to the Weber County Section 108-14-3 includes slopes greater than 25-percent (Weber County Code, 2019).

Site Reconnaissance

The Site was reconnoitered on October 17, 2019. The Site was accessed from SR-226 from via a paved parking area on the northwest that apparently served the former Hill

Haus Lodge facility. The former lodge building shown on Figure 2 has been razed and cleared from the site, and the construction pad location for the proposed modular structure appeared prepared for concrete placement. Surface vegetation on the site consisted of moderately to densely clustered wooded areas of scrub oak, maple, and fir trees, with a ground cover of Oregon grape and sparse grasses and weeds. Soils exposed by the grading for the pad appeared to consist of silty gravelly clays/silty gravels with angular- to sub-angular cobble and boulder sized particles.

During the reconnaissance no conditions of imminent geologic hazard were observed at the Site.

CONCLUSIONS

Based upon the findings of this review we believe that the Modular Structure Site at the former Hill Haus Lodge location at Snowbasin Resort is not adversely exposed to the geological hazards specified in the Section 108-22 Natural Hazard Areas of the Weber County Code (2019).

LIMITATIONS

Our services were limited to the scope of work discussed in the introduction section of this report. The results provided by this study are limited to geological hazards included as "potential hazards" in Section 108-22 Natural Hazard Areas of the Weber County Code (2019). The reporting provided here is not based upon any subsurface observations, and should in no way preclude the results of a geotechnical engineering soils and groundwater studies for foundations, earthwork, and geoseismic design prepared by a professional engineer licensed in the State of Utah.

Although risk can never be eliminated, more detailed and extensive studies yield more information, which may help understand and manage the level of risk. The recommendations contained in this report are based on our site observations, available data, probabilities, and our understanding of the facilities investigated. This report was prepared in accordance with the generally accepted standard of practice at the time the report was written. No warranty, express or implied, is made.

This report may be used only by the **Client** and only for the purposes stated within a reasonable time from its issuance. The regulatory requirements and the "state of practice" can and do change from time to time, and the conclusions presented herein may not remain current. Based on the intended use of the report, or future changes to design, GCS Geoscience may require that additional work be performed and that an updated report be issued. Non-compliance with any of these requirements by the client or anyone else, unless specifically agreed to in advance by GCS Geoscience in writing will release GCS Geoscience from any liability resulting from the use of this report by any unauthorized party.

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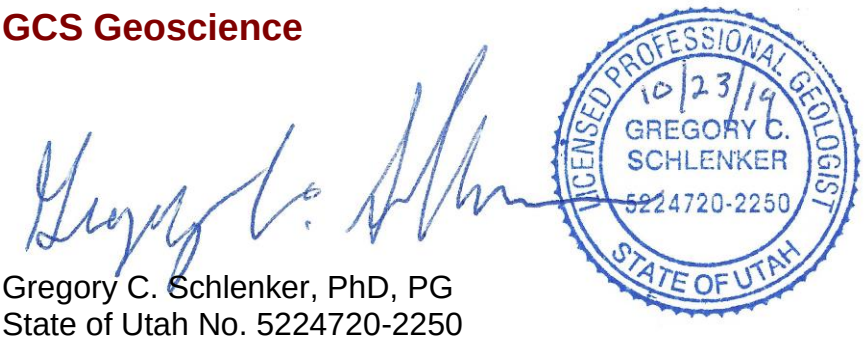
We appreciate the opportunity to work with you on this project and look forward to assisting with you in the future. If you have any questions or need additional information on this or other reporting, please contact the undersigned at (801) 745-0262 or (801) 458-0207.

Respectfully submitted,

GCS Geoscience



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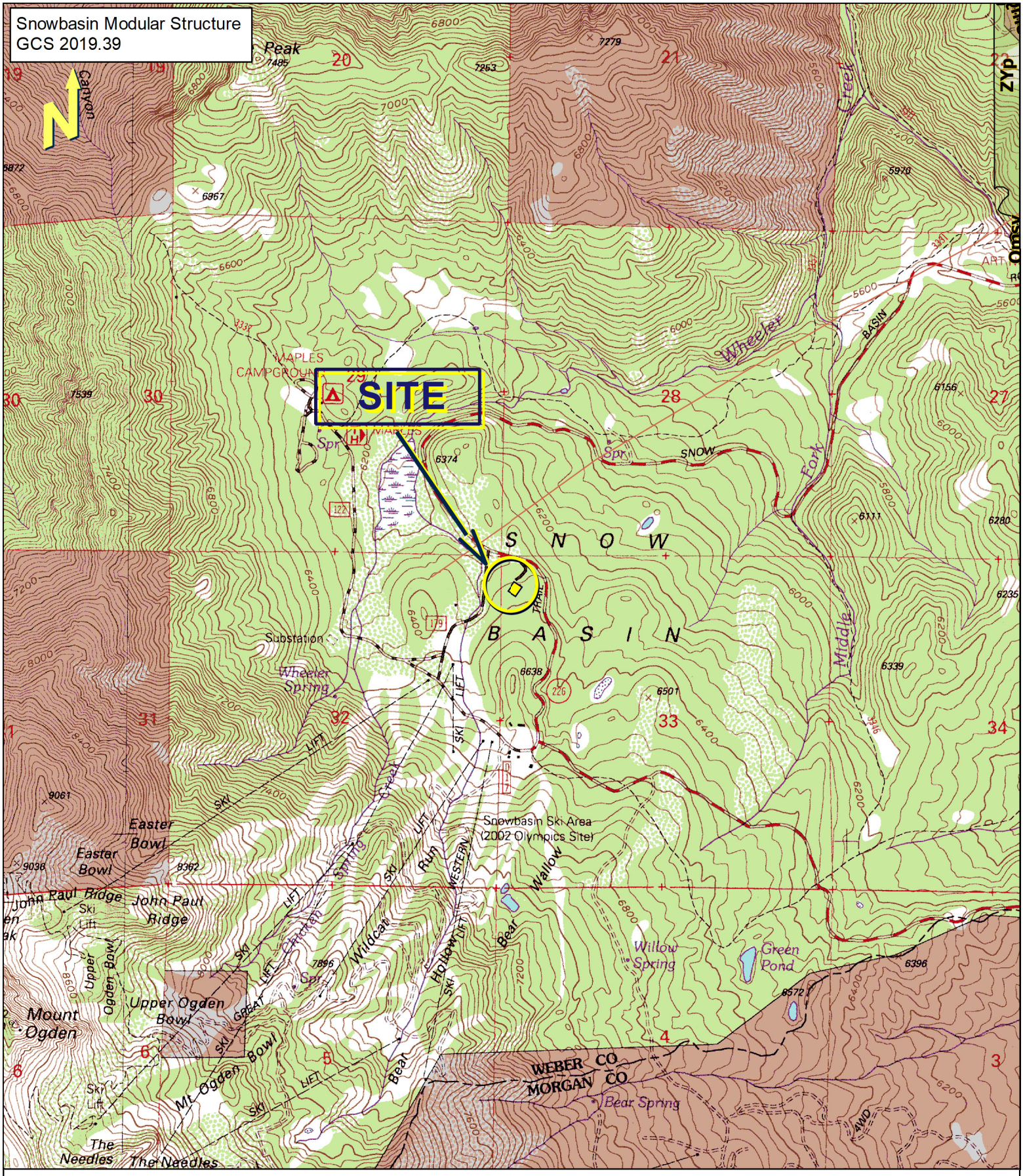
Encl. Figure 1, Site Vicinity Map
Figure 2, Aerial Coverage
Figure 3, Geologic Mapping
Figure 4, LiDAR Analysis



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

0 2000 4000 ft

1:24,000

FIGURE 1
VICINITY MAP

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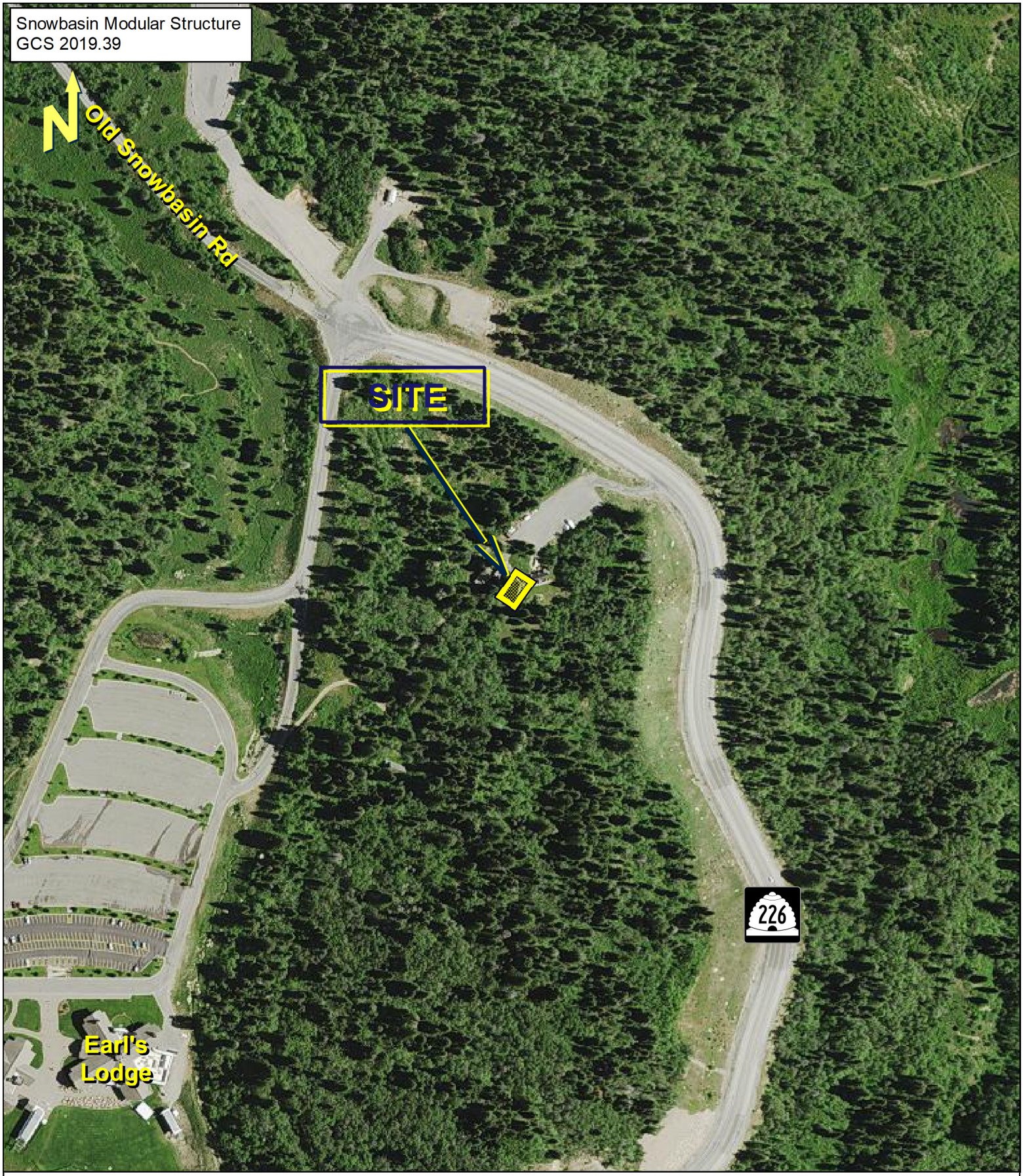

Base:
2014 1.0m Color NAIP Orthoimagery,
from Utah AGRC; http://gis.utah.gov/

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1:3,600

FIGURE 2
AERIAL COVERAGE

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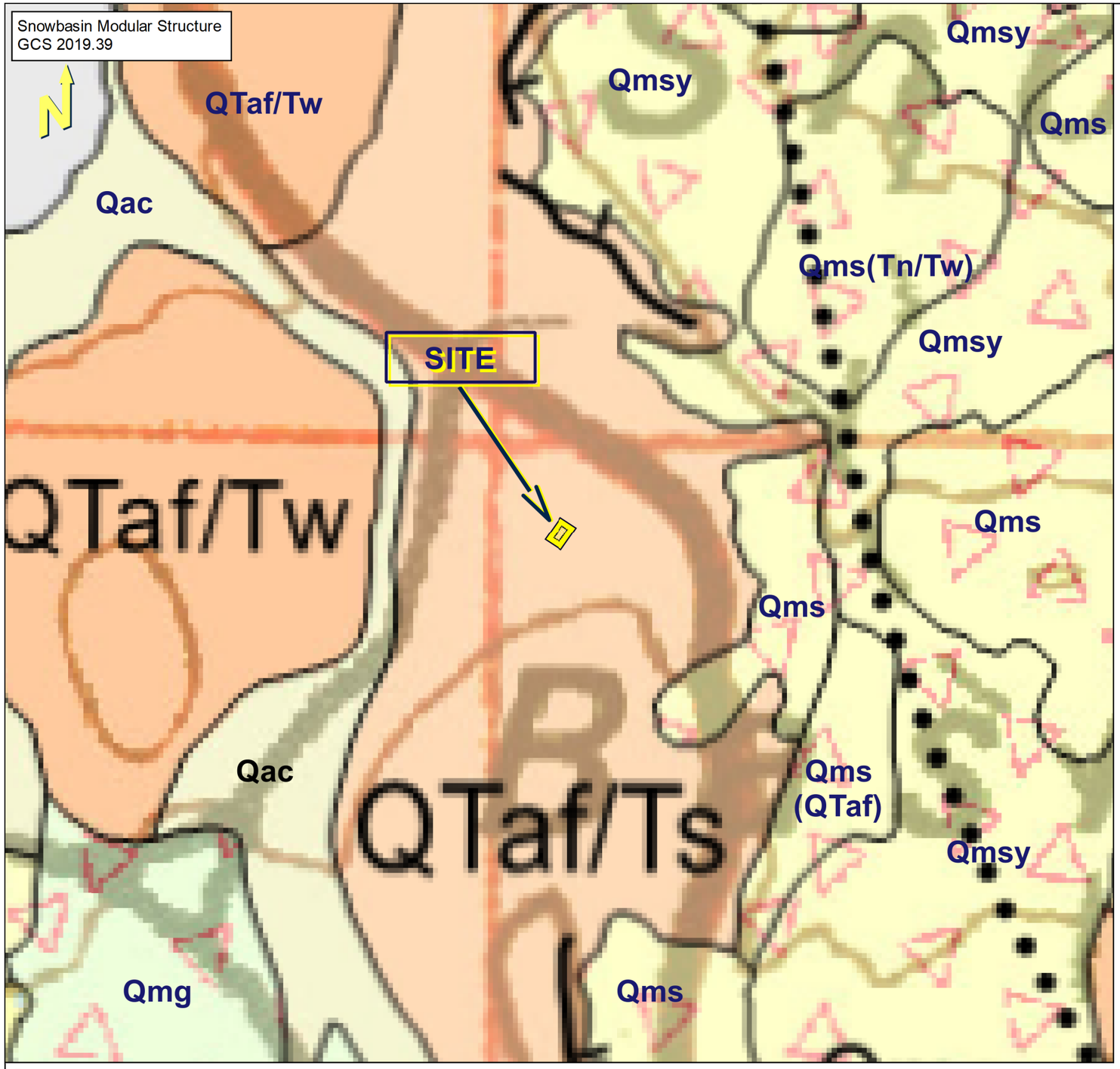

Geologic Classification
(after Coogan and King, 2016

Qac - Alluvium and colluvium (Holocene and Pleistocene) - Includes stream and fan alluvium, colluvium, and locally mass-movement deposits...

Qmsy - Younger landslide and slump deposits (Holocene) - Poorly sorted clay- to boulder-sized material…

Qms - Landslide and slump deposits (Holocene and Pleistocene) - Poorly sorted clay- to boulder-sized material…

Qmg - Mass-movement and glacial deposits, undivided (Holocene and Pleistocene) – Unsorted and unstratified clay, silt, sand, and gravel; mapped where glacial deposits lack typical moraine morphology…

Qms(QTaf) – Block landslide deposits (Holocene and Pleistocene) – comprised of **QTaf** materials...

Qms(Tn/Tw) – Block landslide deposits (Holocene and Pleistocene) – comprised of **Tn** and/or **Tw** materials...

QTaf/Ts – QTaf - High-level alluvial-fan deposits (lower Pleistocene and/or Pliocene) – Gravel, sand, silt, and clay above other stream-terrace and alluvial-fan deposits / over **Ts Tertiary strata,** undivided including **Tw Wasatch Formation** and/or **Tn Norwood Formation**…

QTaf/Tw – QTaf - High-level alluvial-fan deposits (lower Pleistocene and/or Pliocene) – Gravel, sand, silt, and clay above other stream-terrace and alluvial-fan deposits / over **Tw Wasatch Formation**…

Tn - Norwood Formation (lower Oligocene and upper Eocene) – Typically light-gray to light-brown altered tuff (claystone), altered tuffaceous siltstone and sandstone, and conglomerate…

Tw - Wasatch Formation (Eocene and upper Paleocene) – Typically red to brownish-red sandstone, siltstone, mudstone, and conglomerate with minor gray limestone and marlstone locally; conglomerate clasts mainly rounded Neoproterozic and Paleozoic sedimentary rocks, typically Neoproterozoic and Cambrian quartzite…

Normal Fault - Concealed

Landslide Scarp

Base:
Coogan, J.C., and King, J.K., 2016, Interim geologic map of the Ogden 30' x 60' quadrangle, Box Elder, Cache, Davis, Morgan, Rich, and Summit Counties, Utah, and Uinta County, Wyoming: Utah Geological Survey Open File Report 653DM, 3 plates, 147 p.

0 400 800 ft

1:4,800

FIGURE 3
GEOLOGIC MAPPING

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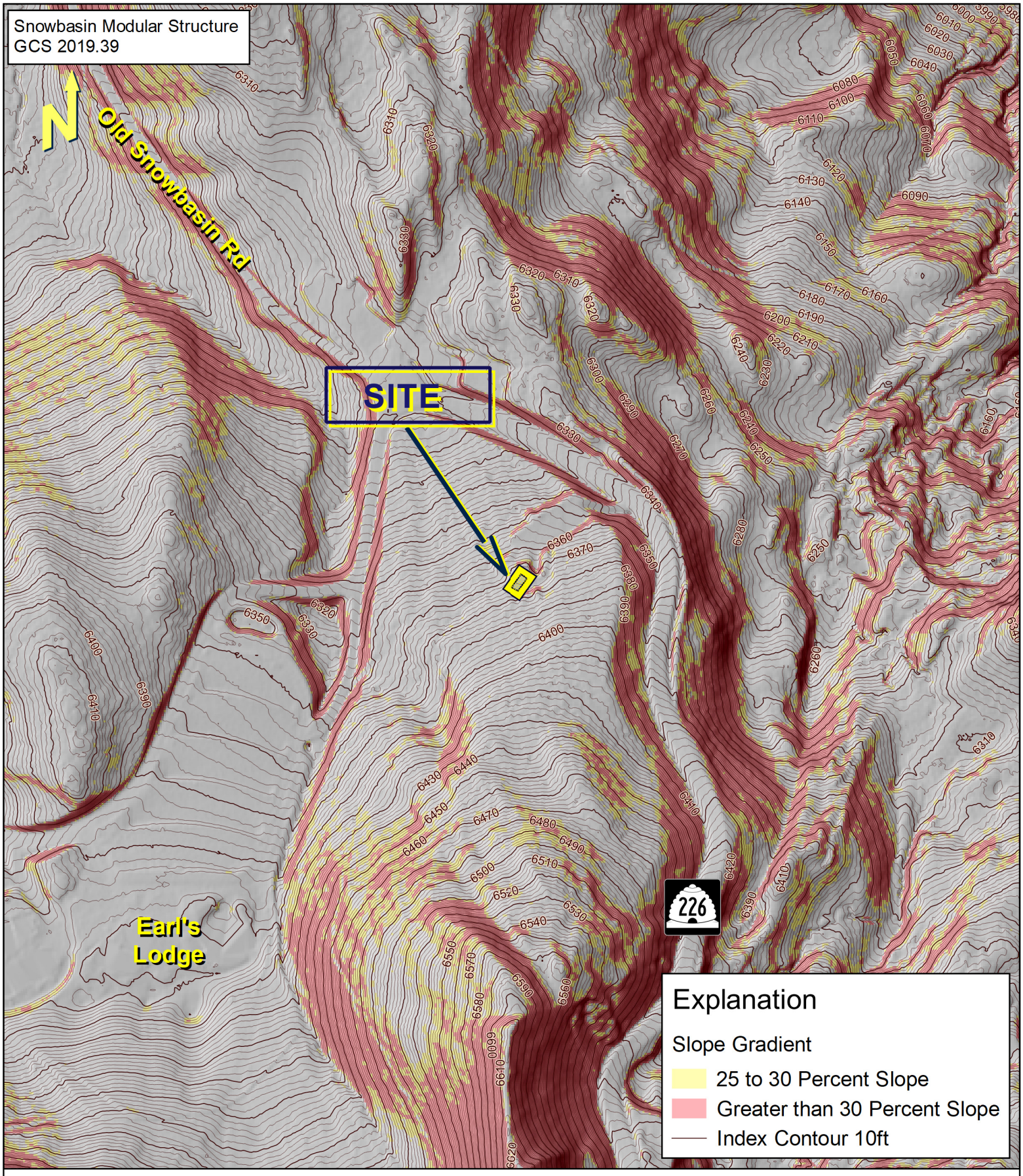

Base:
2006 2.0 m LiDAR Imagery
from Utah AGRC; http://gis.utah.gov/

0 400 800 ft

1:4,800

FIGURE 4
LiDAR ANALYSIS

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