REPORT

GEOLOGIC HAZARDS EVALUATION
OSMAN PROPERTY
4337 NORTH 2900 EAST
LIBERTY, WEBER COUNTY, UTAH

Prepared for

Charles Osman
976 Bridgecreek Drive
Layton, Utah 84041

June 25, 2020

Prepared by

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June 25, 2020

Charles Osman
976 Bridgecreek Drive
Layton, Utah 84041

Letter of Transmittal: REPORT
Geologic Hazards Evaluation
Osman Property
4337 North 2900 East
Liberty, Weber County, Utah

Dear Mr. Osman:

Western Geologic & Environmental has completed a Geologic Hazards Evaluation for the Osman Property at 4337 North 2900 East in Liberty, Utah and submits the attached report for your review.

If you have any questions regarding this report, please contact us at (801) 359-7222.

Sincerely,
Western Geologic & Environmental LLC

LICENSED PROFESSIONAL GEOLOGIST
06/25/2020
BILL DUANE BLACK
NO. 5224898-2250
STATE OF UTAH

Bill. D. Black, P.G.
Subcontract Geologist

Reviewed By:

LICENSED PROFESSIONAL GEOLOGIST
06/25/2020
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STATE OF UTAH

Kevin J. Thomas, P.G.
Principal Geologist

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WG&E Project No. 5426

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1.0 INTRODUCTION

This report presents the results of a geology and geologic hazards review and evaluation conducted by Western Geologic & Environmental LLC (Western Geologic) for the Osman Property located at 4337 North 2900 East in Liberty, Utah (Figure 1 – Project Location). The Project consists of a 7.37-acre parcel identified as Weber County Assessor's parcel number 22-008-0074. The Project is on generally southeast-facing slopes at the base of the Wasatch Range in western Ogden Valley in the S1/2 Section 18, Township 7 North, Range 1 East (Salt Lake Base Line and Meridian; Figure 1). Elevation of the site ranges from about 5,191 feet to 5,463 feet above sea level. The property is currently undeveloped. No formalized development plans were provided, but it is our understanding that the intended development is for a single-family residential home in the central northeast part of the site.

2.0 PURPOSE AND SCOPE

The purpose and scope of this investigation is to identify and interpret surficial geologic conditions at the site to identify potential risk from geologic hazards to the Project. This investigation is intended to: (1) provide preliminary geologic information and assessment of geologic conditions at the site; (2) identify potential geologic hazards that may be present and qualitatively assess their risk to the intended site use; and (3) provide recommendations for additional site- and hazard-specific studies or mitigation measures, as may be needed based on our findings. Such recommendations could require further multi-disciplinary evaluations, and/or may need design criteria that are beyond our professional scope. Our investigation was conducted concurrently with a geotechnical engineering study performed at the Project by Christensen Geotechnical.

2.1 Methodology

The following services were performed in accordance with the above-stated purpose and scope:

- A site reconnaissance conducted by an experienced certified engineering geologist to assess the site setting and look for adverse geologic conditions;
- Review of readily-available geologic maps, reports, and air photos;
- Logging of three onsite walk-in test pits to assess subsurface conditions;
- Preparation of one cross section profile based on site-specific subsurface data and inferred conditions; and
- Evaluation of available data and preparation of this report, which presents the results of our study.

The engineering geology section of this report has been prepared in accordance with Bowman and Lund (2016) and current generally accepted professional engineering geologic principles and practice in Utah, and meets specifications provided in Chapter 27 of the Weber County Land Use Code within the above stated scope. We do not include discussion of radon hazard potential, as recommended in Bowman and Lund (2016), because radon gas poses an environmental health hazard and indoor levels are heavily influenced by several post-construction, non-geologic factors. The hazard from radon should be evaluated by long-term testing following construction.

2.2 Limitations and Exceptions

This investigation was performed at the request of Mr. Charles Osman (the Client) using the methods and procedures consistent with good commercial and customary practice designed to conform to acceptable industry standards. The analysis and recommendations submitted in this report are based upon the data obtained from site-specific observations and compilation of known geologic information. This information and the conclusions of this report should not be interpolated to adjacent properties without additional site-specific information. In the event that any changes are later made in the location of the proposed site, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and conclusions of this report modified or approved in writing by the engineering geologist.

This report has been prepared by the staff of Western Geologic for the Client under the professional supervision of the principal and/or senior staff whose seal(s) and signatures appear hereon. Neither Western Geologic, nor any staff member assigned to this investigation has any interest or contemplated interest, financial or otherwise, in the subject or surrounding properties, or in any entity which owns, leases, or occupies the subject or surrounding properties or which may be responsible for environmental issues identified during the course of this investigation, and has no personal bias with respect to the parties involved.

The information contained in this report has received appropriate technical review and approval. The conclusions represent professional judgment and are founded upon the findings of the investigations identified in the report and the interpretation of such data based on our experience and expertise according to the existing standard of care. No other warranty or limitation exists, either expressed or implied.

The investigation was prepared in accordance with the approved scope of work outlined in our proposal for the use and benefit of the Client; its successors, and assignees. It is based, in part, upon documents, writings, and information owned, possessed, or secured by the Client. Neither this report, nor any information contained herein shall be used or relied upon for any purpose by any other person or entity without the express written permission of the Client. This report is not for the use or benefit of, nor may it be relied upon by any other person or entity, for any purpose without the advance written consent of Western Geologic.

In expressing the opinions stated in this report, Western Geologic has exercised the degree of skill and care ordinarily exercised by a reasonable prudent environmental professional in the same community and in the same time frame given the same or similar facts and circumstances. Documentation and data provided by the Client, designated representatives of the Client or other interested third parties, or from the public domain, and referred to in the preparation of this assessment, have been used and referenced with the understanding that Western Geologic assumes no responsibility or liability for their accuracy. The independent conclusions represent our professional judgment based on information and data available to us during the course of this assignment. Factual information regarding operations, conditions, and test data provided by the Client or their representative has been assumed to be correct and complete. The conclusions presented are based on the data provided, observations, and conditions that existed at the time of the field exploration.

3.0 HYDROLOGY

The U.S. Geological Survey (USGS) topographic map of the Huntsville Quadrangle shows the site is on the northwestern margin of Ogden Valley at the eastern base of the Wasatch Range about 0.9 miles northwest of Liberty, Utah (Figure 1). No perennial or intermittent streams are shown crossing the site, but a detention pond is near the southeast site corner on Figure 1. A small pond is also in the central part of the site at the slope toe (range front base) that is not mapped but appears to have been associated with seasonal livestock watering. The pond is reportedly fed by seeps nearby to the west. The nearest active drainage is Chicken Creek about 1,500 feet to the south (Figure 1). No springs are mapped at the site, but Limekiln and Liberty Springs are shown in the area on Figure 1 south of Chicken Creek.

Ogden Valley is dominated in the valley bottom by unconsolidated lacustrine and alluvial basin-fill deposits. Slopes in the site area are mainly in weathered Tertiary-age tuffaceous bedrock overlain by a veneer of unconsolidated Quaternary alluvial and colluvial deposits. Avery (1994) indicates groundwater in Ogden Valley occurs under perched, confined, and unconfined conditions in the valley fill to depths of 750 feet or more. A well-stratified lacustrine silt layer forms a leaky confining bed in the upper part of the valley-fill aquifer. The aquifer below the confining beds is the principal aquifer, which is in primarily fluvial and alluvial-fan deposits. The principal aquifer is recharged from precipitation, seepage from surface water, and subsurface inflow from bedrock into valley fill along the valley margins (Avery, 1994). The confined aquifer is typically overlain by a shallow, unconfined aquifer recharged from surface flow and upward leakage. Groundwater flow is generally from the valley margins into the valley fill, and then toward the head of Ogden Canyon (Avery, 1994).

Groundwater was observed at a depth of 9.7 feet below the ground surface (bgs) in test pit TP-1, but was not observed in the remaining test pits to their explored depths. Given the above and our onsite observations, we anticipate that groundwater is generally about 9 to 10 feet deep in the eastern half of the Project and 10 to 30 feet deep in the western half. Groundwater depths at the site likely vary seasonally from snowmelt runoff and annually from climatic fluctuations. Such variations would be typical for an alpine environment. Perched conditions above less-permeable, clay-rich bedrock layers may also be present in the subsurface that could cause locally shallower groundwater levels. Based on topography, we expect groundwater flow at the site to be generally to the southeast.

4.0 GEOLOGY

4.1 Surficial Geology

The site is located on the northwestern margin of Ogden Valley, a sediment-filled intermontane valley within the Wasatch Range, a major north-south trending mountain range marking the eastern boundary of the Basin and Range physiographic province (Stokes; 1977, 1986). Surficial geology of the site is mapped by Coogan and King (2016; Figure 2) as a complex sequence of various Quaternary landslide deposits (unit Qms).

Coogan and King (2016) describe surficial geologic units within a mile of the site on Figure 2 as follows:

Qal, Qal1, Qal2, Qal2? - *Stream alluvium and flood-plain deposits (Holocene and uppermost Pleistocene).* Sand, silt, clay, and gravel in channels, flood plains, and terraces typically less than 16 feet (5 m) above river and stream level; moderately sorted; unconsolidated; along the same drainage Qal2 is lower than Qat2 and has likely been subject to flooding, at least prior to dam building; present in broad plains along the Bear, Ogden, and Weber Rivers and larger tributaries like Deep, Cottonwood, East Canyon, Lost, and Saleratus Creeks, along Box Elder, Heiners, and Yellow Creeks, and in narrower plains of larger tributary streams; locally includes muddy, organic overbank and oxbow lake deposits; composition depends on source area, so in back valleys typically contains many quartzite cobbles recycled from the Wasatch Formation; mostly Holocene, but deposited after regression of Lake Bonneville from the late Pleistocene Provo shoreline; width in Morgan Valley is combined flood plain of Weber River and East Canyon and Deep Creeks; 6 to 20 feet (2-6 m) thick and possibly as much as 50 feet (15 m) along Weber River and thinner in the Kaysville quadrangle; greater thicknesses (>50 feet [15 m]) are reported in Morgan Valley (Utah Division of Water Rights, well drilling database), but likely include Lake Bonneville and older Pleistocene deposits.

Suffixes 1 and 2 indicate ages where they can be separated, with 1 including active channels and 2 including low terraces 10 to 20 feet (3-6 m) above the Weber and Ogden Rivers, and the South Fork Ogden River that may have been in the flood plain prior to damming of these waterways. Qal2 queried in low terraces above Bear River, Saleratus Creek, and Dry Creek where deposits may not be in the flood plain.

Qaf, Qafy, Qaf3, Qaf3?, Qaf4, Qaf4?, Qaf5 - *Alluvial-fan deposits (Holocene and Pleistocene).* Mostly sand, silt, and gravel that is poorly bedded and poorly sorted and that is not close to late Pleistocene Lake Bonneville and is geographically in the Huff Creek and upper Bear River drainages; variably consolidated; includes debris flows, particularly in drainages and at drainage mouths (fan heads); generally less than 60 feet (18 m) thick. Qaf with no suffix used where age uncertain or for composite fans where portions of fans with multiple ages cannot be shown separately at map scale; toes of some fans have been removed by human disturbances, so their age cannot be determined.

Where possible, subdivided into relative ages, indicated by letter and number suffixes (like Qa and Qat suffixes) and relative ages only apply to the local drainage, with unit Qafy being the lowest (youngest) fans and unit 3 may or may not post-date Lake Bonneville. Relative ages of these fans are partly based on heights above present drainages at drainage-eroded edge of fan. The relative age is queried where the age is uncertain, generally due to the height not fitting into the typical order of surfaces. The various deposits listed, Qafy and Qaf3 through Qaf5, are 20 to 140 feet (6-40 m) above and west of Saleratus Creek, and also above Yellow Creek and the Bear River. Qafy fans are active, impinge on present-day floodplains, divert active streams, and overlie low terraces.

Qac - *Alluvium and colluvium (Holocene and Pleistocene).* Unsorted to variably sorted gravel, sand, silt, and clay in variable proportions; includes stream and fan alluvium, colluvium, and, locally, mass-movement deposits too small to show at map scale; typically mapped along smaller drainages that lack flat bottoms; more extensive east of Henefer where Wasatch Formation (Tw) strata easily weather to debris that "chokes" drainages; 6 to 20 feet (2-6 m) thick. Some deposits are "perched" on benches 80 feet (25 m) and more above present-day drainages like Left Fork Heiners Creek (Heiners Creek quadrangle) and Harris Canyon (Henefer quadrangle). In the Devils Slide quadrangle, some deposits are "perched" on benches about 60 to 130 feet (18-40 m) above Quarry Cottonwood Canyon indicating the alluvium is at least partly Lake Bonneville age and older (see Qab and Qao in tables 1 and 2).

Qafp, Qafp?, Qafb, Qafb?, Qafpb, Qafpb? - *Lake Bonneville-age alluvial-fan deposits (upper Pleistocene).* Like undivided alluvial fans, but height above present drainages appears to be related to shorelines of Lake Bonneville and is within certain limits (see table 1); these fans are inactive, unconsolidated to weakly consolidated, and locally dissected; fans labeled Qafp and Qafb are related to the Provo (and slightly lower) and Bonneville shorelines of late Pleistocene Lake Bonneville, respectively, while unit Qafpb is used where fans may be related to the Provo or Bonneville shoreline (for example Qafpb is ~40 feet [12 m] above Lost Creek Valley), or where fans of different ages cannot be shown separately at map scale; Qafp fans typically contain well-rounded, recycled Lake Bonneville gravel and sand and are moderately well sorted; generally 10 to less than 60 feet (3-18 m) thick. Lake Bonneville-age fans are queried where relative age is uncertain (see Qaf for details); fans labeled Qafpb? are above the Bonneville shoreline and might be Qafo or like Qafm; see the note under Qao about two possible ages of older alluvium (Qao, Qato, and Qafo).

Most of the Lake Bonneville-age fans in the James Peak quadrangle are far from the Bonneville shoreline and their age is inferred from their stratigraphic relationship(s) to coeval Pinedale glacial outwash (see age equality in Table 3).

The channels (Qafp/Qdlb) on the Weber River delta and Lake Bonneville fines (Qafp on Qlfb) probably record scour and fill during the rapid drawdown of the lake as it fell from the Bonneville shoreline to the Provo shoreline.

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.

Qls, Qls?, Qlsp, Qlsb, Qlsb? *- Lake Bonneville sand (upper Pleistocene).* Mostly sand with some silt and gravel deposited nearshore below and near the Provo shoreline (Qlsp) and between the Provo and Bonneville shorelines (Qlsb); Qls mapped downslope from slope break below Provo shoreline beach deposits where thin Lake Bonneville regressional sand may overlie transgressional sand; grades downslope into unit Qlf with decreasing sand content and laterally with more gravel into units Qdlp, Qdlb, and upslope with more gravel into unit Qlgb; Qls and Qlsb queried where grain size or unit identification uncertain; may be as much as 75 feet (25 m) thick, and thickest near Ogden; typically less than 20 feet (6 m) thick in Morgan Valley; may include small deltas and deltas that lack typical delta shape.

Qla, Qla? *- Lake Bonneville lacustrine deposits and post- and pre-Lake Bonneville alluvial deposits, undivided (Holocene and upper? Pleistocene).* Mostly poorly sorted and poorly bedded sand, silt, and clay, with some gravel; mapped where Lake Bonneville deposits are reworked by later stream action or covered by thin stream and fan deposits, and where lake deposits are thin and overlie older alluvial deposits; unit queried where may be dominantly alluvium; deposits typically eroded from shallow Norwood Formation; mostly mapped near Bonneville shoreline; also mapped in Peterson quadrangle along upper Deep Creek above Bonneville shoreline where lake deposits seem to indicate landslide dam of creek; thickness uncertain.

Qdlb, Qdlb? - *Transgressive and Bonneville-shoreline deltaic and lacustrine deposits (upper Pleistocene).* Mostly sand, silty sand, and gravelly sand deposited near shore in Lake Bonneville; extensive at mouth of Weber Canyon; related to transgression to and occupation of the Bonneville shoreline with lacustrine deposits covering deltaic deposits; in Morgan Valley and near mouth of Coldwater Canyon (North Ogden quadrangle) contain more cobbles and overall more gravel; 0 to at least 40 feet (12 m) thick in Ogden and Morgan Valleys; about 400 feet (120 m) thick in bluff at the mouth of Weber Canyon. These deposits are prone to slope failures.

Qafp, Qafp?, Qafb, Qafb?, Qafpb, Qafpb? - *Lake Bonneville-age alluvial-fan deposits (upper Pleistocene).* Like undivided alluvial fans, but height above present drainages appears to be related to shorelines of Lake Bonneville and is within certain limits (see table 1); these fans are inactive, unconsolidated to weakly consolidated, and locally dissected; fans labeled Qafp and Qafb are related to the Provo (and slightly lower) and Bonneville shorelines of late Pleistocene Lake Bonneville, respectively, while unit Qafpb is used where fans may be related to the Provo or Bonneville shoreline (for example Qafpb is ~40 feet [12 m] above Lost Creek Valley), or where fans of different ages cannot be shown separately at map scale; Qafp fans typically contain well-rounded, recycled Lake Bonneville gravel and sand and are moderately well sorted; generally 10 to less than 60 feet (3-18 m) thick. Lake Bonneville-age fans are queried where relative age is uncertain (see Qaf for details); fans labeled Qafpb? are above the Bonneville shoreline and might be Qafo or like Qafm; see the note under Qao about two possible ages of older alluvium (Qao, Qato, and Qafo).

Most of the Lake Bonneville-age fans in the James Peak quadrangle are far from the Bonneville shoreline and their age is inferred from their stratigraphic relationship(s) to coeval Pinedale glacial outwash (see age equality in Table 3).

The channels (Qafp/Qdlb) on the Weber River delta and Lake Bonneville fines (Qafp on Qlfb) probably record scour and fill during the rapid drawdown of the lake as it fell from the Bonneville shoreline to the Provo shoreline.

Qmdf, Qmdf? - *Debris- and mud-flow deposits (Holocene and upper and middle? Pleistocene).* Very poorly sorted, clay- to boulder-sized material in unstratified deposits characterized by rubbly surface and debris-flow levees with channels, lobes, and mounding; variably vegetated; in drainages typically form mounds, an indication of more viscous Qmdf, rather than being flat like unit Qac; Qmdf queried where may not be mostly debris- and mud-flow deposits; many debris flows cannot be shown separately from alluvial fans at map scale; 0 to 40 feet (0-12 m) thick. Age(s) uncertain; deposits in drainages likely post-date the Provo shoreline of Lake Bonneville, while deposits above drainages, like north of the Right Hand Fork Peterson Creek, are likely as old as Bull Lake glaciation, but could pre-date Bull Lake glaciation and be middle Pleistocene.

QTms(ZYp) - *Quaternary and/or Tertiary mega-landslide (Pleistocene and/or Pliocene).* Jumbled mass of formation of Perry Canyon (ZYp) with blocks of rock from North Ogden divide klippe out of stratigraphic position and "floating" in muddy Perry Canyon; mostly mapped as ZYpm and ZYpg by Crittenden and Sorensen (1985b); inconsistent and divergent attitudes shown by Crittenden and Sorensen (1985b) also support mass movement; north margin of landslide uncertain due to overturned dips in adjacent ZYpm outcrop; mass seems to have slid down Willard thrust plane; estimate up to about 700 feet (210 m) thick. Younger landslides, including Qms(QTms) and Qms?(QTms) are mapped on this mass, indicating continued instability.

Tn, Tn? *- Norwood Formation (lower Oligocene and upper Eocene).* Typically light-gray to light-brown altered tuff (claystone), altered tuffaceous siltstone and sandstone, and conglomerate; unaltered tuff, present in type section south of Morgan, is rare; locally colored light shades of red and green; variable calcareous cement and zeolitization; involved in numerous landslides of various sizes; estimate 2000-foot (600 m) thick in exposures on west side of Ogden Valley (based on bedding dip, outcrop width, and topography). Norwood Formation queried where poor exposures may actually be surficial deposits. For detailed Norwood Formation information see description under heading "Sub-Willard Thrust - Ogden Canyon Area" since most of this unit is in and near Morgan Valley and covers the Willard thrust, Ogden Canyon, and Durst Mountain areas.

Cm, Cm? *- Maxfield Limestone (Middle Cambrian).* From top down includes dolomite, limestone, argillaceous to silty limestone and calcareous siltstone and argillite, and basal limestone with argillaceous interval (see Yonkee and Lowe, 2004; King and others, 2008 for more member details); members mappable at 1:24,000 scale, but like Ophir Formation thicknesses highly variable due to deformation; total thickness about 600 to 900 feet (180-270 m) (King and others, 2008).

According to Yonkee and Lowe (2004), the Bathyuriscus sp., Elrathina sp., Peronopsis sp., and Ptychagnostus sp. trilobite fossils reported by Rigo (1968, USGS No. 5948-CO in the middle limestone of the Ophir Shale) in Ogden Canyon are in the basal limestone member of the Maxfield. Elrathia can be used as a proxy for the Middle Cambrian Bolaspidella zone (see Robison, 1976, figure 4) and this zone is in the Bloomington Formation shales on the Willard thrust sheet (see Oviatt, 1986; Jensen and King, 1996, table 2). This supports the Maxfield Limestone as partly equivalent to the Bloomington Formation, but leaves the Blacksmith Dolomite without an equivalent carbonate unit below the Willard thrust sheet. However, Rigo (1968) did not provide a usable sample location and the sample location is not on the map of Crittenden and Sorensen (1985b).

Co, Co? *- Ophir Formation (Middle Cambria*n) . Upper and lower brown-weathering, slope-forming, gray to olive-gray, variably calcareous and micaceous to silty argillite to slate with intercalated gray, silty limestone beds; middle ledge-forming, gray limestone; total thickness about 450 to 650 feet (140-200 m) (Sorensen and Crittenden, 1972) where likely less deformed, but highly deformed in most outcrops. Only subdivided north of Ogden Canyon to show structure.

Rigo (1968, USGS No. 5947-CO) reported Ehmaniella sp., Alokistocare sp., and Zacanthoides sp. Trilobites from the lower member indicating an early Middle Cambrian age. These trilobites may be in the upper and, possibly, lower Ute Formation on the Willard thrust sheet (see unit Cu), leaving the Langston Formation and possibly the lower Ute Formation without lithologically equivalent strata below the Willard thrust sheet.

Ct, Ct? *- Tintic Quartzite (Middle and Lower Cambrian).* Tan-weathering, cliff-forming, very well-cemented quartzite, with lenses and beds of quartz-pebble conglomerate, and lesser thin argillite layers; quartzite is tan, white, reddish tan and pale-orange tan with abundant cross-bedding; argillite more abundant at top and quartz-pebble conglomerate increases downward; greenish-tan to purplish-tan to tan, arkosic sandstone, conglomerate, and micaceous argillite at base that is 50 to 200 feet (15-60 m) thick and derived from unconformably underlying gneissic and schistose Farmington Canyon Complex; about 1100 to 1500 feet (335-450 m) thick.

Citations, tables, and figures above are not provided herein, but are in Coogan and King (2016). Unit Tn is not mapped at the site, but was interpreted in subsurface exposures. Descriptions of other units on Figure 2 are provided in Coogan and King (2016).

4.2 Seismotectonic Setting

The property is located at the northwestern margin of Ogden Valley, a roughly 40-square mile back valley described by Gilbert (1928) as a structural trough similar to Cache and Morgan Valleys to the north and south, respectively. The back valleys of the northern Wasatch Range are in a transition zone between the Basin and Range and Middle Rocky Mountains physiographic provinces (Stokes, 1977, 1986). The Basin and Range is characterized by a series of generally north-trending elongate mountain ranges, separated by predominately alluvial and lacustrine sediment-filled valleys and typically bounded on one or both sides by major normal faults (Stewart, 1978). The boundary between the Basin and Range and Middle Rocky Mountains provinces is marked by the Wasatch fault zone at the base of the Wasatch Range. Late Cenozoic normal faulting, a characteristic of the Basin and Range, began between about 17 and 10 million years ago in the Nevada (Stewart, 1980) and Utah (Anderson, 1989) portions of the province. The faulting is a result of a roughly east-west directed, regional extensional stress regime that has continued to the present (Zoback and Zoback, 1989; Zoback, 1989). The back valleys are morphologically similar to valleys in the Basin and Range, but exhibit less structural relief (Sullivan and others 1986).

Ogden Valley occupies a structural trough created by up to 2,000 feet of vertical displacement on normal faults bounding the east and west sides of the valley. The Ogden Valley southwestern margin faults (aka West Ogden Valley fault) is shown on the Utah Geological Survey Quaternary Fault Database (Black and others, 2003) trending northwestward about 0.63 miles southwest of the site. Sullivan and others (1986) indicate the most recent movement on this fault is pre-Holocene.

The site is also in the central portion of the Intermountain Seismic Belt (ISB), a generally north-south trending zone of historical seismicity along the eastern margin of the Basin and Range province extending from northern Arizona to northwestern Montana (Sbar and others, 1972; Smith and Sbar, 1974). At least 16 earthquakes of magnitude 6.0 or greater have occurred within the ISB since 1850; the largest of these earthquakes was a M 7.5 event in 1959 near Hebgen Lake, Montana. None of these earthquakes occurred along the Wasatch fault or other known late Quaternary faults (Arabasz and others, 1992; Smith and

Arabasz, 1991). The closest event was the 1934 Hansel Valley (M 6.6) event north of the Great Salt Lake. The March 18, 2020 M 5.7 earthquake north of Magna, Utah reportedly showed a style, location, and slip depth consistent with an earthquake on the Wasatch fault system (https://earthquake.usgs.gov/earthquakes/eventpage/uu60363602/executive). Despite being moderate in size (less than magnitude 6.0), this earthquake was felt from southern Idaho to south-central Utah and caused serious damage to multiple buildings (https://www.ksl.com/article/46731630/).

4.3 Lake Bonneville History

Lakes occupied nearly 100 basins in the western United States during late-Quaternary time, the largest of which was Lake Bonneville in northwestern Utah. The Bonneville basin consists of several topographically closed basins created by regional extension in the Basin and Range (Gwynn, 1980; Miller, 1990), and has been an area of internal drainage for much of the past 15 million years. Lake Bonneville consisted of numerous topographically closed basins, including the Salt Lake and Cache Valleys (Oviatt and others, 1992). Sediments from Lake Bonneville comprise much of the unconsolidated deposits in the site vicinity.

Timing of events related to the transgression and regression of Lake Bonneville are indicated in Oviatt (2015). Approximately 30,000 years ago, Lake Bonneville began a slow transgression (rise) to its highest level of 5,160 to 5,200 feet above mean sea level. The lake rise eventually slowed as water levels approached an external basin threshold in northern Cache Valley at Red Rock Pass near Zenda, Idaho. Lake Bonneville reached the Red Rock Pass threshold and occupied its highest shoreline, termed the Bonneville beach, around 18,000 years ago. Headward erosion of the Snake River-Bonneville basin drainage divide, possibly combined with landsliding in the threshold area, then caused a catastrophic incision that caused the lake level to lower by about 425 feet in less than a year (Jarrett and Malde, 1987; O'Conner, 1993). Following the Bonneville flood, the lake stabilized and formed a lower shoreline referred to as the Provo shoreline up to about 16,000 years ago. Climatic factors then caused the lake to regress rapidly from the Provo shoreline, and by about 13,000 years ago the lake had eventually dropped below historic levels of Great Salt Lake. Oviatt and others (1992) deem this low stage the end of the Bonneville lake cycle. Great Salt Lake then experienced a brief transgression between 12,800 and 11,600 years ago to the Gilbert level at about 4,250 feet before receding to and remaining within about 20 feet of its historic average level (Lund, 1990; Oviatt, 2015). The highest Bonneville shoreline is not mapped in the area on Figure 2.

5.0 SITE CHARACTERIZATION

5.1 Empirical Observations

On May 22, 2020, Mr. Bill D. Black of Western Geologic conducted a reconnaissance of the property to observe geomorphic and surficial conditions. The reconnaissance was conducted in conjunction with the subsurface exploration. Weather was partly cloudy with temperatures in the mid-50s (°F).

The site is on the northwestern margin of Ogden Valley on slopes overlooking North Fork Ogden River. Native vegetation consists of mature maple, aspen and pine trees, oak brush, sage brush, and grasses. Thistles were also observed in the former livestock pond area. The former livestock pond is reportedly fed by seasonal seeps at the toe of the slopes to the west. No other seeps or springs were observed or reported, although the ground surface appeared very moist to saturated at the time of our reconnaissance. No perennial or intermittent streams flow across the property, but a small ephemeral drainage flows from the former pond to the east and then southward. The small drainage is a narrow gully that had an inch or two of water at the time of our investigation. No evidence for recent or ongoing landslides or slope instability was observed, although slopes in the eastern part of the site appeared slightly hummocky. Steep slopes in the western half of the site are heavily vegetated and were not directly observed. No bedrock outcrops, characteristic debris flow morphology, or other evidence for geologic hazards was observed at the site during the site reconnaissance.

5.2 Air Photo Observations

Black and white orthophotography from 1997, high-resolution color orthophotography from 2012, and bare earth DEM LIDAR imagery from 2011 (Figures 3A-3C) were examined to obtain information about the geomorphology of the Project area. Site-specific surficial geologic mapping is shown on Figures 3A-C based on our empirical observations, air photo interpretation, and mapping in Coogan and King (2016; Figure 2). The site is underlain by a sequence of landslide deposits that we infer are contemporaneous with or post-date when Lake Bonneville occupied Ogden Valley. The steep, heavily vegetated slopes in the western half of the site may be a partial reactivation of a large block landslide that occurred prior to Lake Bonneville further west. The eastern half of the site appears to underlain by an earthflow possibly associated with this reactivation. The areas further north and south are underlain by various landslide deposits that are both older and younger. Figure 3C shows a slope gradient map from geoprocessed LIDAR data at gradient intervals of <15% (unshaded), 15-25% (in yellow) and >25% (in red). Steep slopes are found mainly in the western half of the Project. Overall gradient of the slopes below (southeast of) TP-2 is about 7.7:1 (horizontal:vertical; 13% or 7.4 degrees). No evidence for other geologic hazards was observed on the air photos at the site or in the area.

5.3 Subsurface Investigation

Three onsite walk-in test pits were excavated at the Project on May 22 to assess subsurface conditions. The test pits were logged by Bill D. Black, P.G. of Western Geologic concurrently with the Project geotechnical investigation conducted by Christensen Geotechnical. Locations of the test pits are shown on Figures 3A-C. The test pit locations were measured using a hand-held GPS unit and by trend and distance methods. The test pits were logged at a scale of 1-inch equals five feet (1:60) following methodology in McCalpin (1996), and digitally photographed at 5-foot intervals to document the exposures. The photos are not provided herein, but are available on request. Logs of the test pits are provided on Figures 4A-B. Stratigraphic interpretations and descriptions are provided on the logs. Groundwater was observed in TP-1 at a depth of 9.7 feet bgs, but was not observed in the remaining test pits to their explored depths (Figures 4A-B). TP-2 and TP-3 both exposed weathered Norwood Formation bedrock overlain by colluvium that varied from 1.6 to 9.5 feet thick and may be an earthflow deposit.

5.4 Cross Sections

Figure 5 shows one cross section (A-A') across the site as located on Figures 3A-C at a scale of 1 inch equals 50 feet with no vertical exaggeration. Units and contacts are based on subsurface data from the test pits (Figures 4A-B) and/or inferred from the surficial geologic mapping. The topographic profile is based on geoprocessed 2011 LIDAR data. The LIDAR data provides a snapshot of topographic conditions at the time it was acquired; past, present and future surficial topography may vary. Units and contacts should be considered approximate and inferred, and variations should be expected at depth and laterally. We caution that some portions of the cross section have limited or no subsurface data. Schematic bedding dip was calculated using http://app.visiblegeology.com/ApparentDip.html based on the profile trend and average strike and dip from our measurements. Inferred groundwater level is shown on the cross section based on the depth encountered in TP-1 and our site observations. Given the above and our onsite observations, we anticipate that groundwater is generally about 9 to 10 feet deep in the eastern half of the Project and 10 to 30 feet deep in the western half.

6.0 GEOLOGIC HAZARDS

Assessment of potential geologic hazards and the resulting risks imposed is critical in determining the suitability of the site for development. Table 1 below shows a summary of the geologic hazards reviewed at the site, as well as a relative (qualitative) assessment of risk to the Project for each hazard. A "high" hazard rating (H) indicates a hazard is present at the site (whether currently or in the geologic past) that is likely to pose significant risk and/or may require further study or mitigation techniques. A "moderate" hazard rating (M) indicates a hazard that poses an equivocal risk. Moderate-risk hazards may also require further studies or mitigation. A "low" hazard rating (L) indicates the hazard is not present, poses little or no risk, and/or is not likely to significantly impact the Project. Low-risk hazards typically require no additional studies or mitigation. We note that these hazard ratings represent a conservative assessment for the entire site and risk may vary in some areas. Careful selection of development areas can minimize risk by avoiding known hazard areas.

Table 1. *Geologic hazards summary.*

Hazard	H	M	L
Earthquake Ground Shaking	X		
Surface Fault Rupture			X
Liquefaction and Lateral-spread Ground Failure			X
Tectonic Deformation			X
Seismic Seiche and Storm Surge			X
Stream Flooding			X
Shallow Groundwater	X		
Landslides and Slope Failures	X		
Debris Flows and Floods			X
Rock Fall			X
Problem Soil and Rock		X	

6.1 Earthquake Ground Shaking

Ground shaking refers to the ground surface acceleration caused by seismic waves generated during an earthquake. Strong ground motion is likely to present a significant risk during moderate to large earthquakes located within a 60 mile radius of the Project area (Boore and others, 1993). Seismic sources include mapped active faults, as well as a random or "floating" earthquake source on faults not evident at the surface. The Utah Geological Survey Quaternary Fault Database (Black and others, 2003; January 2017 update) shows numerous class A faults within 60 miles of the Project that may pose potential seismic sources.

The extent of property damage and loss of life due to ground shaking depends on factors such as: (1) proximity of the earthquake and strength of seismic waves at the surface (horizontal motions are the most damaging); (2) amplitude, duration, and frequency of ground motions; (3) nature of foundation materials; and (4) building design. Based on 2018 IBC provisions, a site class of D (stiff soil), and a risk category of II, calculated seismic values for the site (centered on 41.338002° N, -111.880262° W) are summarized below:

Table 2. *Seismic hazards summary.*

Type	Value
S_S	*1.133 g*
S_1	*0.413 g*
S_{MS} (F_a x S_S)	*1.36 g*
S_{M1} (F_v x S_1)	*See ASCE 7-16 Section 11.4.8*
S_{DS} (2/3 x S_{MS})	*0.907 g*
S_{D1} (2/3 x S_{M1})	*See ASCE 7-16 Section 11.4.8*
Site Coefficient, F_a	*= 1.2*
Site Coefficient, F_v	*See ASCE 7-16 Section 11.4.8*
Peak Ground Acceleration, PGA	*= 0.612 g*

The site class should be confirmed by the Project geotechnical engineer based on site-specific data. Given the above information, earthquake ground shaking poses a high risk to the site. Earthquake ground shaking is a regional hazard common to all Wasatch Front areas. The hazard is mitigated by design and construction in accordance with the current adopted building code. We note that IBC 2018 provisions require calculation of the spectral acceleration value (S_{M1}), seismic design value (S_{D1}), and site coefficient (F_v) differently from IBC 2015. In municipalities where IBC 2018 has been adopted, the Project engineer or architect should determine these seismic values in accordance with ASCE 7-16 Section 11.4.8 guidelines.

6.2 Surface Fault Rupture

Movement along faults at depth generates earthquakes. During earthquakes larger than Richter magnitude 6.5, ruptures along normal faults in the intermountain region generally propagate to the surface (Smith and Arabasz, 1991) as one side of the fault is uplifted and the other side down dropped. The resulting fault scarp has a near-vertical slope. The surface rupture may be expressed as a large singular rupture or several smaller ruptures in a broad zone. Ground displacement from surface fault rupture can cause significant damage or even collapse to structures located on an active fault.

No active faults are mapped crossing the site or were observed during our reconnaissance or on air photos. The nearest active fault to the Project is the Weber section of the Wasatch fault zone 2.9 miles to the west (Black and others, 2003).

Given all the above, we rate the risk from surface faulting as low. No additional investigation regarding surface faulting appears needed given the proposed development plan and current paleoseismic information.

6.3 Liquefaction and Lateral-Spread Ground Failure

Liquefaction occurs when saturated, loose, cohesionless, soils lose their support capabilities during a seismic event because of the development of excessive pore pressure. Earthquake-induced liquefaction can present a significant risk to structures from bearing-capacity failures to structural footings and foundations, and can damage structures and roadway embankments by triggering lateral spread landslides. Earthquakes of Richter magnitude 5 are generally regarded as the lower threshold for liquefaction. Liquefaction potential at the site is a combination of expected seismic accelerations (earthquake ground shaking), groundwater conditions, and presence of susceptible soils.

Given subsurface soil conditions observed in the test pits at the site, we do not believe significant areas of sandy soils susceptible to liquefaction are present underlying the site. Weber County GIS mapping also shows the site is in an area of very low liquefaction potential (code 1). Based on this, we rate the risk from liquefaction as low.

6.4 Tectonic Deformation

Tectonic deformation refers to subsidence from warping, lowering, and tilting of a valley floor that accompanies surface-faulting earthquakes on normal faults. Large-scale tectonic subsidence may accompany earthquakes along large normal faults (Lund, 1990). Tectonic subsidence is believed to mainly impact those areas immediately adjacent to the downthrown side of active normal faults.

The Project is not in close proximity to and on the downthrown side of any mapped active (Holocene) faults. Based on this, we rate the risk from tectonic subsidence as low.

6.5 Seismic Seiche and Storm Surge

Earthquake-induced seiche presents a risk to structures within the wave-oscillation zone along the edges of large bodies of water, such as the Great Salt Lake. Given the elevation of the subject property and distance from large bodies of water, we rate the risk from seismic seiches as low.

6.6 Stream Flooding

Stream flooding may be caused by direct precipitation, melting snow, or a combination of both. In much of Utah, floods are most common in April through June during spring snowmelt. High flows may be sustained from a few days to several weeks, and the potential for flooding depends on a variety of factors such as surface hydrology, site grading and drainage, and runoff.

No perennial or intermittent streams are mapped or were observed crossing the Project. Federal Emergency Management Agency flood insurance rate mapping (Map Number 49057C0209F, effective on 06/02/2015) classifies the Project in "Zone X" (areas of minimal flood hazards). Given the above, we rate the risk from stream flooding as low. Care should be taken that proper surface drainage is maintained.

6.7 Shallow Groundwater

As discussed Sections 3.0 and 5.3 above, groundwater was observed in TP-1 at a depth of 9.7 feet bgs, but was not observed in the remaining test pits to their explored depths. Based on this and our onsite observations, we anticipate that groundwater is generally about 9 to 10 feet deep in the eastern half of the Project and 10 to 30 feet deep in the western half. Groundwater depths at the site likely vary seasonally from snowmelt runoff and annually from climatic fluctuations. Such variations would be typical for an alpine environment. Perched conditions above less-permeable, clay-rich bedrock layers may also be present in the subsurface that could cause locally shallower groundwater levels.

Given the above, we rate the risk from shallow groundwater as high. The proposed home will require a foundation drainage system to ensure that proper subsurface drainage is maintained. Foundation and site subsurface drainage should be addressed in the Project geotechnical engineering evaluation. Care should be taken that proper subsurface drainage is maintained.

6.8 Landslides and Slope Failures

Slope stability hazards such as landslides, slumps, and other mass movements can develop along moderate to steep slopes where a slope has been disturbed, the head of a slope loaded, or where increased groundwater pore pressures result in driving forces within the slope exceeding restraining forces. Slopes exhibiting prior failures, and also deposits from large landslides, are particularly vulnerable to instability and reactivation.

Landslide colluvium is mapped underlying most of the site. The approximate area of the proposed home is underlain by possible earthflow deposits from an upslope failure to the west that vary from 1.6 to 9.5 feet thick and overlie weathered Tertiary Norwood Formation bedrock comprised of weathered claystone and pebble conglomerate. Thickness of the colluvial veneer increases eastward, but may be about 4 to 8 feet in the approximate home area.

Given the above, we rate the risk from landslides and slope instability as high. We recommend that slope stability be evaluated by the Project geotechnical engineer based on site-specific soil conditions and the data provided in this report. Recommendations should be provided to reduce the landslide hazard risk if factors of safety are determined to be unsuitable. Water, steep man-made cuts, and non-engineered fill materials are often major contributors to slope instability. Care should therefore also be taken to maintain proper site drainage, that site grading does not destabilize slopes at the site without prior geotechnical analysis and grading plans, and that water from man-made sources is minimized in potentially unstable slope areas.

6.9 Debris Flows

Debris flow hazards are typically associated with unconsolidated alluvial fan deposits at the mouths of large range-front drainages, such as those along the Wasatch Front. Debris flows have historically significant damage in the Wasatch Front area.

No evidence for debris flow deposits or characteristics morphology was observed at the site during our reconnaissance or on air photos. Given the above, we rate the risk from debris flows/floods as low. We consider the earthflow deposits in the eastern half of the site to be landslide colluvium, which is already factored into the high landslide risk for the site.

6.10 Rock Fall

No significant bedrock outcrops are at the site or in adjacent higher slopes that could present a source area for rock fall clasts, and no boulders likely from rock falls were observed at the site. Based on the above, we rate the hazard from rock falls as low.

6.11 Problem Soil and Rock

Surficial soils that contain certain clays can swell or collapse when wet. Clay-rich soils were observed in the test pits at the Project that could be susceptible to a degree of swell from water adsorption. Given the above, we rate the risk from problem soil as moderate. Soil conditions and specific recommendations for site grading, subgrade preparation, and footing and foundation design should be provided in the Project geotechnical engineering evaluation.

7.0 CONCLUSIONS AND RECOMMENDATIONS

Earthquake ground shaking, shallow groundwater, and landslides are identified as posing a high relative risk to the Project. The following recommendations are provided with regard to the geologic characterizations in this report:

- ***Seismic Design*** – All habitable structures developed at the property should be constructed to current adopted seismic building codes to reduce the risk of damage, injury, or loss of life from earthquake ground shaking. The Project geotechnical engineer should confirm the ground-shaking hazard and provide appropriate seismic design parameters as needed. Earthquake ground shaking is a hazard that is common for all development along the Wasatch Front.

- ***Geotechnical Evaluation*** – A design-level geotechnical engineering study should be conducted prior to construction to assess soil foundation conditions, provide recommendations regarding subsurface drainage, and evaluate slope stability. The stability evaluation should be based on geologic characterizations in this report and site-specific geotechnical data, and provide recommendations for reducing the risk of landsliding if the factors of safety are deemed unsuitable.

- ***Site Modifications and Drainage*** – No unplanned cuts should be made in the slopes at the site without prior geotechnical analyses, and proper surface and subsurface drainage should be maintained.

- ***Excavation Backfill Considerations*** – The test pits may be in areas where a structure could subsequently be placed. However, backfill may not have been replaced in the excavations in compacted layers. The fill could settle with time and upon saturation. Should structures be located in an excavated area, no footings or structure should be founded over the excavation unless the backfill has been removed and replaced with structural fill.

- ***Hazard Disclosures and Report Availability*** – All hazards identified as posing a high risk at the site should be disclosed to future buyers so that they may understand and be willing to accept any potential developmental challenges and/or risks posed by these hazards. This report should be made available to architects, building contractors, and in the event of a future property sale, real estate agents and potential buyers. The report should be referenced for information on technical data only as interpreted from observations and not as a warranty of conditions throughout the site. The report should be submitted in its entirety, or referenced appropriately, as part of any document submittal to a government agency responsible for planning decisions or geologic review. Incomplete submittals void the professional seals and signatures we provide herein. Although this report and the data herein are the property of the client, the report format is the intellectual property of Western Geologic and should not be copied, used, or modified without express permission of the authors.

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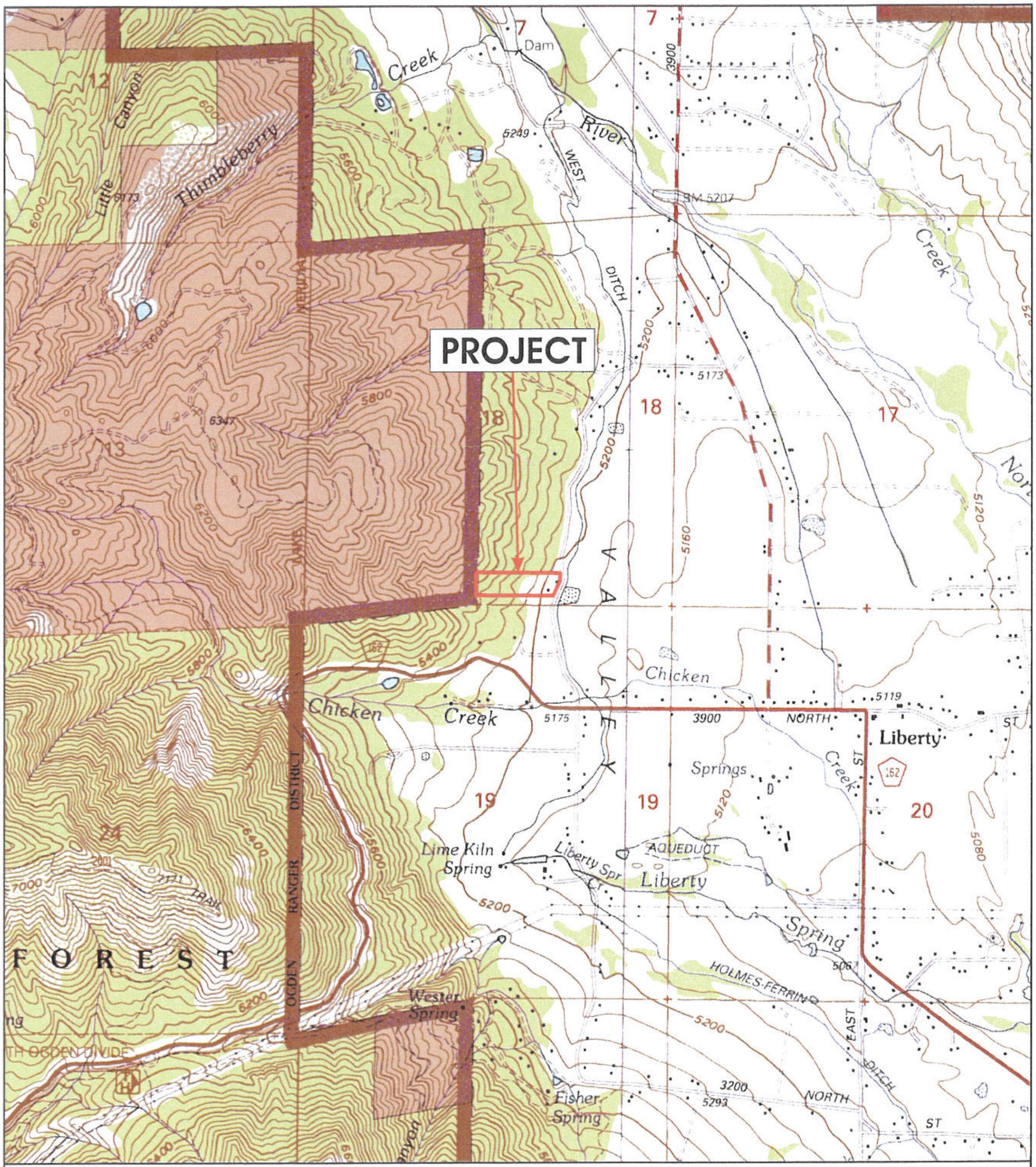
FIGURES



Source: U.S. Geological Survey 7.5 Minute Series Topographic Maps, Utah - Huntsville and North Ogden, 1998;
Project location S1/2, Section 18, T7N, R1E (SLBM).

WESTERN GEOLOGIC

N
W E
S

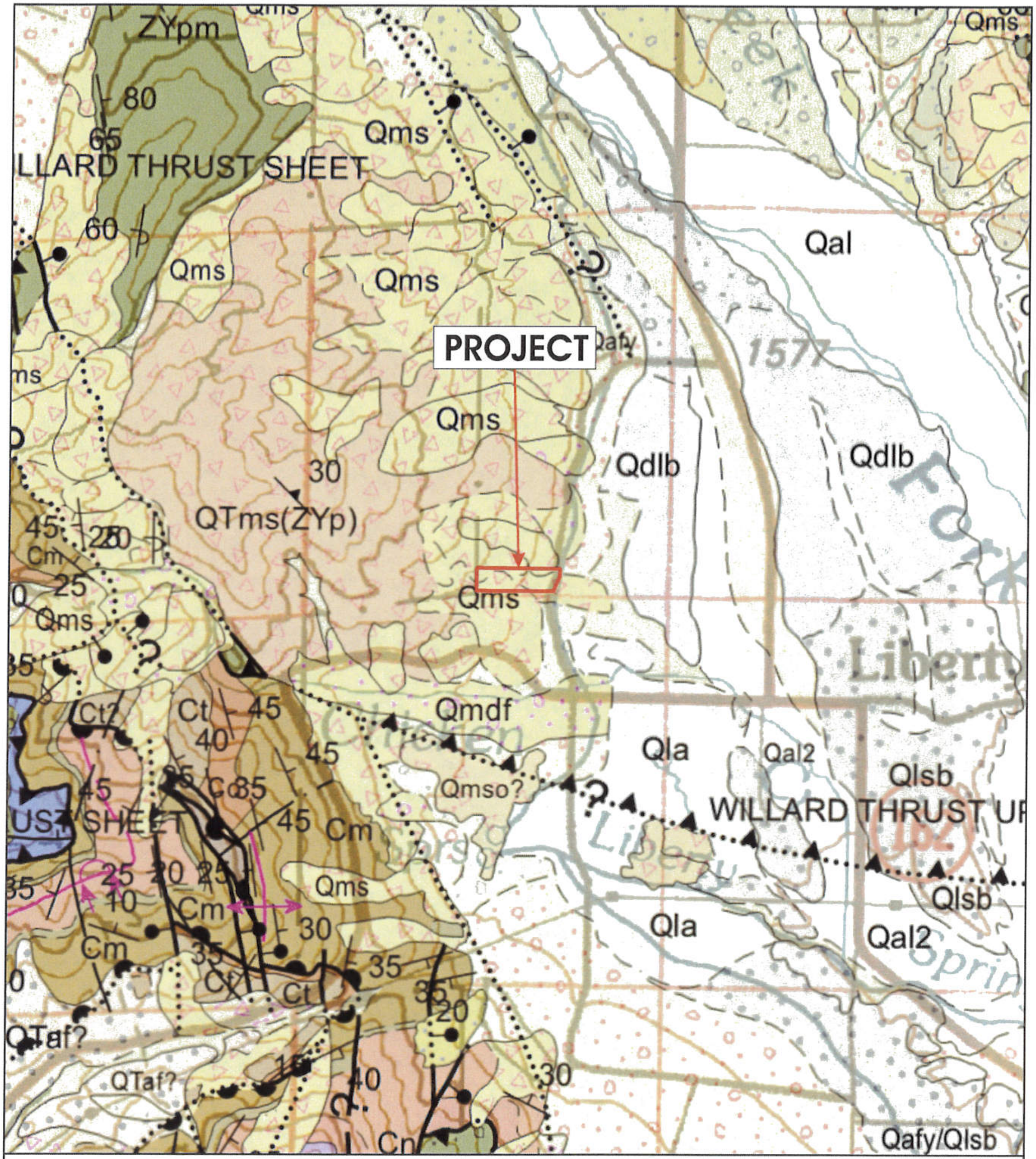
0 1000 2000 feet

Scale 1:24,000
(1 inch = 2000 feet)

LOCATION MAP

GEOLOGIC HAZARDS EVALUATION
Osman Property
4337 North 2900 East
Liberty, Weber County, Utah

FIGURE 1



Source: Coogan and King (2016), original map scale 1:100,000.
See text for explanation of nearby surficial geologic units.

WESTERN
GeoLogic

N
W E
S

0 1000 2000 feet

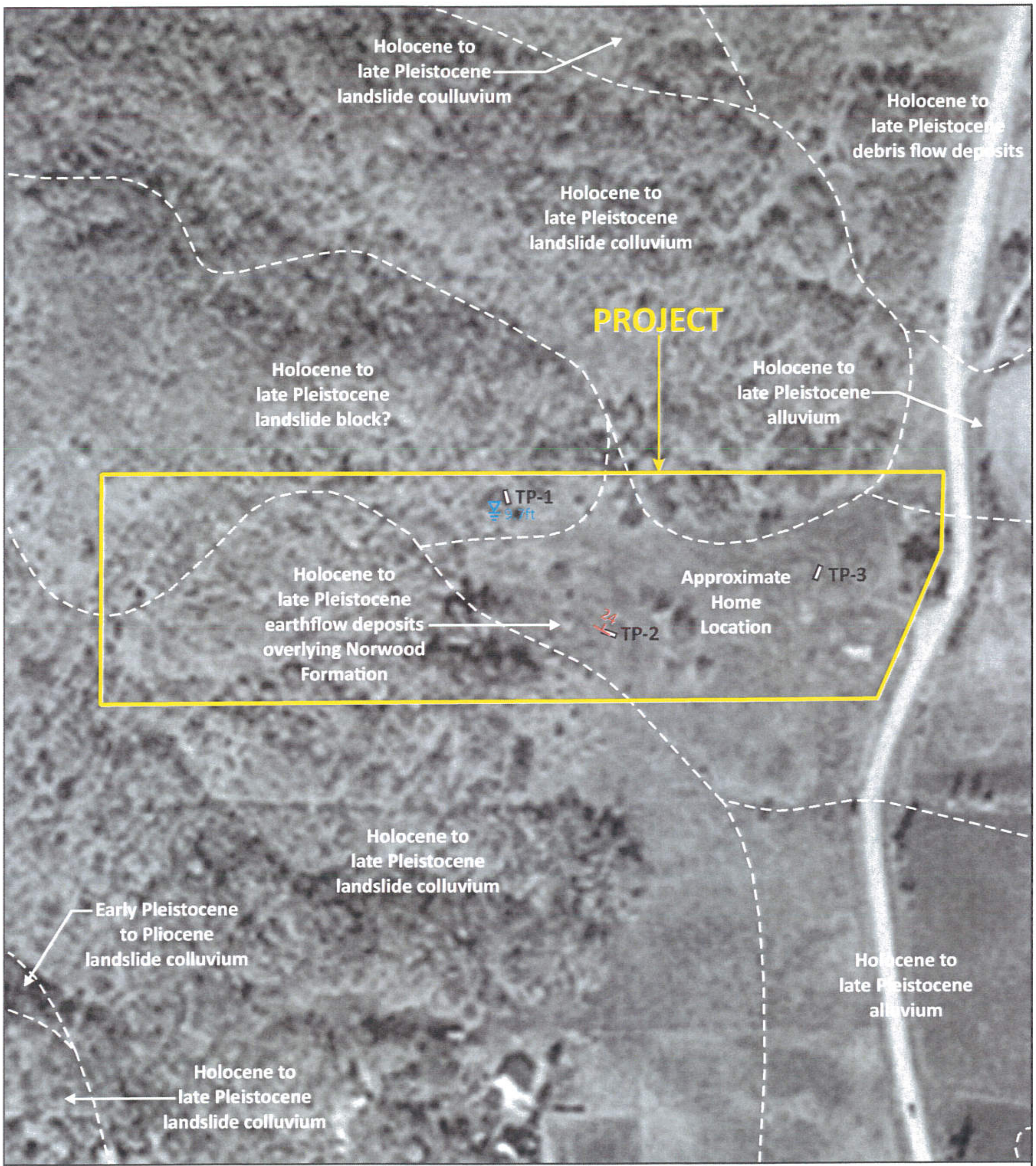
Scale 1:24,000
(1 inch = 2000 feet)

GEOLOGIC MAP

GEOLOGIC HAZARDS EVALUATION

Osman Property
4337 North 2900 East
Liberty, Weber County, Utah

FIGURE 2



Source: Utah AGRC 1997 Digital Orthophoto, 1 m resolution.

1997 AERIAL PHOTO

GEOLOGIC HAZARDS EVALUATION

Osman Property
4337 North 2900 East
Liberty, Weber County, Utah

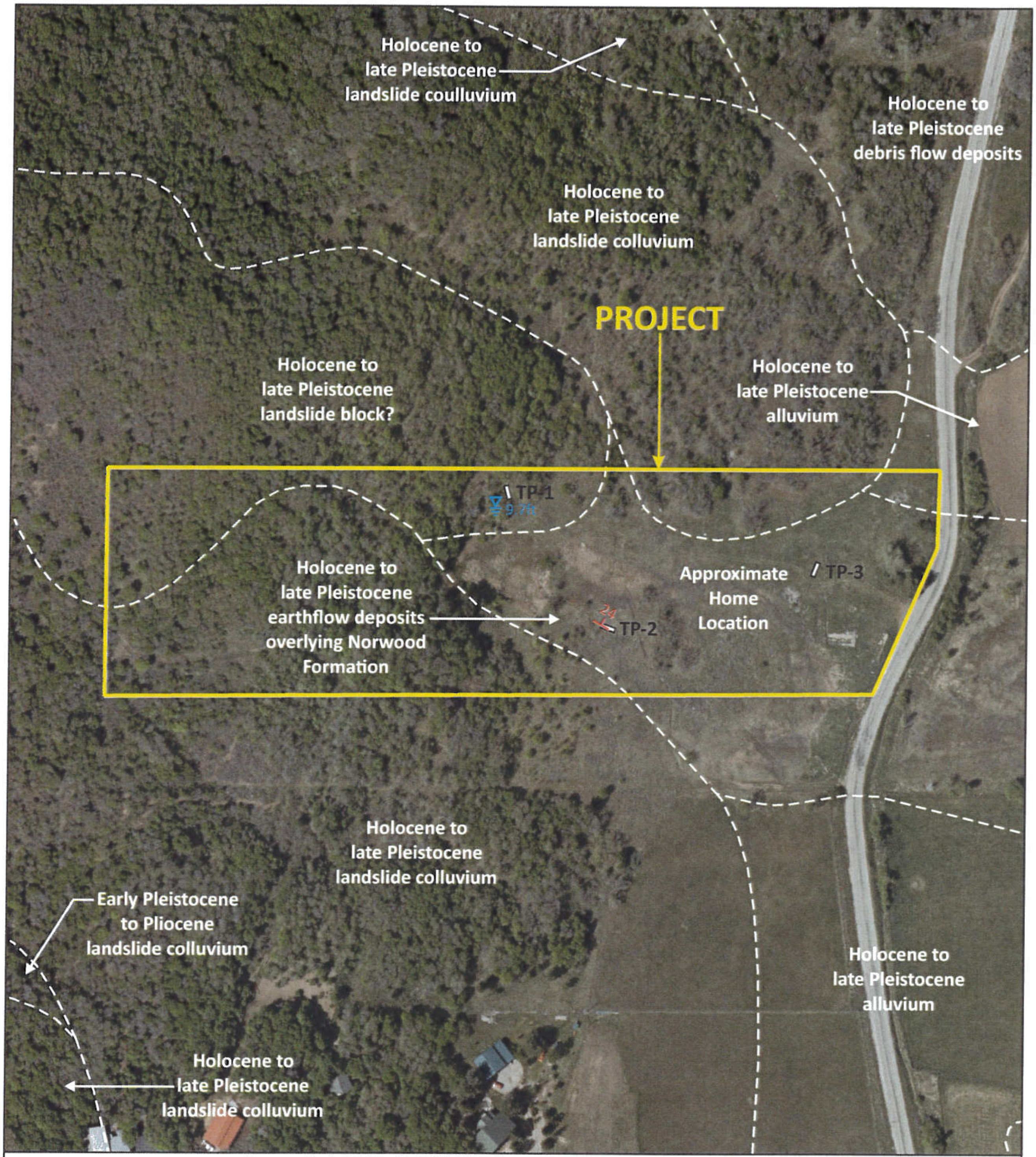
FIGURE 3A

WESTERN
GEOLOGIC

N
W E
S

0 100 200 feet

Scale 1:2,400
(1 inch = 200 feet)



Source: Utah AGRC, 2012 High Resolution Orthophoto, 12.5 cm resolution.

2012 AERIAL PHOTO

GEOLOGIC HAZARDS EVALUATION

Osman Property
4337 North 2900 East
Liberty, Weber County, Utah

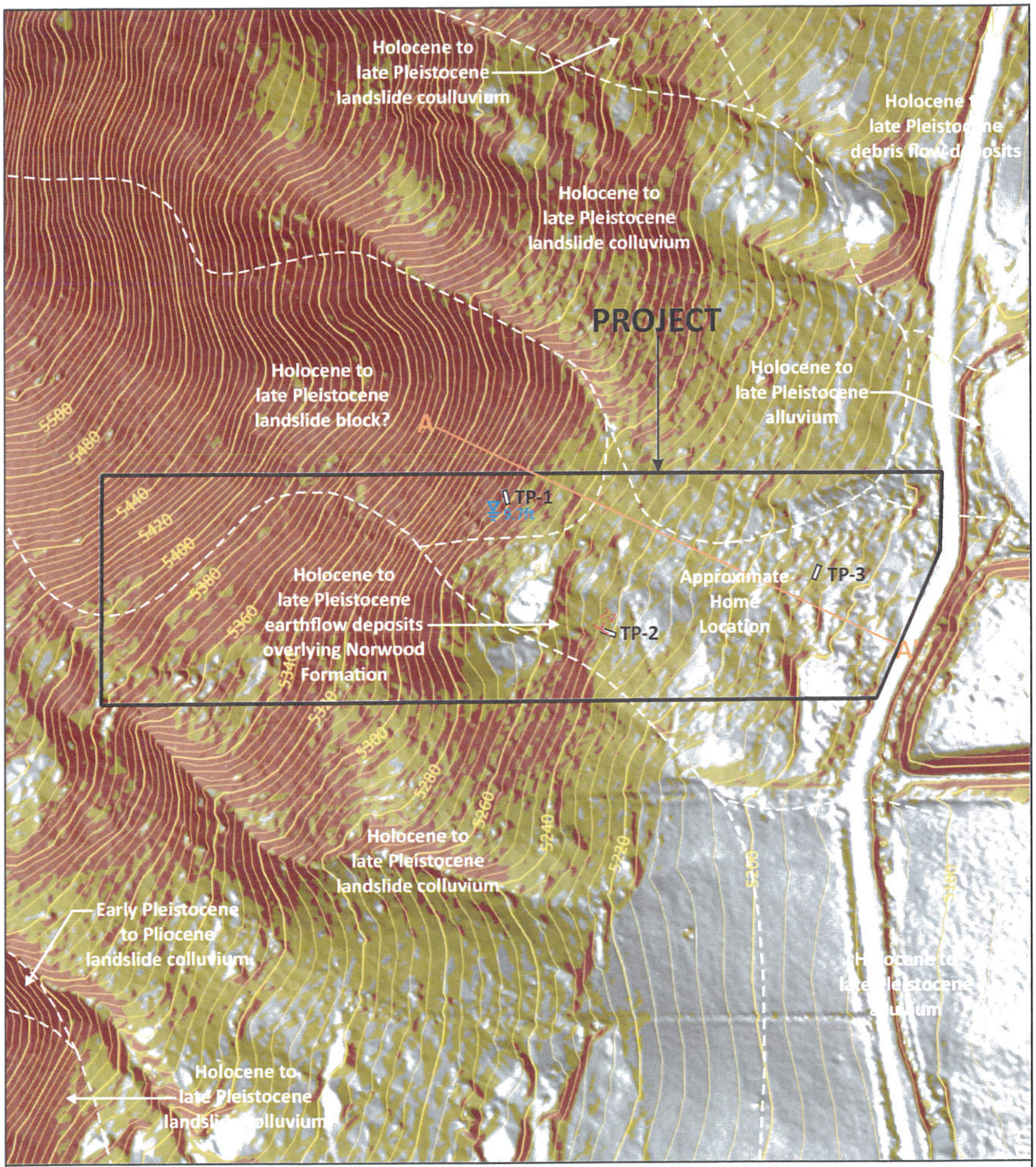
FIGURE 3B

WESTERN
GEOLOGIC

N
W E
S

0 100 200 feet

Scale 1:2,400
(1 inch = 200 feet)



Source: Utah AGRC, 2011 LIDAR Bare Earth DEM, 1m resolution; 4-foot contour interval;
slope gradients <15% unshaded, 15-25% in yellow, and >25% in red.

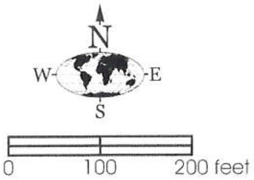
LIDAR ANALYSIS

GEOLOGIC HAZARDS EVALUATION

Osman Property
4337 North 2900 East
Liberty, Weber County, Utah

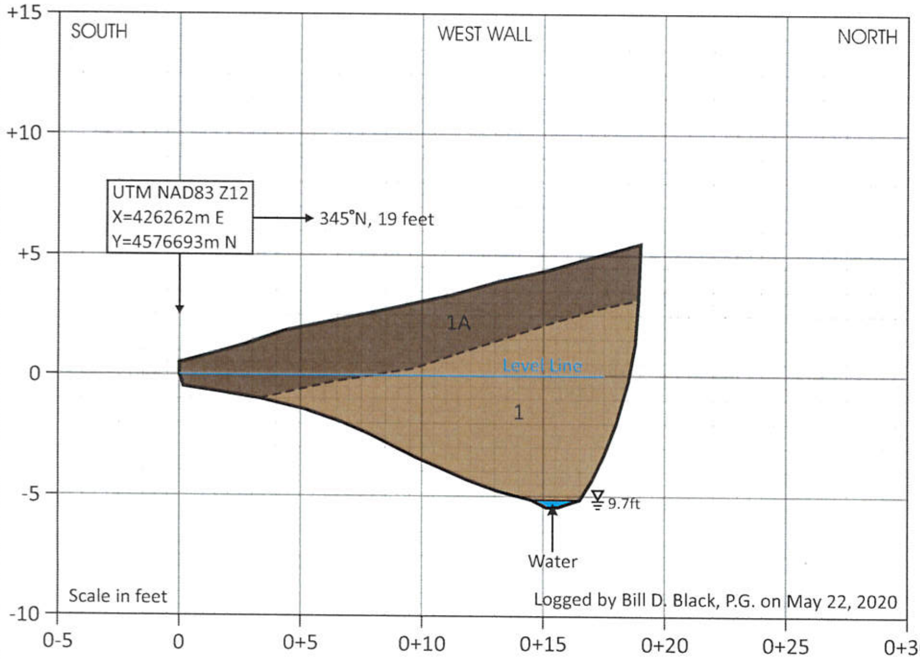
FIGURE 3C

WESTERN
GEOLOGIC



Scale 1:2,400
(1 inch = 200 feet)

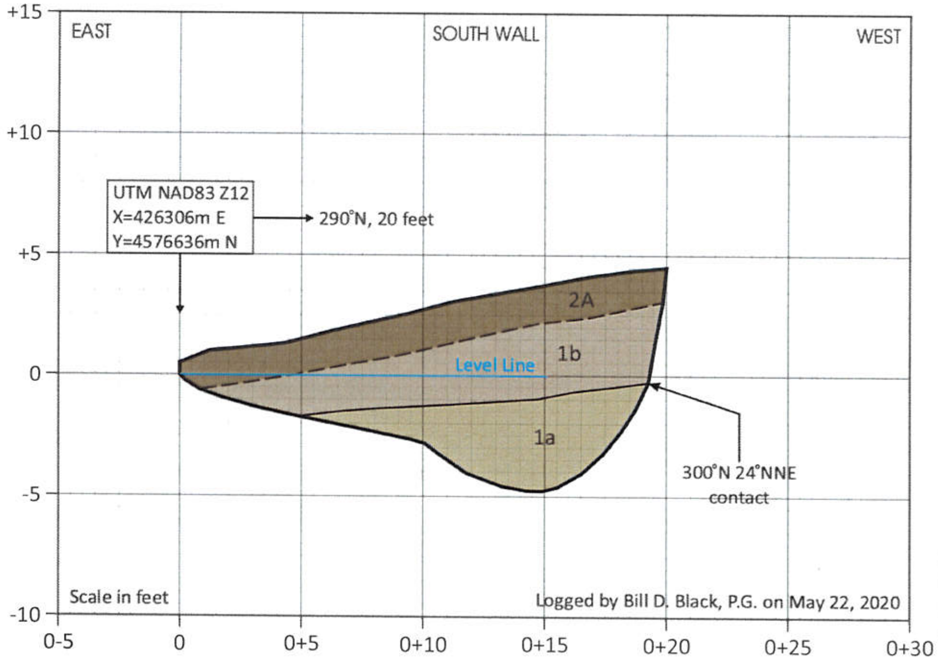
TEST PIT 1



UNIT DESCRIPTIONS

Unit 1. *Holocene to latest Pleistocene colluvium* - Strong brown (7.5YR 4/6), massive, moderate density, lean clay (CL) with sand and gravel; modern A horizon soil (1A) formed in unit.

TEST PIT 2



UNIT DESCRIPTIONS

Unit 1. *Tertiary Norwood Formation* - Sequence of weathered bedrock comprised of a lower (1a), olive gray (5Y 5/2), massive, moderate-high density, claystone; and an upper (1b) strong brown to grayish brown (7.5YR 5/6 to 10YR 5/2), massive, moderate density, pebble conglomerate with a lean to fat clay matrix.

Unit 2A. *Holocene to latest Pleistocene earthflow deposits* - Dark brown (10YR 3/3), massive, low to moderate density, root penetrated, sandy clay to clayey sand (CL/SC) with trace gravel; modern A horizon formed in unit.

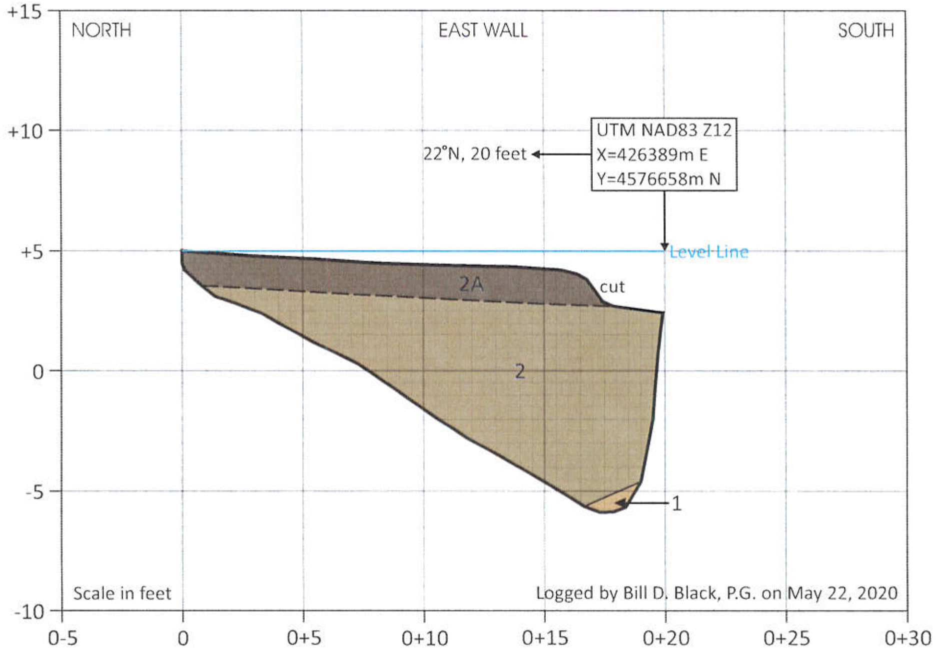
WESTERN GEOLOGIC

TEST PIT LOGS, SHEET 1

GEOLOGIC HAZARDS EVALUATION
Osman Property
4337 North 2900 East
Liberty, Weber County, Utah

FIGURE 4A

TEST PIT 3



UNIT DESCRIPTIONS

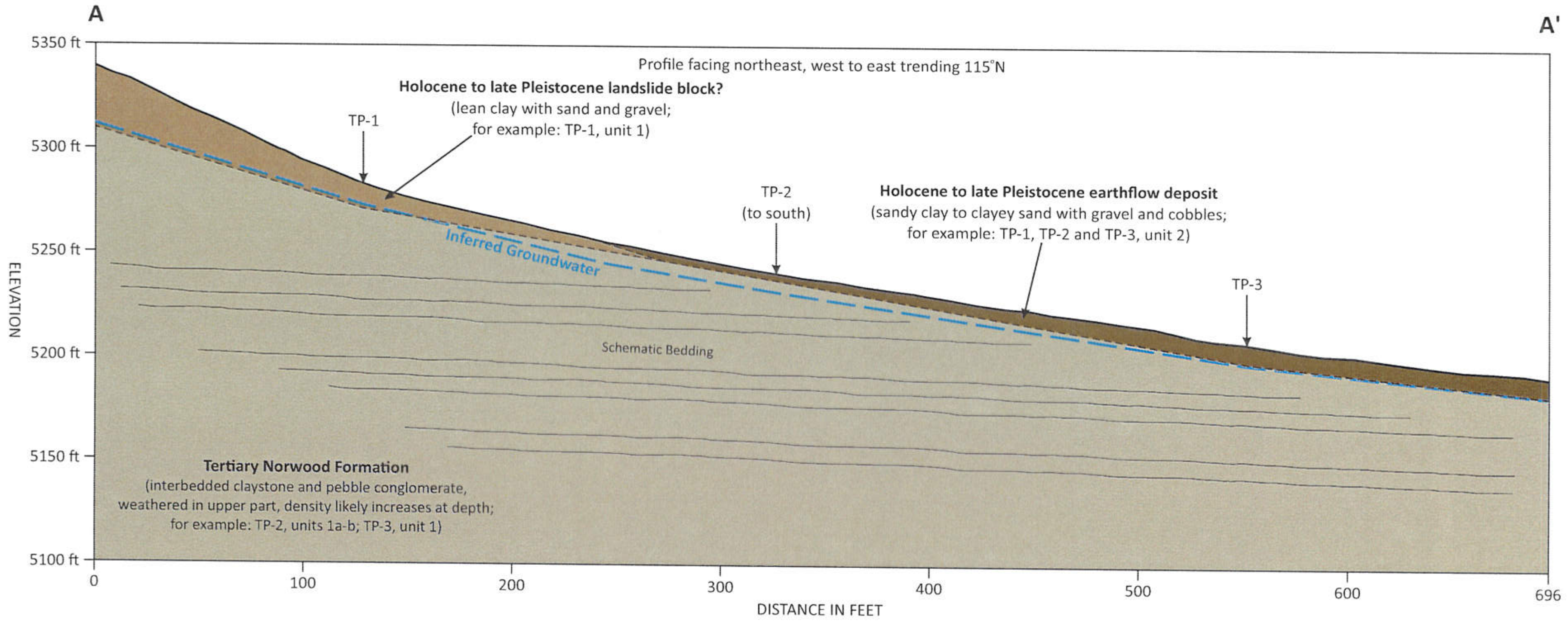
Unit 1. *Tertiary Norwood Formation* - Weathered bedrock comprised of strong brown to grayish brown (7.5YR 5/6 to 10YR 5/2), massive, moderate density, pebble conglomerate with a lean to fat clay matrix.

Unit 2. *Holocene to latest Pleistocene earthflow deposits* - Strong brown (10YR 4/4), massive, moderate density, sandy clay to clayey sand (CL/SC) with gravel and subround to subangular cobbles with strong stage II carbonate; modern A horizon (2A) formed in unit.

TEST PIT LOGS, SHEET 2

GEOLOGIC HAZARDS EVALUATION
Osman Property
4337 North 2900 East
Liberty, Weber County, Utah

FIGURE 4B



SCALE: 1 inch = 50 feet
(no vertical exaggeration)
Unit and textural contacts
are approximate and inferred

CROSS SECTION A-A'

GEOLOGIC HAZARDS EVALUATION
Osman Property
4337 North 2900 East
Liberty, Weber County, Utah

FIGURE 5