Intermountain GeoEnvironmental Services, Inc.
12429 South 300 East, Suite 100, Draper, Utah 84020
T: (801) 748-4044 ~ F: (801) 748-4045

4153 South Commerce Drive, SLC, UT 84107
T: (801) 270-9400 ~ F: (801) 270-9401

December 1, 2016

Summit Mountain Holding Group
3622 North Wolf Creek Drive
Eden, Utah 84310

c/o Watts Enterprises
5200 South Highland Drive #101
Salt Lake City, Utah 84117
Attn: Mr. Rick Everson

IGES Project No. 01628-015

Subject: Geologic Hazards Assessment
Village Nests Condominiums
Summit Powder Mountain Resort
Weber County, Utah

Mr. Everson:

At your request, IGES has performed a geologic hazard assessment for the Village Nests property, located within the greater Summit Powder Mountain Resort in Weber County, Utah (see *Site Vicinity Map*, Figure A-1). This letter report identifies the nature and associated risk of the applicable geologic hazards associated with the property, based upon the results of the literature review, site reconnaissance, and subsurface investigation conducted as part of this assessment.

INTRODUCTION

It is our understanding that the Village Nests project will involve the development of 20 residential structures, about half of which will also include parking garages, plus an additional two dedicated parking garages and carports. The plans provided by NV5 indicate condominiums; based on our review of the plans, it appears each building will have between two and four levels. However, it is unclear how many individual residential units each of the 20 structures will have. The 1.4-acre property is located within the northeastern quarter of Section 8 of Township 7 North, Range 2 East, approximately 6 miles northeast of Pineview Reservoir, within the greater Summit Powder Mountain Resort property. The property is bound on all sides by undeveloped lands.

PURPOSE AND SCOPE

This study was performed as a geologic hazards assessment to identify any surficial or subsurface geologic hazards that may be extant on the property or have the capability to adversely impact the property. Specifically, this study was conducted to:

- Analyze the existing geologic conditions present on the property and relevant adjacent areas;

- Assess the geologic hazards that pose a risk to development across the property, and determine an associated risk for each hazard; and

- Identify the most significant geologic hazard risks, and provide recommendations for appropriate additional studies and/or mitigation practices, if necessary.

In order to achieve the purpose and scope outlined above, the following services were performed as part of this investigation:

- Review of available published geologic reports and maps for the subject property and surrounding areas;

- Stereoscopic review of aerial photographs and analysis of additional available aerial imagery;

- Site reconnaissance by an engineering geologist licensed in the state of Utah to map the surficial geology, determine site conditions, and assess the property for geologic hazards;

- Subsurface excavation and the logging and soil sampling of the test pits; and

- Preparation of this report, summarizing our findings, conclusions, and recommendations.

REVIEW OF GEOLOGIC LITERATURE

A number of pertinent publications were reviewed as part of this assessment. Sorensen and Crittenden, Jr. (1979) provides 1:24,000 scale geologic mapping of the Huntsville Quadrangle, and Crittenden, Jr. (1972) provides 1:24,000 scale geologic mapping of the Brown's Hole Quadrangle. Coogan and King (2001) provide more recent geologic mapping of the area, but at a 1:100,000 scale. An updated Coogan and King (2016) regional geologic map (1:62,500 scale) provides the most recent published geologic mapping that covers the project area. Western Geologic (2012) conducted a reconnaissance-level geologic hazard study for the greater 200-acre Powder Mountain expansion project, including the Village Nests area. The Western Geologic (2012) study modified some of the potential landslide hazard boundaries that had previously been mapped at a regional scale (1:100,000) by Coogan and King (2001) and Elliott and Harty (2010). The corresponding United States Geological Survey (USGS) topographic maps for the Huntsville and Brown's Hole Quadrangles (2014) provide physiographic and hydrologic data for the project area. Regional-scale geologic hazard maps pertaining to landslides (Elliott and Harty, 2010; Colton, 1991), faults (Christenson and Shaw, 2008a; USGS and Utah Geological Survey (UGS), 2006), debris-flows (Christenson and Shaw, 2008b), and liquefaction (Christenson and Shaw, 2008c; Anderson et al., 1994) that cover the project area were also reviewed. The Quaternary Fault and Fold Database (USGS and Utah Geological

Survey (UGS), 2006), was reviewed to identify the location of proximal faults that have had associated Quaternary-aged displacement. The two geotechnical investigations for the greater Powder Mountain property performed by IGES (2012a, 2012b) were reviewed in detail to provide an understanding of the nature of the subsurface materials at the site and to assist in the geologic mapping of the site.

Stereo-paired aerial imagery for the project site and recent and historic Google Earth imagery was also reviewed to assist in the identification of potential adverse geologic conditions. The aerial photographs reviewed are documented in the *References* section of this report.

General Geologic Setting

The Village Nests property is situated in the western portion of the northern Wasatch Mountains, approximately 4 miles northeast of Ogden Valley. The Wasatch Mountains contain a broad depositional history of thick Precambrian and Paleozoic sediments that have been subsequently modified by various tectonic episodes that have included thrusting, folding, intrusion, and volcanics, as well as scouring by glacial and fluvial processes (Stokes, 1987). The uplift of the Wasatch Mountains occurred relatively recently during the Late Tertiary Period (Miocene Epoch) between 12 and 17 million years ago (Milligan, 2000). Since uplift, the Wasatch Front has seen substantial modification due to such occurrences as movement along the Wasatch Fault and associated spurs, the development of the numerous canyons that empty into the current Salt Lake Valley and Utah Valley and their associated alluvial fans, erosion and deposition from Lake Bonneville, and localized mass movement events (Hintze, 1988).

The Wasatch Mountains, as part of the Middle Rocky Mountains Province (Milligan, 2000), were uplifted as a fault block along the Wasatch Fault (Hintze, 1988). Ogden Valley itself is a fault-bounded trough that was occupied by Lake Bonneville (Sorensen and Crittenden, Jr, 1979) before being cut through by the Ogden River and subsequently dammed to form the Pineview Reservoir. The Wasatch Fault and its associated segments are part of an approximately 230-mile long zone of active normal faulting referred to as the Wasatch Fault Zone (WFZ), which has well-documented evidence of late Pleistocene and Holocene (though not historic) movement (Lund, 1990; Hintze, 1988). The faults associated with the WFZ are all normal faults, exhibiting block movement down to the west of the fault and up to the east. The WFZ is contained within a greater area of active seismic activity known as the Intermountain Seismic Belt (ISB), which runs approximately north-south from northwestern Montana, along the Wasatch Front of Utah, through southern Nevada, and into northern Arizona. In terms of earthquake risk and potential associated damage, the ISB ranks only second in North America to the San Andreas Fault Zone in California (Stokes, 1987).

The WFZ consists of a series of ten segments of the Wasatch Fault that each display different characteristics and past movement, and are believed to have movement independent of one another (UGS, 1996). The Village Nests property is located approximately 10.3 miles to the east of the Weber Segment of the Wasatch Fault, which is the closest documented Holocene-aged (active) fault to the property and trends north-south along the Wasatch Front (USGS and UGS, 2006).

Surficial Geology

According to Crittenden, Jr. (1972), the property is entirely underlain by the undivided Tertiary/Cretaceous Wasatch and Evanston Formations (TKwe), described as "unconsolidated pale-red to greenish-red pebble, cobble, and boulder conglomerate. Forms boulder-covered slopes but does not crop out anywhere. Clasts are mainly Precambrian quartzite and are tan, gray, or purple; matrix is mainly poorly consolidated sand and silt." A generalized bedding attitude shows this unit striking due north and dipping 10 degrees to the east; this map forms the basemap for the *Regional Geology Map 1* (Figure A-2). Coogan and King (2001) produced a regional-scale geologic map that covered the property; this map shows the property to be entirely underlain by the Wasatch Formation. Western Geologic (2012) identified a number of landslide deposits contained within the Powder Mountain Resort expansion area, though none of these were shown underlying the Village Nests area (Figure A-3). Finally, Coogan and King (2016) updated their 2001 map, which is generally consistent with the 2001 map and shows the Wasatch Formation bedrock in the area to be striking approximately to the north-northeast, and dipping between 3 and 6 degrees to the east-southeast; additionally, according to this map, the property abuts a north-south trending syncline[1] (Figure A-4).

Hydrology

The USGS topographic maps for the Huntsville and Brown's Hole Quadrangles (2014) show that the Village Nests project area is situated near the top of a ridge, with the topographic gradient down to the east (see Figure A-1). No active or ephemeral stream drainages are found on the property. No springs are known to occur on the property, though it is possible that springs may occur on various parts of the property during peak runoff.

Baseline groundwater depths for the Village Nests property are currently unknown, but are anticipated to fluctuate both seasonally and annually. Groundwater was not encountered in any of the three test pits excavated in this investigation.

Geologic Hazards

Based upon the available geologic literature, regional-scale geologic hazard maps that cover the Village Nests project area have been produced for landslide, fault, debris-flow, and liquefaction hazards. The following is a summary of the data presented in these regional geologic hazard maps.

Landslides

Two regional-scale landslide hazard maps have been produced that cover the project area. Neither Colton (1991) nor more recent mapping by Elliott and Harty (2010) show the property to be underlain by landslide deposits. However, both of these maps denote landslide deposits immediately east and southeast of the property. Colton (1991) shows the landslide deposits sloping down to the east, and Elliott and Harty (2010) classify the Colton (1991) deposits as "Landslide and/or landslide undifferentiated from talus, colluvial, rock-fall, glacial, and soil-creep deposits." More site-specific, Western Geologic (2012) does not show any landslide

[1] Syncline: A fold of which the core contains the stratigraphically younger rocks; it is generally concave upward. (AGI, 2005)

deposits underlying the Village Nests property, though several landslide deposits are noted to the north and west of the property (see Figure A-3).

Faults

Neither Christensen and Shaw (2008a) nor the Quaternary Fault and Fold Database of the United States (USGS and UGS, 2006) show any Quaternary-aged (~2.6 million years ago to the present) faults to be present on or projecting towards the subject property. The Weber County Natural Hazards Overlay Districts defines an active fault to be “a fault displaying evidence of greater than four inches of displacement along one or more of its traces during Holocene time (about 11,000 years ago to the present)” (Weber County, 2015). The closest active fault to the property is the Weber Segment of the Wasatch Fault Zone, located approximately 10.3 miles west of the western margin of the property (USGS and UGS, 2006).

Debris-Flows

Christensen and Shaw (2008b) do not show the project area to be located within a debris-flow hazard special study area.

Liquefaction

Anderson, et al. (1994) and Christensen and Shaw (2008c) both show the project area to be located in an area with very low potential for liquefaction.

REVIEW OF AERIAL IMAGERY

A series of aerial photographs that cover project area were taken from the UGS Aerial Imagery Collection (UGS, 2016) and analyzed stereoscopically for the presence of adverse geologic conditions across the property. This included a review of photos collected from the years 1947, 1953, and 1963. A table displaying the details of the aerial photographs reviewed can be found in the *References* section at the end of this report.

No geologic lineaments, fault scarps, landslide headscarps, or landslide deposits were observed in the aerial photography on the subject property.

Google Earth imagery of the property from between the years of 1993 and 2016 were also reviewed. No landslide or other geological hazard features were noted in the imagery. The property was observed to contain some surficial gravel, cobbles, and boulders, and devoid of drainages. Most of the project area was found to be covered in various forms of vegetation, with no bedrock exposures anywhere on the property.

At the time of this report, no LiDAR data for the project area was available to be reviewed.

SITE RECONNAISSANCE

Mr. Peter E. Doumit, P.G., C.P.G., of IGES conducted reconnaissance of the site and the immediate adjacent properties on June 23, 2016. The site reconnaissance was conducted with the intent to assess the general geologic conditions present across the property, with specific interest in those areas identified in the geologic literature and aerial imagery reviews as potential geologic hazard areas. Additionally, the site reconnaissance provided the opportunity to geologically map the surficial geology of the area. Figure A-5 is a site-specific geologic map of the Village Nests property and adjacent areas.

Variously-sized boulders and cobbles were found scattered across the property, as part of a surficial geologic unit considered to be either weathered Wasatch Formation or colluvial deposits derived from weathered Wasatch Formation. These were typically subangular to subrounded, and were found to be as large as 3.5 feet in diameter. The rock clasts were found to be comprised of pink to purple massive to conglomeratic quartzite.

The eastern side of the property was densely vegetated with aspen trees, which showed minor to no evidence of soil creep downslope to the east on a gentle, even slope. The western portion of the property had the steepest slopes, and was largely covered in grasses. No springs or ephemeral drainages were observed on the property, though abundant mule's ear plants (possibly indicative of shallow groundwater conditions), were observed approximately 150 feet south of the property. Additionally, no evidence of landsliding or other geologic hazards was observed on the property, though potential localized landslide features were observed to the south and east of the property (see Figure A-5).

Due to ongoing development of the access road that forms the western boundary of the property, it was difficult to tell if any of the western portion of the property had been altered by way of human activity. For the purposes of this investigation, it was assumed to be native.

Though no landslide scarps or deposits were noted on the property, given the proximity to mapped landslides and a setting similar to the nearby *Horizon Neighbourhood* property in which soil-creep and landslide evidence was observed in the subsurface, it was decided that subsurface investigation of the Village Nests property would be prudent to assess the nature of subsurface materials at the site.

SUBSURFACE INVESTIGATION

On July 8, 2016, three exploration test pits were excavated at representative locations across the property (Figure A-5). The test pits were excavated with to depths ranging between 12 and 12.5 feet below existing grade with the aid of a Caterpillar 345C tracked excavator. Detailed logs for each of the test pits are displayed in Figures A-6 through A-8. The same three geologic units were encountered in the subsurface for each of the three test pits. These include the following:

A/B Soil Horizon: This topsoil unit was found to be between 6 inches and 1.5 feet thick. In TP-1, the unit was a medium-stiff, dark brown to reddish brown gravelly lean CLAY (CL). However, in TP-2 and TP-3, the unit was found to be a medium-stiff, light brown silty CLAY with gravel (CL-ML) that appeared to be a possible artificial fill unit. The topsoil was found to be forming upon the underlying colluvium unit.

Colluvium: This unit was found to be between 2.5 and 6.5 feet thick, and consisted of a medium-stiff, dark brown to reddish brown gravelly lean CLAY (CL) gradational to clayey GRAVEL (GC). Gravel and larger-sized subrounded to subangular quartzite clasts comprised between 40% and 70% of the unit, with individual clasts up to 1.5 feet in diameter. The unit commonly contained pinhole voids up to 1 mm in diameter. In TP-2 and TP-3, this unit was observed to contain an area comprised of clay and finer clasts with a significantly lower clast concentration (~15%) than the rest of the unit. The unit may be the product of a combination of both alluvial and colluvial deposition, and was derived from weathered Wasatch Formation bedrock.

Wasatch Formation: This unit underlies the colluvial unit, and extends to the maximum depth of exploration (at least 7.5 feet thick), and consisted of weakly consolidated conglomerate bedrock that had been largely disaggregated into a heterogeneous medium-dense to dense mixture of clay, sand, and gravel. Gravel and larger-sized subrounded quartzite clasts comprised between 30% and 70% of the unit, with individual clasts up to 1 foot in diameter. The unit was generally poorly sorted, and exhibited a weak bedding. Pinhole voids between 1 and 2 mm in diameter were occasionally observed in the clayier parts of the unit.

Groundwater was not encountered in any of the test pits. No landslide deposits, shear planes, slickensides, or other evidence of mass-movement was noted in the test pits.

GEOLOGIC HAZARD ASSESSMENT

Geologic hazard assessments are necessary to determine the potential risk associated with particular geologic hazards that are capable of adversely affecting a proposed development area. As such, they are essential in evaluating the suitability of an area for development and provide critical data in both the planning and design stages of a proposed development. The geologic hazard assessment discussion below is based upon a qualitative assessment of the risk associated with a particular geologic hazard, based upon the data reviewed and collected as part of this investigation.

A “low” hazard rating is an indication that the hazard is either absent, is present in such a remote possibility so as to pose limited or little risk, or is not anticipated to impact the project in an adverse way. Areas with a low-risk determination for a particular geologic hazard do not require additional site-specific studies or associated mitigation practices with regard to the geologic hazard in question. A “moderate” hazard rating is an indication that the hazard has the capability of adversely affecting the project at least in part, and that the conditions necessary for the geologic hazard are present in a significant, though not abundant, manner. Areas with a moderate-risk determination for a particular geologic hazard may require additional site-specific studies, depending on location and construction specifics, as well as associated mitigation practices in the areas that have been identified as the most prone to susceptibility to the particular geologic hazard. A “high” hazard rating is an indication that the hazard is very capable of or currently does adversely affecting the project, that the geologic conditions pertaining to the particular hazard are present in abundance, and/or that there is geologic evidence of the hazard having occurred at the area in the historic or geologic past. Areas with a high-risk determination always require additional site-specific hazard investigations and associated mitigation practices where the location and construction specifics are directly impacted by the hazard. For areas with a high-risk geologic hazard, simple avoidance is often considered.

The following are the results of the geologic hazard assessment for the Village Nests property.

Landslides/Mass Movement/Slope Stability

The property is not located on landslide deposits or headscarps, as determined by the geologic literature review, aerial imagery evaluation, site reconnaissance, and subsurface investigation. Though the eastern portion of the property is located adjacent to mapped landslides (Colton, 1991; Elliott and Harty, 2010), these mapped landslide deposits are not noted on the most recent maps that cover the property (Western Geologic, 2012; Coogan and King, 2016). A couple small, localized features that could possibly be small shallow landslide deposits were noted east and southeast of the property during the site reconnaissance, though most of the mapped landslide deposits were observed to be colluvial deposits (see Figure A-5). Additionally, the average slope across the property is found to be approximately 5:1 (horizontal:vertical), which does not require site-specific slope stability analyses. Though slow soil-creep may currently be occurring, the subsurface data indicate that this is restricted to the topsoil. As such, the risk associated with landslide and slope stability hazards on the property is considered to be low.

Rockfall

The property is near the top of a ridge, and no bedrock is exposed upslope of the property. As such, the rockfall hazard associated with the property is considered to be low.

Surface-Fault-Rupture and Earthquake-Related Hazards

No faults are known to be present on or project across the property, and the closest active fault to the property is the Weber Segment of the Wasatch Fault Zone, located approximately 10.3 miles to the west of the property (USGS and UGS, 2006). Given this information, the risk associated with surface-fault-rupture on the property is considered low.

The entire property is subject to earthquake-related ground shaking from a large earthquake generated along the active Wasatch Fault. Given the distance from the Wasatch Fault, the hazard associated with ground shaking is considered to be moderate. Proper building design according to appropriate building code and design parameters can assist in mitigating the hazard associated with earthquake ground shaking.

Liquefaction

The site is underlain by Wasatch Formation, a poorly consolidated sedimentary rock unit (conglomerate). Rock units such as these are not considered susceptible to liquefaction; as such, the potential for liquefaction occurring at the site is considered low.

Debris-Flows and Flooding Hazards

The property is located near the top of a ridge, and the property does not contain and is not located adjacent to any active or ephemeral drainages. Given these conditions, the debris-flow and flooding hazard associated with the property is considered to be low.

Shallow Groundwater

Groundwater was not encountered in any of the three test pits excavated as part of this investigation. These test pits were excavated in early July, and the groundwater level was likely to be on its way down from a seasonal high. No springs were observed on the property, though plants indicative of shallow groundwater conditions and a small pond were observed within 200 feet of the southeastern corner of the property.

Given the existing data, it is expected that groundwater levels will fluctuate both seasonally and annually and the risk associated with shallow groundwater hazards is considered moderate. However, shallow groundwater issues can be mitigated through appropriate grading measures and/or the avoidance of the construction of residences with basements, or constructing basements with foundation drains.

CONCLUSIONS AND RECOMMENDATIONS

Based upon the data collected and reviewed as part of this assessment, IGES makes the following conclusions regarding the geological hazards present at the Village Nests project area:

- **The Village Nests project area does not appear to have major geological hazards that would adversely affect the development as currently proposed.**

- Earthquake ground shaking is the only hazard that may potentially affect all parts of the project area and is considered to pose moderate risk, while other hazards have the potential to affect only limited portions of the project area, or pose minimal risk.

- Despite the fact that groundwater was not encountered in the subsurface investigations, evidence of shallow groundwater conditions were observed near the property; as such, shallow groundwater hazards are considered moderate for the property, though the easternmost proposed structures will be most susceptible to the shallow groundwater hazard (if at all).

- Landslide, rockfall, surface-fault-rupture, liquefaction, debris-flow, and flooding hazards are considered to be low for the property.

Given the conclusions listed above, IGES makes the following recommendations:

- The potential presence of transient shallow groundwater across the property associated with spring run-off and snow melt makes necessary mitigation practices to adequately address this potential hazard. Appropriate grading measures in low-lying areas susceptible to near-surface groundwater conditions is recommended, as is the construction of the proposed residences without basements, or incorporate a foundation drain for residences with basements.

- Because landslide deposits are noted near the property, an IGES geologist or engineer should observe the foundation excavations to confirm the absence of geologic hazards and ensure the placement of footings into appropriate subsurface materials.

- Below all proposed structures or pavement, we recommend a minimum over-excavation of 2 feet below existing grade. Additional over-excavation may be necessary locally if topsoil or otherwise deleterious soils are exposed in the excavation subgrade.

- Shallow spread or continuous wall footings constructed on a minimum of two feet of structural fill or on competent granular native soils (colluvium or conglomerate) may be proportioned utilizing a maximum net allowable bearing pressure of 2,500 psf. This bearing value is for dead load plus live load conditions. A 1/3 increase may be allowed for wind or seismic loading.

- All other recommendations presented in the Design Geotechnical Investigation report by IGES (2012b) should be followed, except where amended herein.

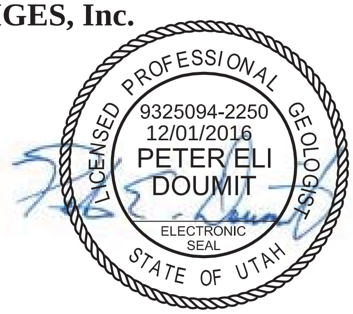
LIMITATIONS

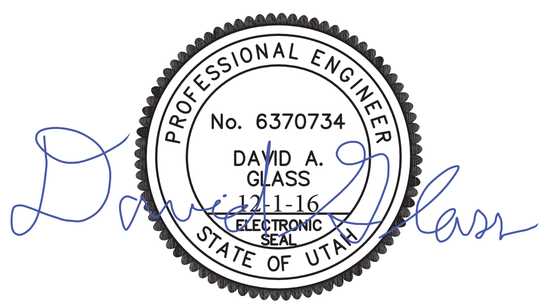
The conclusions and recommendations presented in this report are based on limited geologic literature review, site reconnaissance, subsurface investigation, and our understanding of the proposed construction. It should be noted that construction activities may expose adverse geologic conditions that were hitherto unknown. Therefore, the geologic hazard classifications as denoted in this report are potentially subject to change with data collected from additional excavations across the property. This report was prepared in accordance with the generally accepted standard of practice at the time the report was written. No warranty, expressed or implied, is made.

CLOSURE

We appreciate the opportunity to provide you with our services. If you have any questions, please contact the undersigned at your convenience at (801) 748-4044.

Respectfully Submitted,
IGES, Inc.





Peter E. Doumit, P.G., C.P.G.
Senior Geologist

David A. Glass, P.E.
Senior Geotechnical Engineer

Attachments:

References

Appendix A	Figure A-1	Site Vicinity Map
	Figure A-2	Regional Geology Map 1
	Figure A-3	Regional Geology Map 2
	Figure A-4	Regional Geology Map 3
	Figure A-5	Local Geology Map
	Figures A-6 to A-8	Exploration Logs

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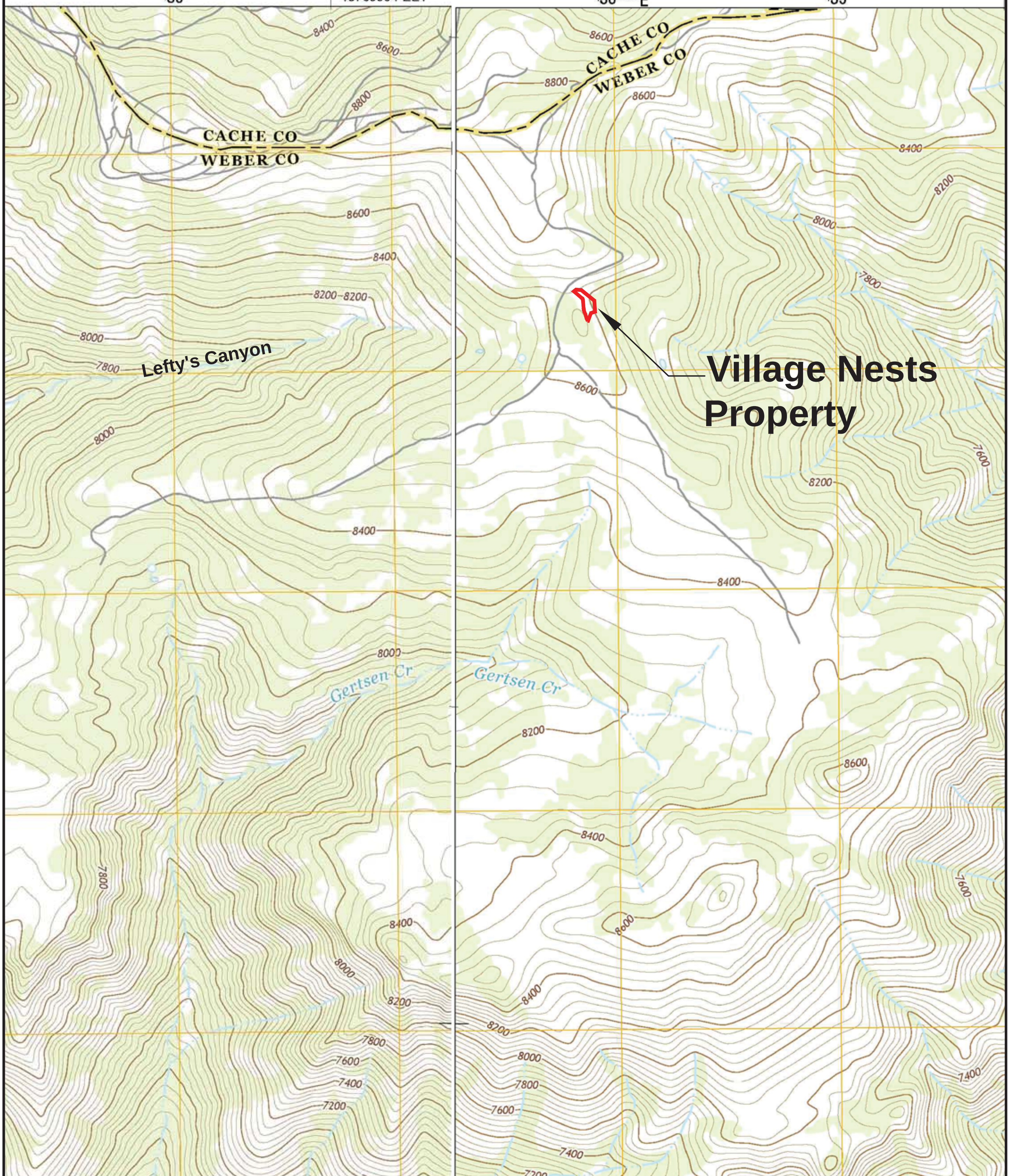
Utah Geological Survey, 2016, Utah Geological Survey Aerial Imagery Collection https://geodata.geology.utah.gov/imagery/

AERIAL PHOTOGRAPHS

Data Set	Date	Flight	Photographs	Scale
1947 AAJ	August 10, 1946	AAJ_1B	88, 89, 90	1:20,000
1953 AAI	September 14, 1952	AAI_4K	34, 35, 36	1:20,000
1963 ELK	June 25, 1963	ELK_3	57, 58, 59	1:15,840

*https://geodata.geology.utah.gov/imagery/

Weber County, 2015, Natural Hazards Overlay Districts, Chapter 27 of Title 104 of the Weber County Code of Ordinances, adopted on December 22, 2015.



BASE MAPS:

-USGS Huntsville 7.5-Minute Topographic Quadrangle Map (2014)

-USGS Brown's Hole 7.5-Minute Topographic Quadrangle Map (2014)

QUADRANGLE LOCATION

N

0 1000 2000 3000

FEET

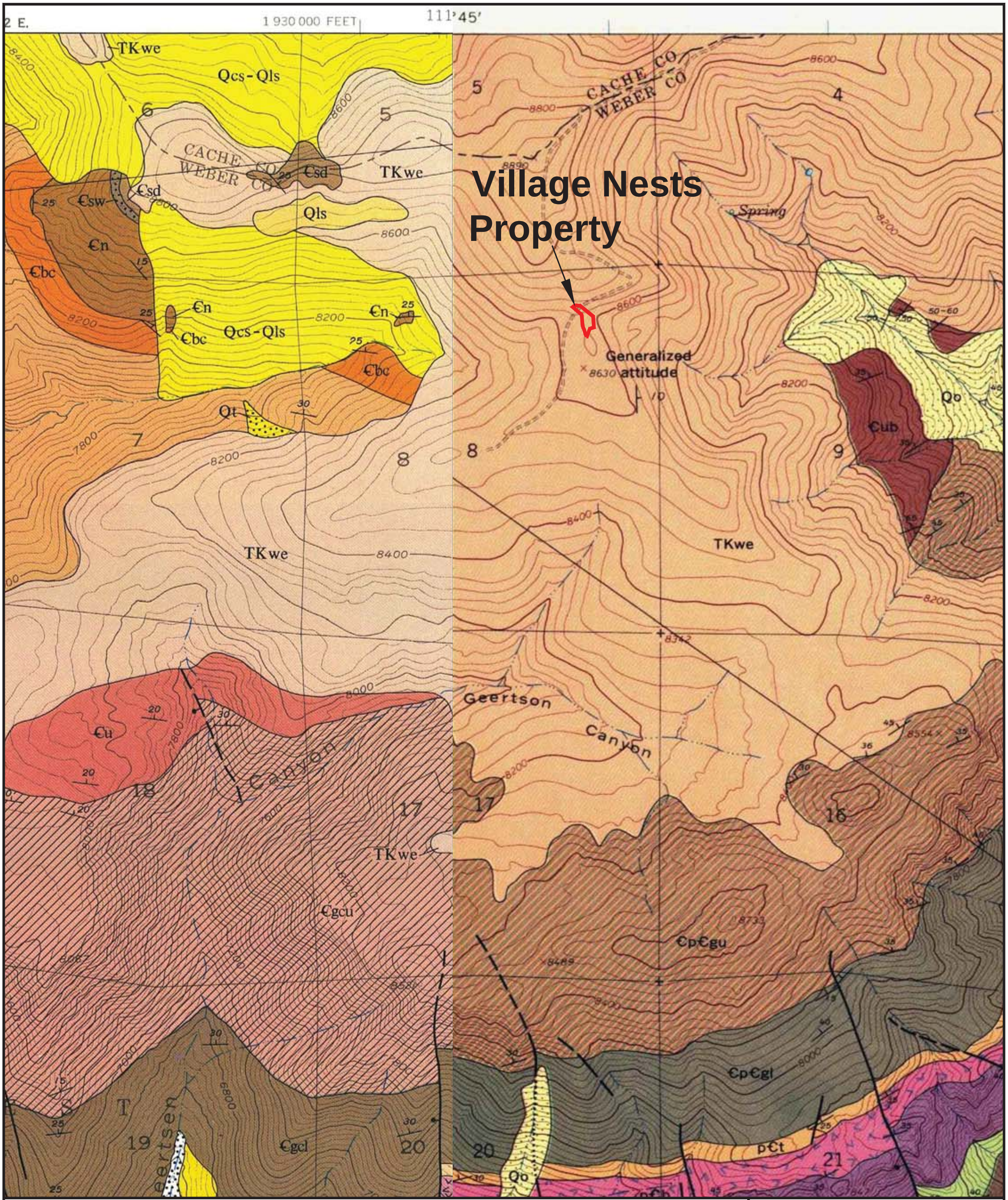
FIGURE A-1

SITE VICINITY MAP

VILLAGE NESTS

GEOTECHNICAL AND GEOLOGIC HAZARD ASSESSMENT
SUMMIT POWDER MOUNTAIN RESORT
WEBER COUNTY, UTAH

DATE: 11/28/2016	SCALE: 1"=2,000'	IGES
PROJECT:01628–015		



BASE MAPS:

-USGS Huntsville 7.5-Minute Geologic Quadrangle Map (GQ-1503), Sorensen and Crittenden, Jr. (1979)

-USGS Brown's Hole 7.5-Minute Geologic Quadrangle Map (GQ-968), Crittenden, Jr. (1972)

UTAH

QUADRANGLE LOCATION

N

0 1000 2000 3000

FEET

FIGURE A-2a

REGIONAL GEOLOGY MAP 1

VILLAGE NESTS

GEOTECHNICAL AND GEOLOGIC HAZARD ASSESSMENT
SUMMIT POWDER MOUNTAIN RESORT
WEBER COUNTY, UTAH

DATE: 11/28/2016 | SCALE: 1"=2,000' | IGES

PROJECT:01628-015

MAP LEGEND

Qal ALLUVIAL DEPOSITS, UNDIFFERENTIATED (Holocene) – Unconsolidated gravel, sand, and silt deposits in presently active stream channels and floodplains; thickness 0-6 m

Qcs COLLUVIUM AND SLOPEWASH (Holocene) – Bouldery colluvium and slopewash chiefly along eastern margin of Ogden Valley; in part, lag from Tertiary units; thickness 0-30 m

Qf ALLUVIAL FAN DEPOSITS (Holocene) – Alluvial fan deposits; postdate, at least in part, time of highest stand of former Lake Bonneville; thickness 0-30 m

Qls LANDSLIDE DEPOSITS (Holocene) – thickness 0-6 m

Qt TALUS DEPOSITS (Holocene) – thickness 0-6 m

TKwe WASATCH AND EVANSTON(?) FORMATIONS, UNDIVIDED (Eocene, Paleocene, and Upper Cretaceous?) – Unconsolidated pale-reddish-brown pebble, cobble, and boulder conglomerate; forms boulder-covered slopes. Clasts are mainly Precambrian quartzite and are tan, gray, or purple; matrix is mainly poorly consolidated sand and silt; thickness 0-150 m

ST. CHARLES LIMESTONE (Upper Cambrian) – Includes:

Ꞓsd Dolomite member – Thin- to thick-bedded, finely to medium crystalline, light- to medium-gray, white- to light-gray-weathering, cliff-forming dolomite; linguloid brachiopods common in basal 15 m; thickness 150-245 m

Ꞓsw Worm Creek Quartzite Member – Thin-bedded, fine- to medium-grained, medium- to dark-gray, tan- to brown-weathering calcareous quartzitic sandstone; detrital grains well-sorted and well-rounded; thickness 6 m

Ꞓn NOUNAN DOLOMITE (Upper and Middle Cambrian) – Thin- to thick-bedded, finely crystalline, medium-gray, light- to medium-gray-weathering, cliff-forming dolomite; white twiggy structures common throughout unit; thickness 150-230 m

Ꞓbc CALLS FORT SHALE MEMBER OF BLOOMINGTON FORMATION (Middle Cambrian) – Olive-drab to light-brown shale and light- to dark-blue-gray limestone with intercalated orange to rusty-brown silty limestone; intraformational conglomerate common throughout unit; thickness 23-90 m

BASE MAPS:

-USGS Huntsville 7.5-Minute Geologic Quadrangle Map (GQ-1503), Sorensen and Crittenden, Jr. (1979)

-USGS Brown's Hole 7.5-Minute Geologic Quadrangle Map (GQ-968), Crittenden, Jr. (1972)

QUADRANGLE LOCATION

N

0 1000 2000 3000

FEET

FIGURE A-2b

REGIONAL GEOLOGY MAP 1

VILLAGE NESTS

GEOTECHNICAL AND GEOLOGIC HAZARD ASSESSMENT
SUMMIT POWDER MOUNTAIN RESORT
WEBER COUNTY, UTAH

DATE: 11/28/2016
PROJECT:01628-015
SCALE: 1"=2,000'
IGES

MAP LEGEND

€lu **CAMBRIAN LIMESTONES, UNDIVIDED** (Middle Cambrian) — Includes limestone and Hodges Shale Members of Bloomington Formation, and Blacksmith and Ute Limestones

€b **BLACKSMITH LIMESTONE** (Middle Cambrian)) — Medium- to thin-bedded, light-gray to dark-blue-gray limestone; thin-bedded, flaggy-weathering, gray to tan silty limestone and interbedded siltstone; light- to dark-gray dolomite, with some reddish siliceous partings; thickness 400? m

€u **UTE LIMESTONE** (Middle Cambrian) — Medium- to thin-bedded, finely crystalline, light- to dark-gray silty limestone with irregular wavy partings, mottled and streaked surfaces, worm tracks, and twiggy structures common throughout unit; oolites and *Girvanella* in many beds; olive-drab fissile shale interbedded throughout unit. Includes thin-bedded, gray-weathering, pale-tan to brown dolomite exposed at base of unit, 18-24 m at head of Geertsen Canyon and 0-3 m elsewhere; thickness 245? m

GEERTSEN CANYON QUARTZITE (Lower Cambrian) — Includes:

€gcu Upper member — Pale-buff to white or flesh-pink quartzite, locally streaked with pale red or purple. Coarse-grained; small pebbles occur throughout unit and increase in abundance downward. Base marked by zone 30-60 m thick of cobble conglomerate in beds 30 cm to 2 m thick; clasts, 5-10 cm in diameter, are mainly reddish vein quartz or quartzite, sparse gray quartzite, or red jasper; thickness 730-820 m

€gcl Lower member — Pale-buff to white and tan quartzite with irregular streaks and lenses of cobble conglomerate decreasing in abundance downward. Lower 90-120 m strongly arkosic, streaked greenish or pinkish. Feldspar clasts increase in size to 0.6-1.3 cm in lower part of unit; thickness 490-520 m

Recently active normal fault — Dashed where inferred. Ticks on downthrown side

Pre-Tertiary normal fault — Dotted where concealed Bar and ball on downthrown side

Thrust fault — Dashed where inferred Sawteeth on upper plate

BASE MAPS:

-USGS Huntsville 7.5-Minute Geologic Quadrangle Map (GQ-1503), Sorensen and Crittenden, Jr. (1979)

-USGS Brown's Hole 7.5-Minute Geologic Quadrangle Map (GQ-968), Crittenden, Jr. (1972)

QUADRANGLE LOCATION

N

0 1000 2000 3000

FEET

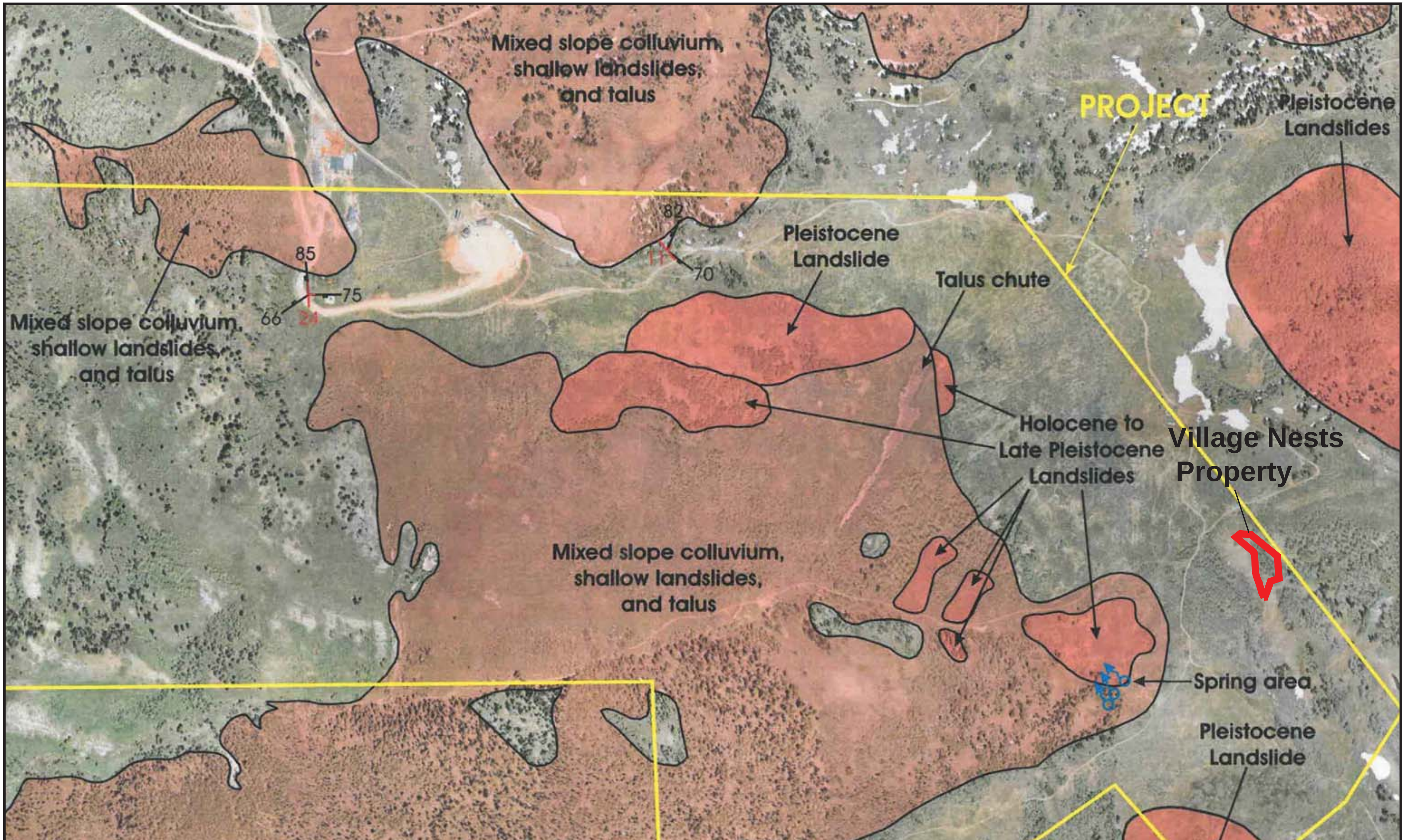
FIGURE A-2c

REGIONAL GEOLOGY MAP 1

VILLAGE NESTS

GEOTECHNICAL AND GEOLOGIC HAZARD ASSESSMENT
SUMMIT POWDER MOUNTAIN RESORT
WEBER COUNTY, UTAH

DATE: 11/28/2016
PROJECT:01628–015
SCALE: 1"=2,000'
IGES



BASE MAP:

Western Geologic (2012) Geologic Hazards Reconnaissance Report, Figure 3

FIGURE A-3

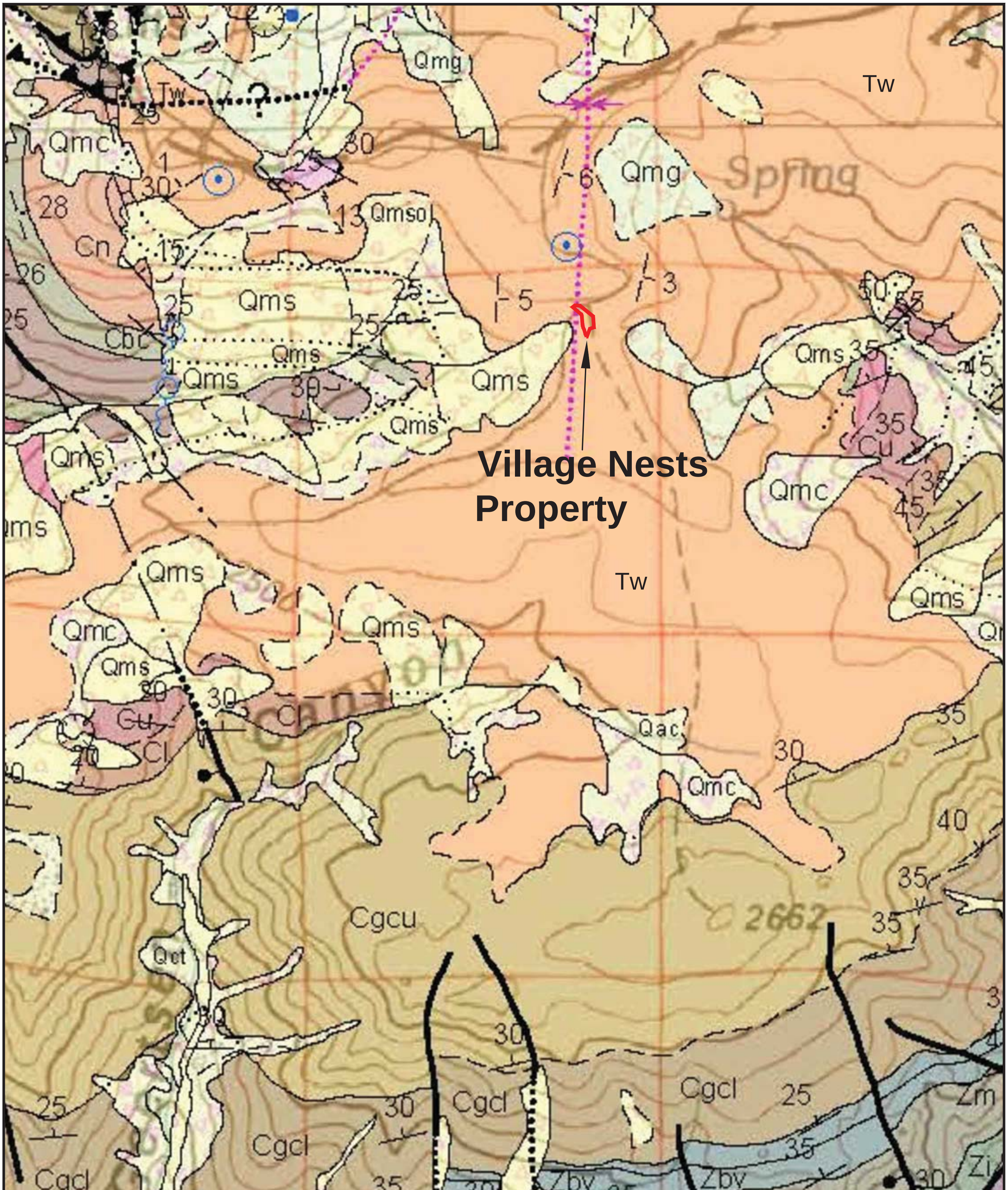
REGIONAL GEOLOGY MAP 2

VILLAGE NESTS

GEOTECHNICAL AND GEOLOGIC HAZARD ASSESSMENT
SUMMIT AT POWDER MOUNTAIN RESORT
WEBER COUNTY, UTAH

DATE: 11/28/2016
FILE: 01628–015
SCALE: 1"=1,000'

IGES



BASE MAP:

-Utah Geological Survey
Ogden 30' x 60' Geologic Quadrangle
Map (OFR-653DM, Plate 1),
Coogan and King (2016)

UTAH

QUADRANGLE LOCATION

N

0 1000 2000 3000
FEET

FIGURE A-4a

REGIONAL GEOLOGY MAP 3

VILLAGE NESTS

GEOTECHNICAL AND GEOLOGIC HAZARD ASSESSMENT
SUMMIT POWDER MOUNTAIN RESORT
WEBER COUNTY, UTAH

DATE: 11/28/2016
PROJECT:01628-015
SCALE: 1"=2,000'

IGES

MAP LEGEND

Qmc **Landslide and colluvial deposits, undivided (Holocene and Pleistocene)** – Poorly sorted to unsorted clay- to boulder-sized material; mapped where landslide deposits are difficult to distinguish from colluvium (slopewash and soil creep) and where mapping separate, small, intermingled areas of landslide and colluvial deposits is not possible at map scale; locally includes talus and debris flow and flood deposits; typically mapped where landslides are thin ("shallow"); also mapped where the blocky or rumpled morphology that is characteristic of landslides has been diminished ("smoothed") by slopewash and soil creep; composition depends on local sources; 6 to 40 feet (2-12 m) thick. These deposits are as unstable as other landslide units (Qms, Qmsy, Qmso).

Qms, Qms?, Qmsy, Qmsy?, Qmso, Qmso?

Landslide deposits (Holocene and upper and middle? Pleistocene) – Poorly sorted clay- to boulder-sized material; includes slides, slumps, and locally flows and floods; generally characterized by hummocky topography, main and internal scarps, and chaotic bedding in displaced blocks; composition depends on local sources; morphology becomes more subdued with time and amount of water in material during emplacement; Qms may be in contact with Qms when landslides are different/distinct; thickness highly variable, up to about 20 to 30 feet (6-9 m) for small slides, and 80 to 100 feet (25-30 m) thick for larger landslides. Qmsy and Qmso queried where relative age uncertain; Qms queried where classification uncertain. Numerous landslides are too small to show at map scale and more detailed maps shown in the index to geologic mapping should be examined.

Qms without a suffix is mapped where the age is uncertain (though likely Holocene and/or late Pleistocene), where portions of slide complexes have different ages but cannot be shown separately at map scale, or where boundaries between slides of different ages are not distinct. Estimated time of emplacement is indicated by relative-age letter suffixes with: Qmsy mapped where landslides deflect streams or failures are in Lake Bonneville deposits, and scarps are variably vegetated; Qmso typically mapped where deposits are "perched" above present drainages, rumpled morphology typical of mass movements has been diminished, and/or younger surficial deposits cover or cut Qmso. Lower perched Qmso deposits are at Qao heights above drainages (95 ka and older) and the higher perched deposits may correlate with high level alluvium (QTa_) (likely older than 780 ka) (see table 1). Suffixes y and o indicate probable Holocene and Pleistocene ages, respectively, with all Qmso likely emplaced before Lake Bonneville transgression. These older deposits are as unstable as other slides, and are easily reactivated with the addition of water, be it irrigation or septic tank drain fields.

Qmg, 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, and appear to have failed or moved down slope; also mapped in upper Strawberry Bowl (Snow Basin quadrangle) where glacial deposits have lost their distinct morphology and the contacts between them and colluvium and talus in the cirques cannot be mapped; likely less than 30 feet (9 m) thick, but may be thicker in Mantua, James Peak, North Ogden, Huntsville, and Peterson quadrangles.

Tw, Tw?

Wasatch Formation (Eocene and upper Paleocene) – Typically red to brownish-red sandstone, siltstone, mudstone, and conglomerate with minor gray limestone and marlstone locally (see Twl); lighter shades of red, yellow, tan, and light gray present locally and more common in uppermost part, complicating mapping of contacts with overlying similarly colored Norwood and Fowkes Formations; clasts typically rounded Neoproterozoic and Paleozoic sedimentary rocks, mainly Neoproterozoic and Cambrian quartzite; basal conglomerate more gray and less likely to be red, and containing more locally derived angular clasts of limestone, dolomite and sandstone, typically from Paleozoic strata, for example in northern Causey Dam

BASE MAPS:

-Utah Geological Survey
Ogden 30' x 60' Geologic Quadrangle
Map (OFR-653DM, Plate 1),
Coogan and King (2016)

N

0 1000 2000 3000

FEET

FIGURE A-4b

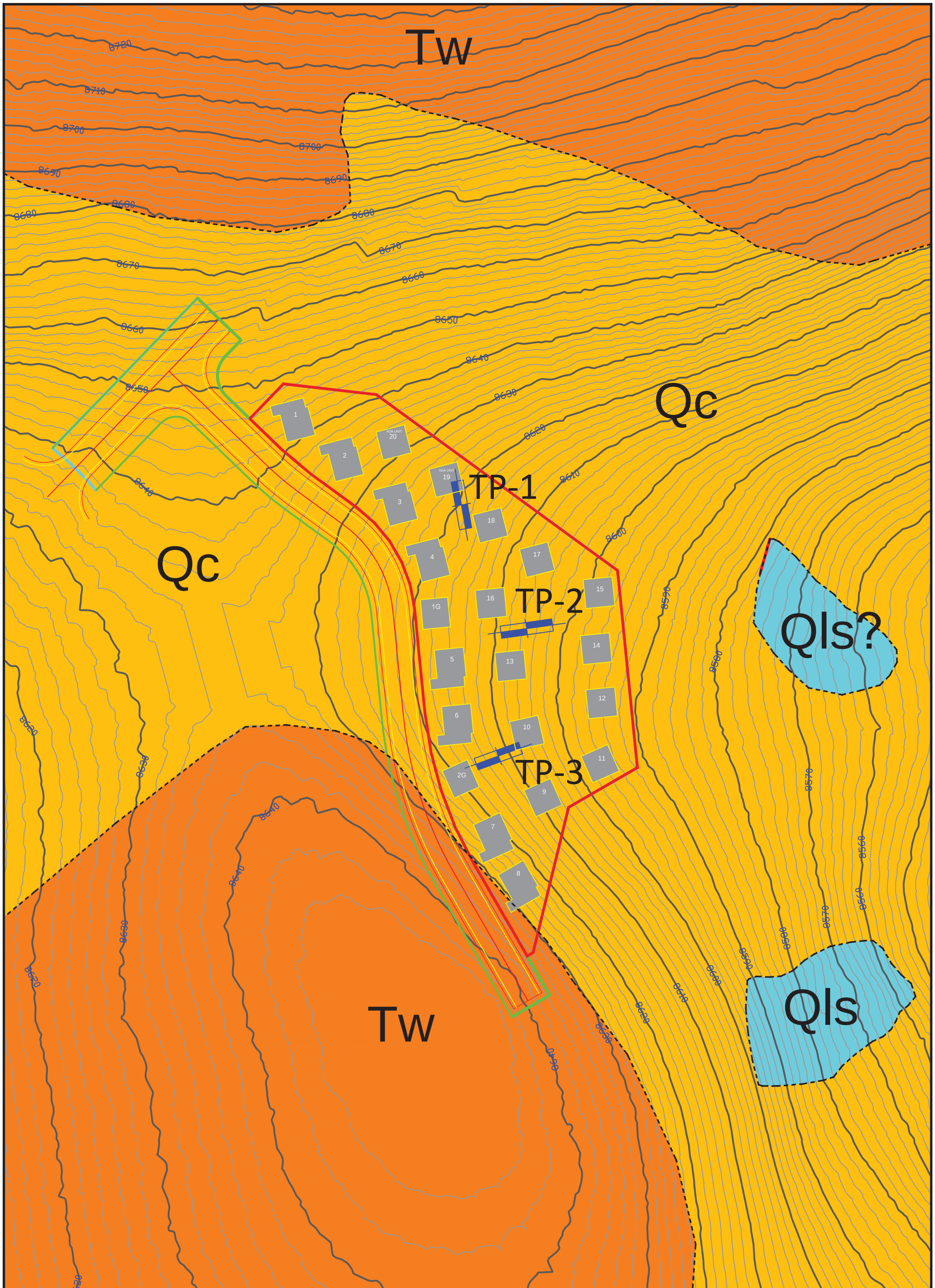
REGIONAL GEOLOGY MAP 1

VILLAGE NESTS

GEOTECHNICAL AND GEOLOGIC HAZARD ASSESSMENT
SUMMIT POWDER MOUNTAIN RESORT
WEBER COUNTY, UTAH

DATE: 11/28/2016
PROJECT:01628–015
SCALE: 1"=2,000'

IGES



LEGEND

Qc COLLUVIUM (HOLOCENE-PLEISTOCENE)

Qls SHALLOW LANDSLIDE DEPOSITS (HOLOCENE-PLEISTOCENE)

Tw WASATCH FORMATION (EOCENE-PALEOCENE)

VILLAGE NESTS PROPERTY BOUNDARY

TP-3 TEST PIT LOCATION

ALL CONTACTS APPROXIMATE

0 150 FEET

N

BASEMAP FROM NV5

FIGURE A-5

LOCAL GEOLOGY MAP

VILLAGE NESTS

GEOTECHNICAL AND GEOLOGIC HAZARD ASSESSMENT

SUMMIT POWDER MOUNTAIN RESORT
WEBER COUNTY, UTAH

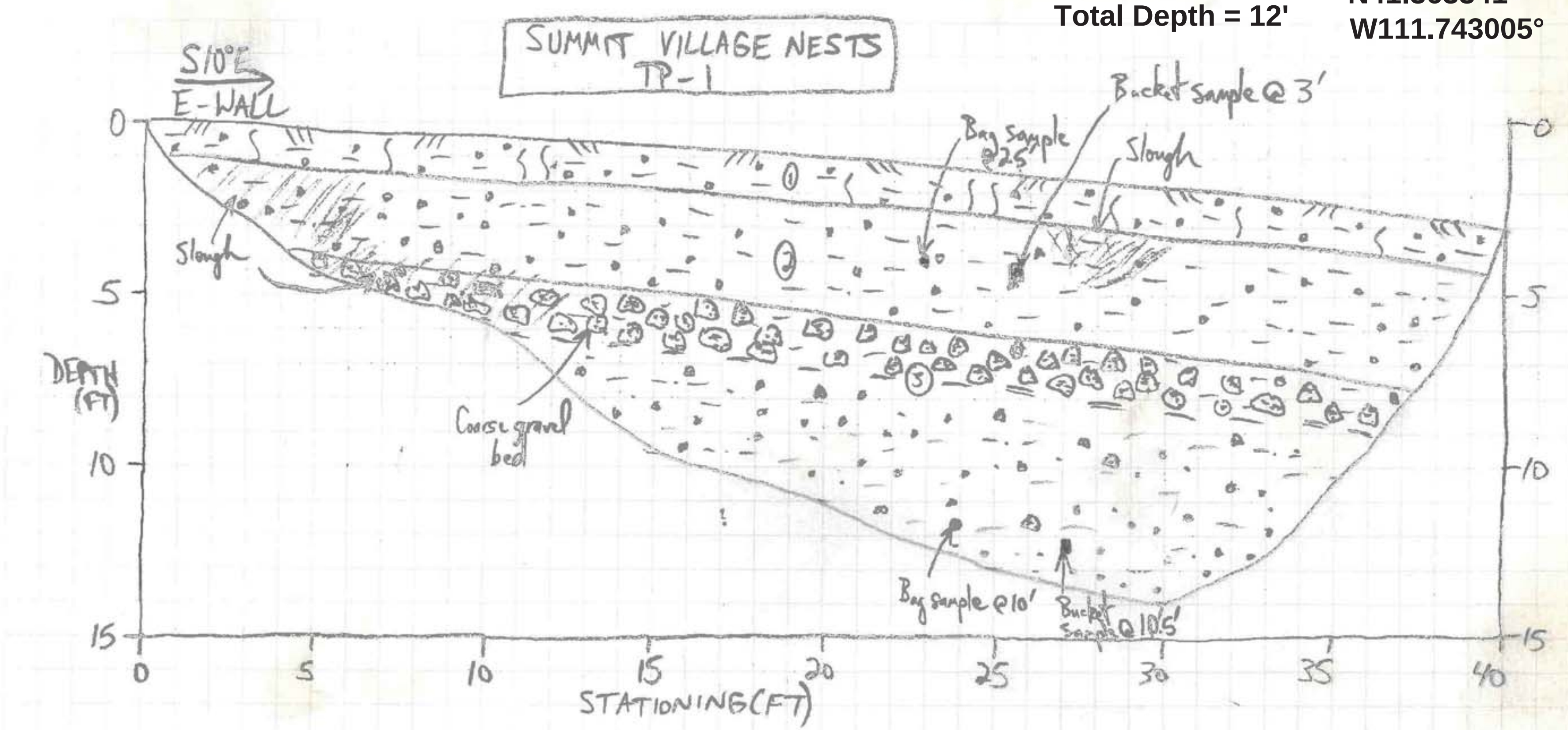
DATE: 11/29/2016 | SCALE: 1"=75'
PROJECT:01628-015

IGES

Project No. 01628-015
Date 7-8-16 by PED
Ckd by ______ on ______

Total Depth = 12'

N41.363341°
W111.743005°



*No groundwater encountered.

LITHOLOGIC UNIT DESCRIPTIONS:

1. A/B Soil Horizon: ~1-1.5' thick; dark yellowish brown (10YR 4/2) to moderate reddish brown (10R 4/6) gravelly lean CLAY (CL), medium stiff, slightly moist, low plasticity, massive; gravel and larger sized clasts comprise ~40% of unit; clasts entirely subrounded to subangular medium light gray (N6) quartzite up to 2" in diameter, though some boulders (1 to 2' in diameter) seen on surface; clasts are largely homogeneous in size, ranging between 1/2" and 2" in diameter; poorly sorted; abundant plant and tree roots; gradational, planar basal contact.

2. Colluvium: ~2-3' thick; moderate reddish brown (10R 4/6) to dark yellowish brown (10YR 4/2) gravelly lean CLAY (CL) gradational to clayey GRAVEL (GC), medium stiff, slightly moist, low plasticity, massive; gravel and larger sized clasts comprise ~60% of unit; clasts entirely quartzite as above and up to 2" in diameter; matrix is largely topsoil; minor silt; abundant pinhole voids (1 mm) throughout; abundant plant and tree roots in upper half of unit, which become less common with depth; irregular, gradational basal contact.

3. Wasatch Fm: ~At least 7.5' thick; dark reddish brown (10R 3/4) to moderate reddish brown (10R 4/6) to pale reddish brown (10R 5/4); weakly consolidated conglomerate bedrock, disaggregated to gravelly lean CLAY (CL) gradational to clayey GRAVEL (GC), stiff, moist, low to moderate plasticity, massive; gravel and larger sized clasts comprise ~50-70% of unit; clasts entirely subrounded to subangular light gray (N7) to grayish purple (5P 4/2) quartzite up to 1' in diameter, though mode size 1-2"; common silt and very fine-grained sand; uppermost ~2' contains coarsest material, with mode clast size ~6"; overall, unit appears somewhat reversely graded; poorly sorted except in upper coarse bed, which is moderately sorted; occasional to common pinhole voids (1-2 mm); rare plant and tree roots.

FIGURE A-6
TP-1 LOG

VILLAGE NESTS

GEOTECHNICAL AND GEOLOGIC HAZARD ASSESSMENT

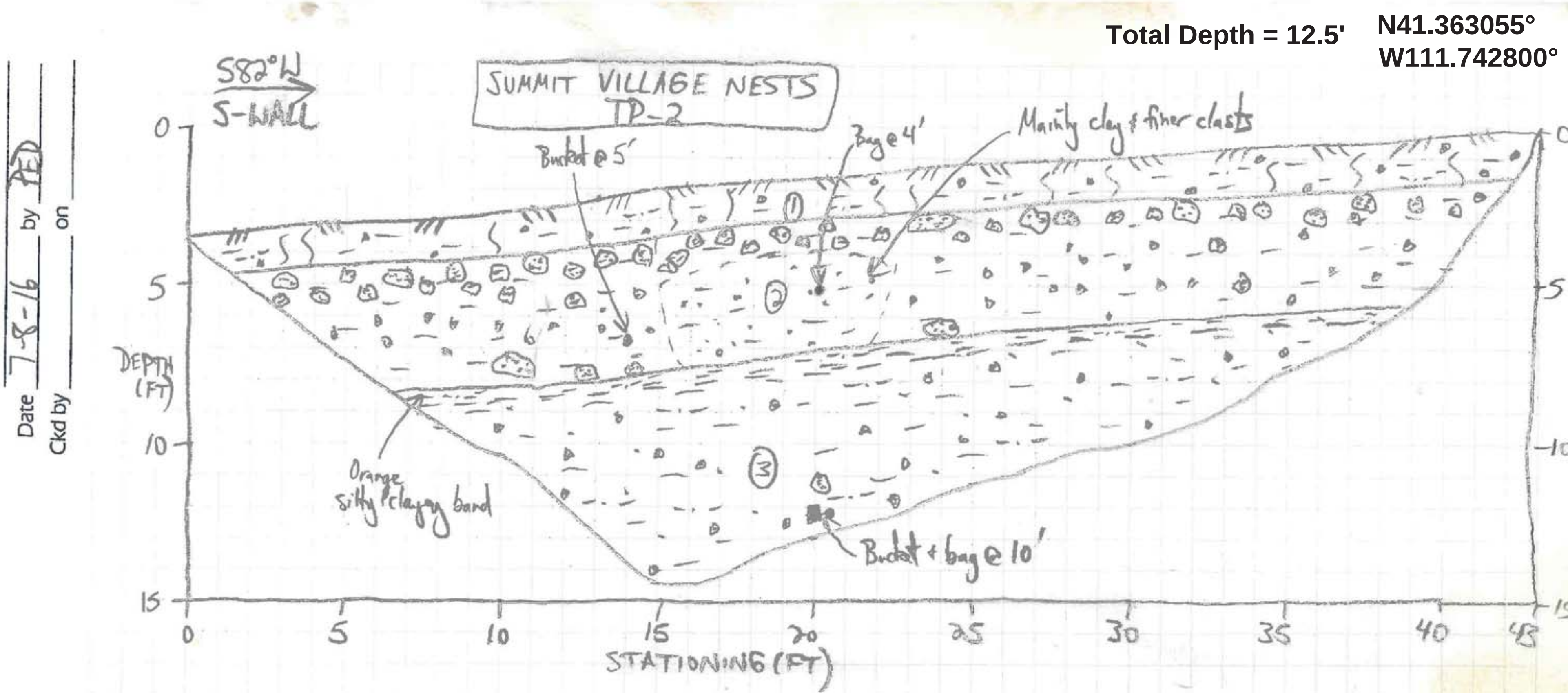
SUMMIT POWDER MOUNTAIN

WEBER COUNTY, UTAH

DATE: 11/22/2016	SCALE: 1"=5'	IGES
PROJECT: 01628-015		

Total Depth = 12.5'

N41.363055°
W111.742800°



*No groundwater encountered.

LITHOLOGIC UNIT DESCRIPTIONS:

1. A/B Soil Horizon: ~1.5' thick; light brown (5YR 6/4) to moderate yellowish brown (10YR 5/4) silty CLAY with gravel (CL-ML), medium stiff, dry, low plasticity, massive; gravel and larger sized clasts comprise ~10-15% of unit; clasts entirely subangular to subrounded medium gray (N5) quartzite up to 5" in diameter, though mode size is 1/2"; common pinhole voids throughout (1 mm); blocky texture in places; common plant and tree roots; possibly fill, as unit does not appear similar to TP-1 topsoil.

2. Colluvium: ~4' thick; dark yellowish brown (10YR 4/2) clayey GRAVEL (GC), medium dense, moist, low plasticity, massive; gravel and larger sized clasts comprise ~70% of unit; clasts entirely quartzite as above, subrounded to subangular, and up to 1.5' in diameter, though mode size ~4"; unit appears to be sorted by clast size: uppermost ~1' has coarsest material (mode size 6"), middle ~2' mode size 4", basal ~1' is mix of both larger and smaller clasts; middle of unit has an anomalously lower clast concentration (~15%), with small clasts (<1") that are largerly subangular; clay component is lean; common pinhole voids throughout (1 mm); occasional plant and tree roots; sharp, planar basal contact.

3. Wasatch Fm: ~At least 7' thick; moderate reddish brown (10R 4/6) to dark yellowish orange (10YR 6/6); poorly consolidated conglomerate bedrock, disaggregated to clayey GRAVEL with sand (GC), medium dense to dense, moist, low plasticity, massive, though possibly weakly thickly bedded; gravel and larger sized clasts comprise ~50-60% of unit; clasts entirely subrounded to subangular quartzite as above up to 1' in diameter, though mode size 2-4"; minor silt component, and becomes sandier with depth; single clast of dark gray shaley dolomite found weathering out of unit in base of test pit; occasional pinhole voids (1 mm) in clayier parts of unit; orange clayey/silty band ~4" thick found at top of unit; rare plant and tree roots.

FIGURE A-7
TP-2 LOG

VILLAGE NESTS

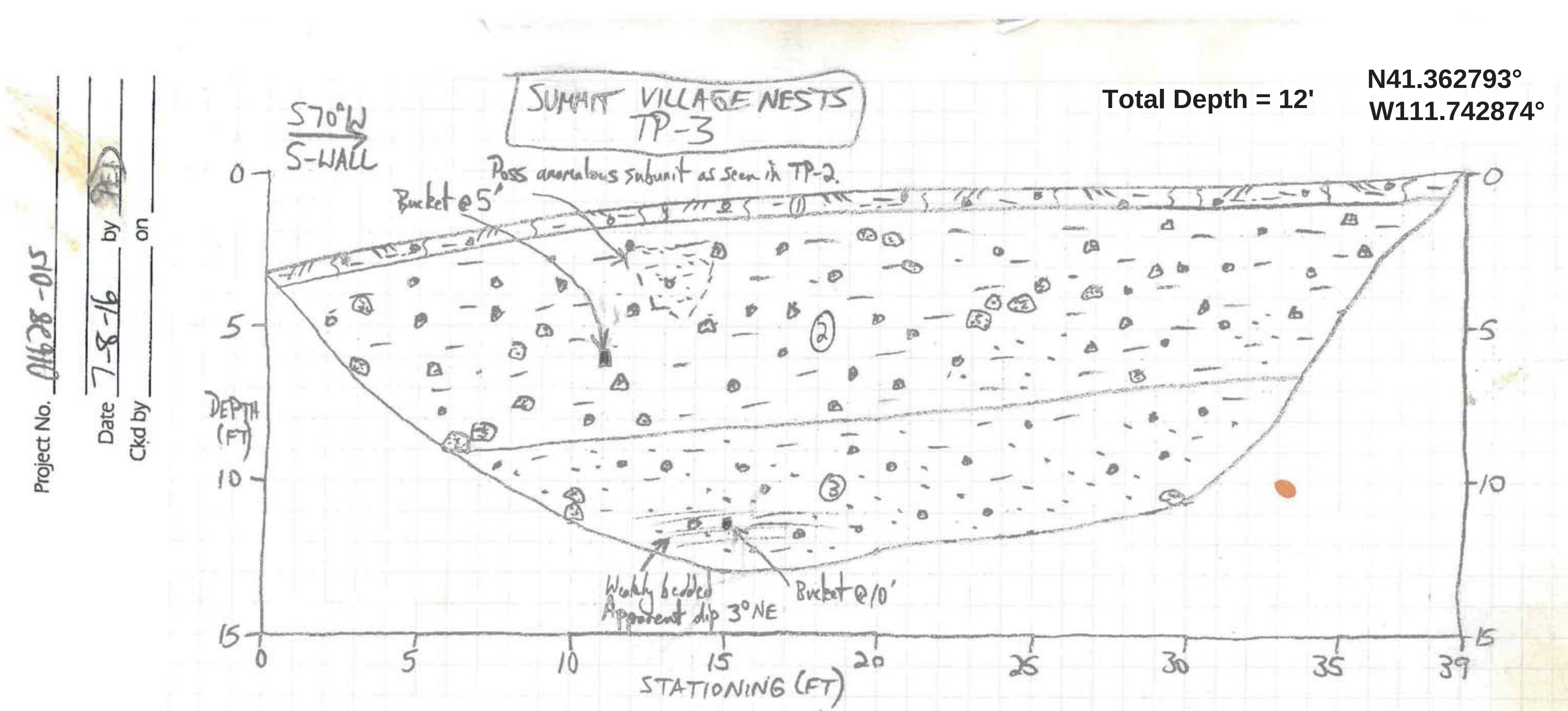
GEOTECHNICAL AND GEOLOGIC HAZARD ASSESSMENT

SUMMIT POWDER MOUNTAIN

WEBER COUNTY, UTAH

DATE: 11/22/2016 SCALE: 1"=5'
PROJECT: 01628-015

IGES



*No groundwater encountered.

LITHOLOGIC UNIT DESCRIPTIONS:

1. A/B Soil Horizon: ~6" thick; light brown (5YR 6/4) to moderate yellowish brown (10YR 5/4) gravelly silty CLAY (CL-ML), medium stiff, dry, low plasticity, massive; gravel and larger sized clasts comprise ~40% of unit; clasts entirely subangular to subrounded medium gray (N5) quartzite up to 5" in diameter, though mode size is 1/2"; common pinhole voids throughout (1 mm); blocky texture in places; common plant and tree roots; same unit as seen in TP-2, except much higher proportion of clasts; unit appears similar to cemented colluvium unit seen elsewhere at Powder Mountain.

2. Colluvium: ~6.5' thick; dark yellowish brown (10YR 4/2) gravelly lean CLAY (CL) gradational to clayey GRAVEL (GC), medium stiff, moist, low plasticity, massive; gravel and larger sized clasts comprise ~40-50% of unit; clasts entirely subrounded to subangular quartzite as above up to 10" in diameter, though in a heterogeneous mixture of clasts sizes (mode size ~1-3"); locally sandy; may contain middle portion with finer clasts, as seen in TP-2, though the subunit is less conspicuous and does not show clast size sorting; poorly sorted; common pinhole voids (1-2 mm) and plant and tree roots; planar, gradational basal contact.

3. Wasatch Fm: ~At least ~5' thick; dark reddish brown (10R 3/4) to moderate reddish brown (10R 4/6); weakly consolidated conglomerate bedrock, disaggregated to clayey SAND with gravel (SC), medium dense to dense, moist, low plasticity, thinly weakly bedded downslope to northeast; gravel and larger sized clasts comprise ~30-40% of unit; clasts entirely subrounded to subangular quartzite as above up to 8" in diameter, though mode size 1-2"; clay component is lean; sand component is medium-grained and includes predominantly quartz grains and some quartzite grains; minor silt; clayey near top and becomes sandier with depth; rare plant and tree roots.

FIGURE A-8

TP-3 LOG

VILLAGE NESTS

GEOTECHNICAL AND GEOLOGIC HAZARD ASSESSMENT

SUMMIT POWDER MOUNTAIN

WEBER COUNTY, UTAH

DATE: 11/22/2016	SCALE: 1"=5'
PROJECT: 01628-015	

IGES