REPORT

GEOLOGIC HAZARDS RECONNAISSANCE

EDEN DEVELOPMENT GROUP LAND

ABOUT 9379 EAST 1800 SOUTH

HUNTSVILLE, WEBER COUNTY, UTAH

Prepared for

Mr. Curtis Hyde
182 West 5450 South
Ogden, Utah 84405

October 3, 2019

Prepared by

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October 3, 2019

Curtis Hyde
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Ogden, Utah 84405

SUBJECT: Geologic Hazards Reconnaissance
Eden Development Group Land
About 9379 East 1800 South
Huntsville, Weber County, Utah

Dear Mr. Hyde:

This report presents the results of a reconnaissance-level engineering geology and geologic hazards review and evaluation conducted by Western Geologic & Environmental LLC (Western Geologic) for the Eden Development Group Land at about 9379 East 1800 South in Huntsville, Utah (Figure 1 – Project Location). The site is in southeastern Ogden Valley in the E1/2 Section 28, Township 6 North, Range 2 East (Salt Lake Base Line and Meridian) at an elevation of from 5,031 to 5,098 feet above mean sea level.

The Project consists of four contiguous parcels identified as Weber County Assessor parcel numbers 21-037-0014 (33.24 acres, on the west), 21-037-0034 (9.22 acres, on the northeast), 21-037-0028 (9.79 acres, on the east), and 21-037-0032 (15.90 acres, on the southeast). The current owner of parcel 21-037-0014 is listed as B&H Investment Properties LLC, whereas the remaining parcels are owned by Eden Development Group LLC. Parcel 21-037-0034 (the northeastern parcel) is currently developed by an existing home and several outlying buildings, but the remaining parcels are undeveloped. No formalized development plans were provided, but it is our understanding that current plans are to develop three single-family residential homes: (1) in the southeast part of the western parcel (21-037-0014); (2) in the southwest part of the southeastern parcel (21-037-0032); and (3) in the east part of the eastern parcel (21-037-0028).

PURPOSE AND SCOPE

The purpose and scope of this investigation is to identify and interpret surficial geologic conditions at the site and 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. No hazard-specific evaluations or subsurface exploration were conducted for this report or within the scope of our study.

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; 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. However, 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. Our site reconnaissance did not constitute a formal inspection and was limited to observation of readily evident surficial geologic conditions in areas that were observable and accessed.

HYDROLOGY

The U.S. Geological Survey (USGS) topographic map of the Durst Mountain Quadrangle shows the site is in southeastern Ogden Valley straddling the mouth of Bennett Creek, which flows northward to the South Bench Canal and thence to South Fork Ogden River (Figure 1). Bennett Creek was at a low fall flow level and nearly dry at the time of our investigation. Several ephemeral tributaries of Bennett Creek also flow across the Project but were all dry at the time of our investigation. Weber County hazard mapping shows the site is in FEMA flood zone X, a zone of minimal stream flooding.

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).

The site is at the southeastern margin of Ogden Valley, which is dominated in the valley bottom by unconsolidated lacustrine and alluvial basin-fill deposits. Slopes in the site area are in weathered fanglomerate bedrock and Pleistocene- to Holocene-age alluvium. The Utah Division of Water Rights Well Driller Database shows several water wells in the Project vicinity that report static groundwater depths of 1 foot above to 34 feet below the ground surface (Figure 1).

Three of these wells are within the Project and show groundwater depths of from 5 to 24 feet. All the above suggests groundwater is likely 10 to 30 feet deep in areas adjacent to the floodplain of Bennett Creek and less than 10 feet deep within the floodplain. Groundwater depths at the site may also 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 layers may also be present in the subsurface that could cause locally shallower groundwater levels.

GEOLOGY

Surficial Geology

The site is located on the southern 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) as Tertiary-age fanglomerate (unit Thv), Quaternary-age conglomerate (unit Qcg), unconsolidated stream and undivided alluvium (units Qal and Qay), mixed lacustrine deposits from late Pleistocene Lake Bonneville (unit Qdlb), fan alluvium graded to the Provo level of Lake Bonneville (unit Qafp?), and undivided younger fan alluvium (unit Qafy, Figure 2).

Coogan and King (2016) describe surficial geologic units in the site area on Figure 2 as follows:

> ***Qal, Qal1, Qal2, Qal2?*** *– Stream alluvium and floodplain deposits (Holocene and uppermost Pleistocene).* Sand, silt, clay, and gravel in channels, floodplains, 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 floodplain 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 floodplain 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 floodplain.

***Qaf1, Qaf2, Qaf2?, Qafy, Qafy?** – Younger alluvial-fan deposits (Holocene and uppermost Pleistocene).* Like undivided alluvial fans, but all of these fans are unconsolidated and should be considered active; height above present drainages is low and is within certain limits; generally less than 40 feet (12 m) thick; near former Lake Bonneville, fans are shown as Qafy where Qaf1 and Qaf2 cannot be separated, and all contain well-rounded recycled Lake Bonneville gravel. Younger alluvial fan deposits are queried where relative age is uncertain (see Qaf for details).

Qaf1 fans are active because they impinge on and deflect present-day drainages. Qaf2 fans appear to underlie Qaf1 fans but may be active. Qafy fans are active, impinge on present-day floodplains, divert active streams, overlie low terraces, and/or cap alluvial deposits (Qap) related to the Provo and regressive shorelines. Therefore, Qafy fans are younger than the Provo shoreline and likely mostly Holocene in age, but may be as old as latest Pleistocene and may be partly older than Qaf1 fans.

***Qa, Qa?** – Alluvium, undivided (Holocene and Pleistocene).* Sand, silt, clay, and gravel in stream and alluvial-fan deposits near late Pleistocene Lake Bonneville and are geographically in the Ogden and Weber River, and lower Bear River drainages; composition depends on source area; variably sorted; variably consolidated; deposits lack fan shape of Qaf and are distinguished from terraces (Qat) based on upper surface sloping toward adjacent streams from sides of drainage, or are shown where fans and terraces are too small to show separately at map scale; Qa with no suffix used where age uncertain or alluvium of different ages cannot be shown separately at map scale; Qa queried where relative age uncertain, generally due to height not fitting into ranges in table 1 and/or typical order of surfaces contradicts height-derived age (see following paragraphs); generally 6 to 20 feet (2-6 m) thick.

Where possible, alluvium is subdivided into relative ages, indicated by number and letter suffixes. This alluvium is listed and described separately below. The relative ages of alluvium, including terraces and fans, are in part based on deposit heights above present adjacent drainages in Morgan and Round Valleys, and this subdivision apparently works in and is applied in Ogden, Henefer, and Lost Creek Valleys and above the North, Middle, and South Forks of Ogden River (see table 1 and 2). Alluvial deposits mapped in the Henefer quadrangle (Coogan, 2010b) and Lost Creek drainage (Coogan, 2004a-c) were revised during mapping of the Devils Slide quadrangle (see table 2). Comparable alluvium along Box Elder Creek in the northwest part of the map area (Mantua quadrangle) seems to be slightly higher than in Morgan Valley. Units Qa2, Qay, Qap, Qab, Qapb, Qao, and Qaoe described below are near Lake Bonneville. Their relative age is queried where age uncertain, generally due to height not fitting into ranges in table 1 and/or typical order of surfaces contradicts height-derived age.

***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.

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 (slope wash 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 slope wash 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).

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).

Qcg – *Gravelly colluvial deposits (Holocene and Pleistocene).* Gravelly materials present downslope from gravel-rich deposits of various ages (for example units Keh, Tw, Tcg, Thv, QTaf, QTa, Qafoe, Qaoe, Qafo, and Qa); may contain residual deposits; typically differentiated from colluvium and residual gravel (Qc, Qng) by prominent stripes trending downhill on aerial photographs; stripes are concentrations of gravel up to boulder size; generally 6 to 20 feet (2-6 m) thick.

Qng – *Colluvial and residual gravel deposits (Holocene and Pleistocene).* Poorly sorted pebble to boulder gravel in a matrix of silt and sand; gravel of uncertain origin, but probably includes colluvium and residuum, and at least locally glacial deposits (for example near Powder Mountain) and alluvium; mostly gravel-armored deposits on and near alluvial and colluvial deposits like units Qcg, QTay?, QTao?, and QTaf; locally on gravel-rich bedrock (Thv, Tcg, Tw, and Keh) and Paleozoic quartzite (Cgcu and Ct); typically have gently dipping upper surface; present on Durst Mountain, near high-level fans (QTaf) near head of Strawberry Creek (Snow Basin quadrangle), in northeast corner of Peterson quadrangle, and on benches above streams in east part of Peterson quadrangle; generally 6 to 20 feet (2-6 m) thick.

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.

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.

Ql, Ql? *– Lake Bonneville deposits, undivided (upper Pleistocene).* Silt, clay, sand, and cobbly gravel in variable proportions; mapped where grain size is mixed, deposits of different materials cannot be shown separately at map scale, or surface weathering obscures grain size and deposits are not exposed in scarps or construction cuts; thickness uncertain.

Thv? *– Fanglomerate of Huntsville area(?) (Pliocene and/or Miocene).* Brown to reddish-brown weathering sand, silt, and gravel (pebbles to boulders) on flat area near 7313-foot [2230 m] elevation hill on eastern margin of Mantua quadrangle; queried due to uncertain origin; located on Rendezvous Peak erosion surface of Williams (1948), so uncertain age (compare Williams, 1948 to 1958); similar patches on topographic highs to north and south are mapped as Salt Lake Formation conglomerate (Tslc); reddish color may be from erosion of Wasatch Formation and/or terra rossa development on underlying karstic carbonate rocks; may be post- or late-Salt Lake Formation age, like Thv on Durst Mountain.

Tcg, Tcg? – *Unnamed Tertiary conglomeratic rocks (Oligocene?).* Characterized by rounded, cobble- to boulder-sized, quartzite-clast conglomerate with pebbles and less than 10 percent to more than 50 percent gray, tan, or reddish-gray to reddish-tan matrix; conglomerate clasts locally angular to subangular Tintic Quartzite and angular to rounded lower Paleozoic carbonate rocks; interbedded with tan, gray, and reddish-brown, pebble-bearing mudstone to sandstone and some claystone (altered tuff); most beds poorly indurated and poorly exposed; mudstone likely constitutes matrix of conglomeratic beds; in Morgan and Durst Mountain quadrangles, about 500 to 700 feet (150-210 m) thick and thickening northward to possibly 3000 feet (900 m), though faulting may make this estimate too large.

Reddish-hued Tcg strata mostly contain recycled Wasatch Formation clasts (quartzite and carbonate) with a distinct reddish patina in a reddish matrix. Some non-conglomeratic beds in Tcg look like gray upper Norwood Formation (Tn) and are locally tuffaceous, indicating the units are interbedded. Further, some Tcg pebble beds have carbonate and chert clasts (like the Norwood) and lesser quartzite clasts, and Tcg conglomerate includes rare altered tuff clasts from the Norwood Formation. Despite tuffaceous matrix, unit Tcg seems to be less prone to mass movements than Norwood strata.

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.

Keh, Keh? *– Hams Fork Member of Evanston Formation (Upper Cretaceous, Maastrichtian-Campanian).* Light gray to tan conglomerate with lesser conglomeratic sandstone, and sandstone, with quartzite and chert clasts, as exposed along South Fork Ogden River; lower Hams Fork markedly coarsens to cobble conglomerate dominated by Cambrian and Neoproterozoic quartzite clasts (not mapped separately here, but mapped as Kehc to southeast); about 300 to 1000 feet (140-300 m) thick along South Fork Ogden River, thinning to west; thins to absence to north and west along regional angular unconformities. DeCelles and Cavazza (1999, figure 7A) showed a basal conglomerate as 66 feet (20 m) thick in the Causey Dam quadrangle. Unconformably truncated beneath Wasatch Formation and overlies Cretaceous Weber Canyon Conglomerate and Paleozoic rocks, with angular unconformity, along Right Fork South Fork Ogden River, indicating northern Causey Dam quadrangle, northwestern Horse Ridge, and western Dairy Ridge quadrangles were areas of high paleotopography (after Coogan, 2006a-b).

The age of the Hams Fork here is based on Mullens (1969; 1971, p. 13) note of Late Cretaceous pollen in a sample (D3971) that is from upper part of our Keh unit.

These South Fork Ogden River Keh exposures are not the same lithologically as those near Devils Slide, in the Lost Creek drainage, and in Echo Canyon; but these outcrops form a nearly continuous band down the South Fork and along the east flank of Durst Mountain to Devils Slide and other exposures to the east. The lithology of Keh along the east flank of Durst Mountain also differs from that in the other areas mentioned.

Jn *– Nugget Formation (Lower Jurassic).* Pale-grayish-orange, pinkish-tan, and locally white, well cemented, cross-bedded, quartz sandstone with frosted sand grains; typically about 1000 to 1100 feet (300-335 m) thick in subsurface.

Numerous subsurface thicknesses have been reported because the Nugget is a reservoir rock in the gas and oil fields near the Utah-Wyoming state line. About 1050 feet (320 m) of Nugget was cut in the American Quasar Minnow Hill well (API 43-033-30018, Utah DOGM; AMSTRAT log D-4952); about 1000 feet (300 m) of Nugget was cut in the Woodruff Narrows field Amoco 1-4H and Chevron-Amoco 1-32G wells (API 49-041-20289 and 49-041-20627 wells, WOGCC), with the 1-4H well just east of the Ogden map area. South of Woodruff Narrows 1011 feet (308 m) and 956 feet (291 m) of Nugget was cut in the Amoco Bradley and Chevron 1-35 wells (API 49-041-20509 and 49-041-20315, respectively, WOGCC), and 1040 feet (317 m) was cut in the Amoco A-MF-Chev well (after AMSTRAT log D-4943, API 43-033-30011). Farther south in the Yellow Creek field 1050 to 1150 feet (320-350 m) of Nugget was cut in the Champlin 375-Amoco C, Amoco Bradbury, Celsius [Mtn Fuel] 4-36, and Urroz wells, (API 49-041-20413, 49-041- 20421, 49-041-20578, and API 49-041-20321, WOGCC), and 1050 feet (320 m) of Nugget was cut in the Anschutz 14-33 well (API 43-043-30315, Utah DOGM). In the Cave Creek field about 1100 feet (335 m) of Nugget was cut in the Champlin 846-Amoco A (API 43-043-30100, Utah DOGM well file) and Fawcett & Son wells (AMSTRAT log D-5672, API 43-043-30078). In the Anschutz Ranch East field, 1145 feet, 1118 and 1056 feet (349, 340, and 322 m) of Nugget was cut in the ARE 30-10, U14-20, and Champlin 458-Amoco D1 wells (API 43-043-30215, 43-043-30145 and 43-043-30129, respectively, Utah DOGM). In the Anschutz Ranch (west) field 1096 and 1053 feet (334 and 321 m) of Nugget was cut in the Anschutz 28-1 and 34-2 wells (API 43-043-30032 and 43-043-30106, respectively, Utah DOGM), while the 1209 feet (369 m) of Nugget was cut in the Island Ranching D-1 well (API 43-043-30161, Utah DOGM) seems too large.

***TRt** – Thaynes Formation, undivided (Lower Triassic).* Brownish-gray, thin-bedded, calcareous siltstone; gray, thin-bedded, silty shale; and thin- to medium-bedded, gray, fossiliferous limestone in upper and lower part; separated by a resistant ridge of gray, very thick- to medium-bedded, fossiliferous limestone in middle part (Coogan, 2004a, 2006a-b; this report); estimated thickness of 1850 feet (565 m) (upper tongue of Dinwoody not included) from several miles south of Weber River in Devils Slide quadrangle, about the same total thickness as to northeast in Lost Creek drainage, 1835 feet (560 m) (Coogan, 2006a-b; note about 1300 feet (400 m) in Dairy Ridge quadrangle (Coogan, 2006a).

In subsurface north of the map area, about 1930 feet (590 m) of Thaynes was cut in the American Quasar Putnam well in the Birch Creek fold belt (API 43-033-30002, Utah DOGM) and about 1700 to 1800 feet (510-540 m) was cut in the American Quasar Hoffman well near Randolph, Utah (API 43-033-30001, Utah DOGM). In the map area, estimate 2273 feet (693 m) of Thaynes penetrated in the Amoco Deseret WIU well, but not dip corrected (King after AMSTRAT log D-4948 and API 43-029-30009, Utah DOGM well file), and 2057 feet (627 m) of Thaynes was reportedly penetrated in the Champlin 432-Amoco C well in the Peck Canyon quadrangle (see API 043-29-30011, Utah DOGM well file). Member names are after Kummel (1954). Note that Kummel's (1954) members, from about 70 miles (110 km) to the north near Bear Lake in Idaho, are recognizable near Devils Slide and that most of these members are recognizable another 25 miles (40 km) to the southwest near Salt Lake City, Utah (see Mathews, 1931; Solien and others, 1979). Member descriptions from Coogan (2004a, 2006a-b) and this report.

***Cn** – Nounan Formation (Cambrian).* Medium-dark-gray, thick-bedded dolomite and some limestone; estimated thickness 350 to 400 feet (105-120 m); see also Eardley (1944, his Cambrian units 6-8). The Nounan Formation does not appear to be present to the north of the map area in the Birch Creek fold belt (API 43-033-30042, 43-033-30043, 43-033-30028, and 43-033-30002, Utah DOGM), likely due to the unconformity that excised Silurian and Ordovician strata, and the Cambrian part of the St. Charles Formation elsewhere in the map area (see above).

***Cm, Cm?** – Maxfield Limestone (Middle Cambrian).* Limestone and calcareous siltstone; estimated thickness 300 feet (60 m); see also Eardley (1944, his Cambrian units 3-5). Queried where may be Nounan Formation (Cn). Bloomington Formation is not present on Durst Mountain. Strata in subsurface that are lithologically similar to Maxfield are called Gallatin Limestone (Cg) (Wyoming terminology).

Zkc, Zkc? – Kelley Canyon Formation (Neoproterozoic). Dark-gray to black, gray to olive-gray-weathering argillite to phyllite, with rare metacarbonate (for example basal meta-dolomite); grades into overlying Caddy Canyon quartzite with increasing quartzite; gradational interval mapped as Papoose Creek Formation (Zpc); 1000 feet (300 m) thick in Mantua quadrangle (this report), where Papoose Creek Formation is mapped separately, and reportedly 2000 feet (600 m) thick near Huntsville (Crittenden and others, 1971, figure 7), but only shown as about 1600 feet (500 m) thick to Papoose Creek transition zone by Crittenden (1972). The Kelley Canyon Formation is prone to slope failures.

Citations, tables, and/or figures referenced above are not provided herein but are in Coogan and King (2016).

Seismotectonic Setting
The property is located at the southeastern 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 1988).

Ogden Valley occupies a structural trough created by up to 2,000 feet of vertical displacement on normal faults bounding the northeastern and southwestern margins of the valley. Coogan and King (2016) and the Utah Geological Survey Quaternary Fault Database (Black and others, 2003; January 2017 update) show these faults about 1.9 and 4.9 miles to the north and west, respectively. Both faults were most-recently active more than 10,000 years ago (Sullivan and others, 1986). The nearest active (Holocene-age) fault to the site is the Weber segment of the Wasatch fault zone about 10.4 miles to the west.

The site is also situated near the central portion of the Intermountain Seismic Belt (ISB). The ISB is a north-south-trending zone of historical seismicity along the eastern margin of the Basin and Range province which extends for approximately 900 miles 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, with the largest of these events the M_S 7.5 1959 Hebgen Lake, Montana earthquake. However, none of these events have occurred along the Wasatch fault zone or other known late Quaternary faults in the region (Arabasz and others, 1992; Smith and Arabasz, 1991). The closest of these events to the site was the 1934 Hansel Valley (M_S 6.6) event north of the Great Salt Lake and south of the town of Snowville.

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). Portions of Ogden Valley were inundated by Lake Bonneville at its highstand and sediments from Lake Bonneville are mapped nearby on Figure 2. The lake highstand (Bonneville shoreline) is near the southwest boundary of the Project and to the east and west (blue line and B, Figure 2).

Timing of events related to the transgression and regression of Lake Bonneville is indicated by calendar age estimates of significant radiocarbon dates in the Bonneville Basin (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. During the transgression and highstand, major drainages that emanate from within the Wasatch Range (such as the Weber River) formed large deltaic complexes in the lake at their canyon mouths. Headward erosion of the Snake River-Bonneville basin drainage divide then caused a catastrophic incision of the threshold and the lake level lowered by roughly 360 feet in fewer than two months (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 between about 16,500 and 15,000 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. Drainages that fed Lake Bonneville began downcutting through stranded deltaic complexes and near-shore deposits as the lake receded from the Provo shoreline. Oviatt and others (1992) deem this low stage the end of the Bonneville lake cycle. Great Salt Lake then experienced a brief transgression around 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).

SITE CHARACTERIZATION

Empirical Observations

On September 26, 2019 Bill D. Black, P.G. of Western Geologic conducted a brief reconnaissance of the property and nearby area. Weather at the time of the site visit was clear with temperatures in the 60’s (°F). A photographic record of our reconnaissance is included in the Appendix. The site is in southeastern Ogden Valley straddling the Bennett Creek floodplain and adjacent slopes. The south part of the Project is on a bedrock-cored ridge downcut on the east by Bennett Creek and on the west by Bally Watts Creek. Native vegetation at the Project appeared to consist mainly of grasses, weeds, brush, and mature trees. Bennett Creek was at a low fall flow level at the time of our reconnaissance. Several ephemeral tributaries of Bennett Creek also cross the Project that were all dry at the time of our site visit. One of these ephemeral drainages is from a seasonal seep located slightly east of the southeastern proposed home site at the base of the bedrock-cored ridge. The seep is reportedly active only following spring snowmelt and heavy rainstorms. An excavation conducted in the area of the southwestern home site reportedly encountered dense shallow bedrock but had been closed by the time of our site visit. No other evidence of active or ephemeral drainages, seeps or springs, ongoing or previous slope instability, characteristic debris flow features, bedrock outcrops, or other geologic hazards was observed.

Air Photo Observations
Black and white aerial photography from 1997, high-resolution orthophotography from 2012, and bare earth DEM LIDAR from 2016 available from the Utah AGRC were reviewed to obtain information about the geomorphology of the Project area (Figures 3A-3C). Approximate locations of the proposed home sites are denoted on the air photos and LIDAR image by 1, 2 and 3. The eastern part of the site straddles Bennett Creek, which flows to the north. Several ephemeral drainage courses also flow into Bennett Creek which are likely active only following spring snowmelt or large rainstorms. A small pond is on the creek that appears to be a man-made structure for seasonal retention (such as for livestock watering). Home sites 1 and 2 are on the bedrock-cored ridge in the south part of the Project, whereas home site 3 is slightly east of Bennett Creek in an orchard at the floodplain margin. Slopes at the site generally dip to the northwest, north, and northeast and are mainly gentler than 20% (Figure 3C, in green). Slopes steeper than 30% (in red) are found around the margin of the bedrock-cored ridge in the south part of the Project and along the east margin of the Bennett Creek floodplain. All these slopes are a result of alluvial downcutting and generally show less than 25 feet of overall vertical relief. We anticipate the slopes and slope toes are mantled by a thin veneer of slope colluvium from local erosion, but the slopes show no evidence of slumps, landslides or instability. No surficial evidence of geologic hazards, except for possible stream flooding, was observed at the site or in the area on the air photos.

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			X

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 2015 IBC provisions, a site class of D (stiff soil), and a risk category of II, calculated uniform-hazard and deterministic ground motion values with a 2% chance of exceedance in 50 years are as follows:

Table 2. *Seismic hazards summary.*
(Site Location: 41.23053º N, -111.72377º W)

S_S	*0.767 g*
S_1	*0.256 g*
S_{MS} (F_a x S_S)	*0.915 g*
S_{M1} (F_v x S_1)	*0.483 g*
S_{DS} (2/3 x S_{MS})	*0.61 g*
S_{D1} (2/3 x S_{M1})	*0.322 g*
Site Coefficient, F_a	*= 1.193*
Site Coefficient, F_v	*= 1.889*
PGA, Peak Ground Acceleration	*0.296 g*

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 appropriate building codes.

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 or were observed at the site or nearby. The nearest active (Holocene-age) fault to the site is the Weber segment of the WFZ about 10.4 miles to the west. Given the above, the risk from surface faulting is low.

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 (earthquake ground shaking) accelerations, groundwater conditions, and presence of susceptible soils.

Although the Project is in an area of potentially strong ground shaking and has locally shallow groundwater, based on our experience it is unlikely that any soils susceptible to liquefaction are prevalent. Given this, we rate the liquefaction potential at the site as low. It is possible that pockets of sandy soils may be present in the Bennett Creek floodplain, as would be typical for stream alluvium, that could produce limited localized variations.

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 a normal fault. Given that the site is not on the downthrown side of any active faults, we rate the risk from tectonic subsidence as low.

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 relative elevations and distance to the nearest large body of water (Pineview Reservoir), we rate the risk from seismic seiches and storm surges as low.

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.

The eastern part of the Project straddles Bennett Creek, which may produce shallow seasonal flooding following spring snowmelt. Several ephemeral tributaries of the creek also flow across the Project that are reportedly active only in the spring. However, Weber County hazard maps indicate that the site is not in a FEMA hazard zone subject to substantial flooding (zone X). Given the above, we rate the risk from stream flooding as moderate. The hazard from stream flooding should be addressed in the civil engineering design for the Project in accordance with Weber County guidelines.

Shallow Groundwater

Based on evidence discussed in the Hydrology Section above, groundwater in the area of proposed home sites 1 and 2 at the Project is likely between 10 to 30 feet deep and likely less than 10 feet deep in the area of proposed home site 3. Shallower levels may also occur seasonally, as would be expected for an alpine environment. Given all the above, we rate the risk from shallow groundwater as moderate. The proposed homes will require foundation drainage systems to ensure that proper subsurface drainage is maintained. We recommend the designs be provided or reviewed (and approved) by a licensed geotechnical engineer.

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.

No landslides are mapped or were evident at the Project and no evidence of recent or ongoing slope instability was observed. Analysis of geo-processed LIDAR data indicates slopes in the area of the proposed home sites are mainly gentler that 20% (as shaded in green on Figure 3C). Given all the above, we rate the risk from landslides as low. However, care should be taken to maintain proper site drainage and that no substantial cuts are made in the slopes without prior geotechnical analysis.

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. Proposed home site 3 is in an area subject to alluvial-fan flooding, but no debris-flow channels, levees, or other debris-flow features were observed during our reconnaissance or on air photos. Proposed home sites 1 and 2 are on the bedrock-cored ridge overlooking Bennett Creek and not subject to alluvial-fan flooding. Given all the above, we rate the hazard from debris flows to the Project as low.

Rock Fall
No significant bedrock outcrops were observed at the site or in higher slopes that could present a source area for rock fall clasts. We therefore rate the hazard from rock falls to the Project as low.

Problem Soil and Rock
The U.S. Department of Agriculture Natural Resources Conservation Service (https://websoilsurvey.nrcs.usda.gov/app/) maps the soil in the area of proposed home sites 1 and 2 as "Yeates Hollow very stony loam, 10 to 30 percent slopes." This soil is described as a mountainside, bench and alluvial-fan soil formed in alluvium and/or colluvium overlying weathered conglomerate. The typical profile reportedly consists of an A horizon formed in very stony loam to a depth of 10 inches, a B horizon formed in very gravelly loam and very gravelly clay loam from 10 to 55 inches, and bedrock below 55 inches. Proposed home site 3 is in an area mapped as "Fluvaquentic Haploborolls-Fluventic Haploxerolls complex, 1 to 6 percent slopes." This soil is described as a floodplain and stream-terrace soil formed in alluvium. The soil profile reportedly varies. Weber County hazard mapping does not show any areas of potential expansive soil or rock at the Project. Given all the above, we rate the risk from problem soil as low. Evaluation of and recommendations regarding soil foundation conditions should be conducted and provided as needed in site-specific geotechnical investigations once development plans have been formalized.

CONCLUSIONS AND RECOMMENDATIONS

Earthquake ground shaking is the only geologic hazard identified as posing a high relative risk to the Project. This hazard is a regional hazard common in all Wasatch Front areas. Stream flooding and shallow groundwater also pose a moderate (equivocal) risk.

We recommend the following:

- ***Seismic Design*** – All habitable structures developed at the property should be designed and constructed to current seismic building codes to reduce the risk of damage, injury, or loss of life from earthquake ground shaking.

- ***Geotechnical Investigation*** – Site-specific geotechnical investigations should be conducted prior to construction to assess soil foundation conditions. No substantial slope cuts should be made in the slopes at the site without prior geotechnical analyses.

- ***Site Hydrology*** **–** Surface drainage and the potential for seasonal stream flooding should be addressed with regard to the proposed home sites in accordance with all Weber County requirements. The proposed homes will also require foundation drainage systems to ensure proper subsurface drainage. We recommend the designs be provided or reviewed (and approved) by a licensed geotechnical engineer.

- ***Report Availability*** – This report and any subsequent reports regarding geologic conditions at the property should be made available to the architect and building contractor, as well as real estate agents and potential buyers in the event of a future sale. 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 the authors and should not be copied, used, or modified without their express permission.

LIMITATIONS

This investigation was performed at the request of 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.

It has been a pleasure working with you on the Project. Should you have any questions, please call.

Sincerely,
Western Geologic & Environmental LLC

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

Reviewed By:

Kevin J. Thomas, P.G.
Principal Geologist

ATTACHMENTS

Figure 1. Location Map (8.5”x11”)
Figure 2. Geologic Map (8.5”x11”)
Figure 3A. 1997 Air Photo (8.5”x11”)
Figure 3B. 2012 Air Photo (8.5”x11”)
Figure 3C. LIDAR Analysis (8.5”x11”)
Appendix. Photographic Record of Site Reconnaissance

C:\Users\GLENDA\Documents\WG&E\PROJECTS\Hyde, Curtis\Huntsville, UT - Geo Haz Recon - About 9379 East 1800 South #5247\Geo Haz Recon - Eden Development Group Land - About 9379 E 1800 S.docx

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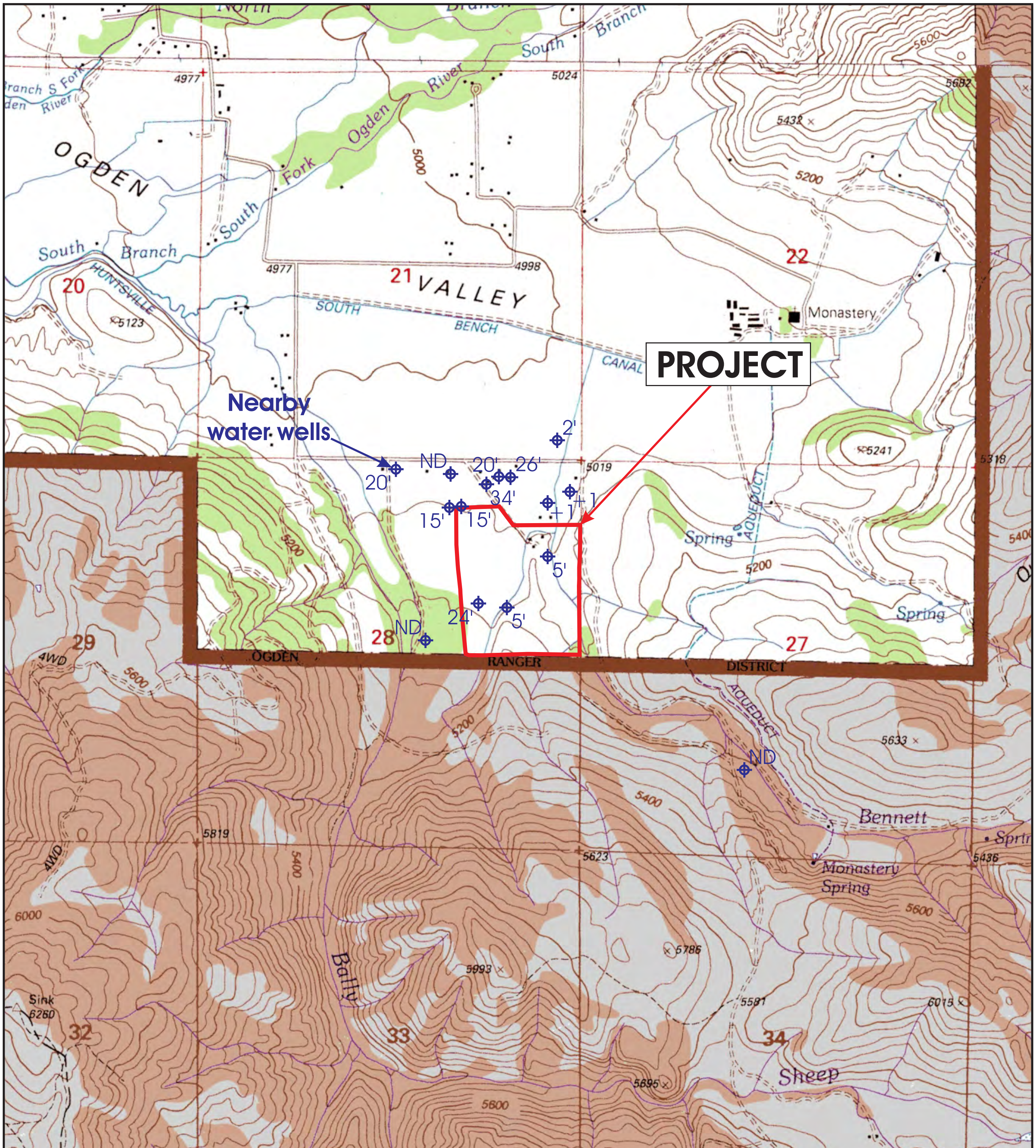
FIGURES



Source: U.S. Geological Survey 7.5 Minute Series Topographic Maps, Utah - Huntsville, Browns Hole, Snow Basin and Durst Mountain, 1998; Project location NE1/4, Section 28, T6N, R2E (SLBM).

WESTERN GEOLOGIC

N W E S

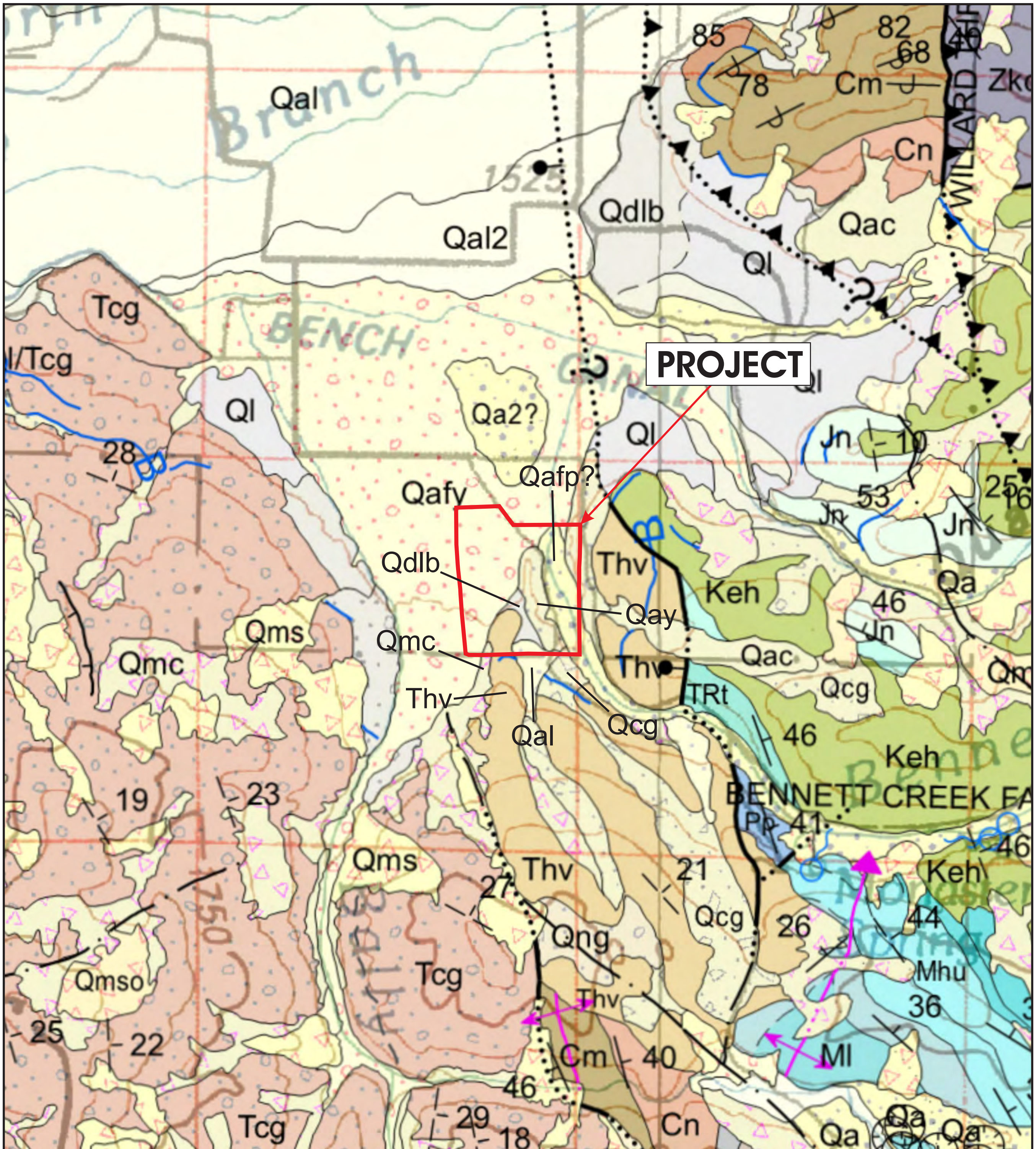
0 1000 2000 feet

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

LOCATION MAP

GEOLOGIC HAZARDS RECONNAISSANCE
Eden Development Group Land
About 9379 East 1800 South
Huntsville, 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

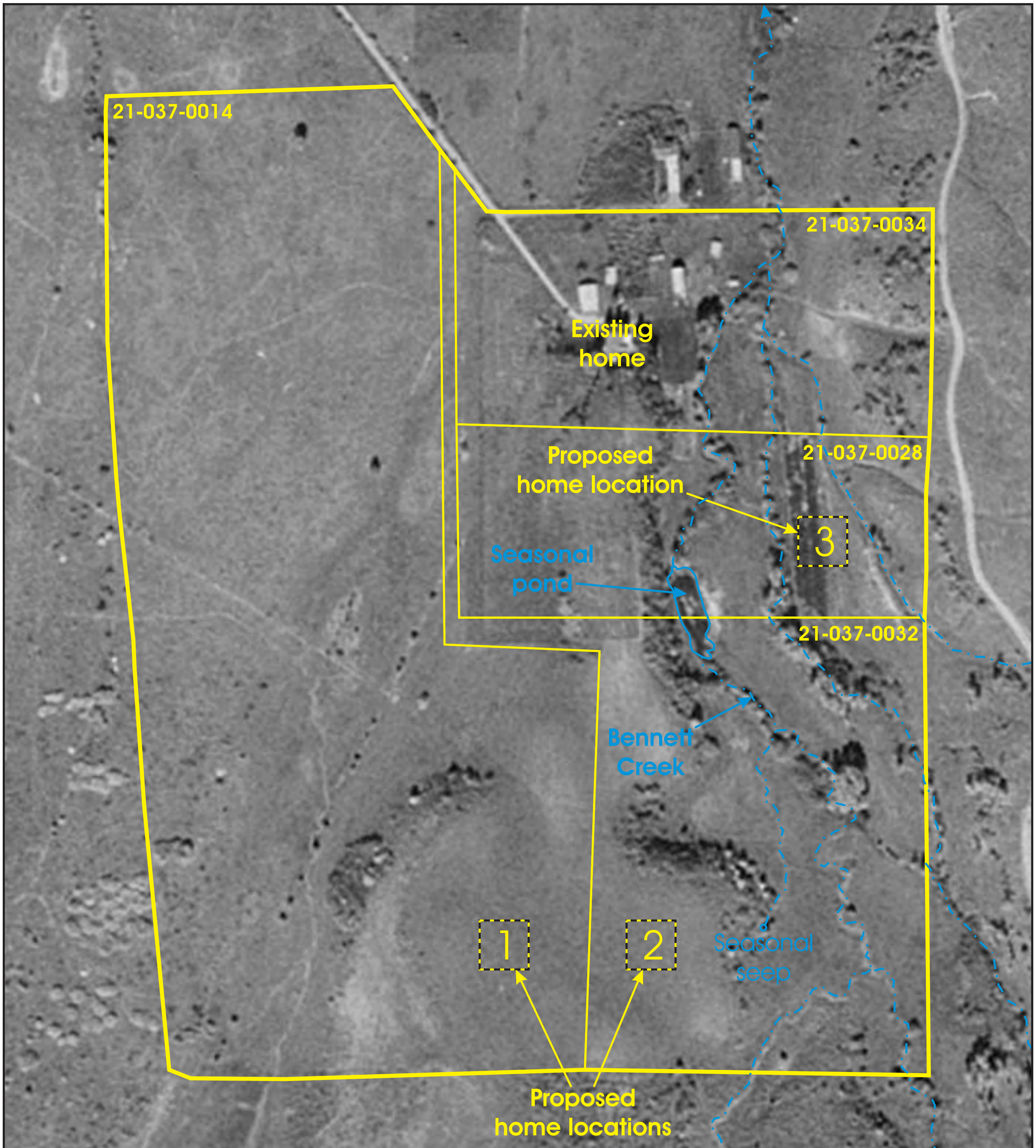
0 1000 2000 feet

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

GEOLOGIC MAP

GEOLOGIC HAZARDS RECONNAISSANCE
Eden Development Group Land
About 9379 East 1800 South
Huntsville, Weber County, Utah

FIGURE 2



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

WESTERN GEOLOGIC

N W E S

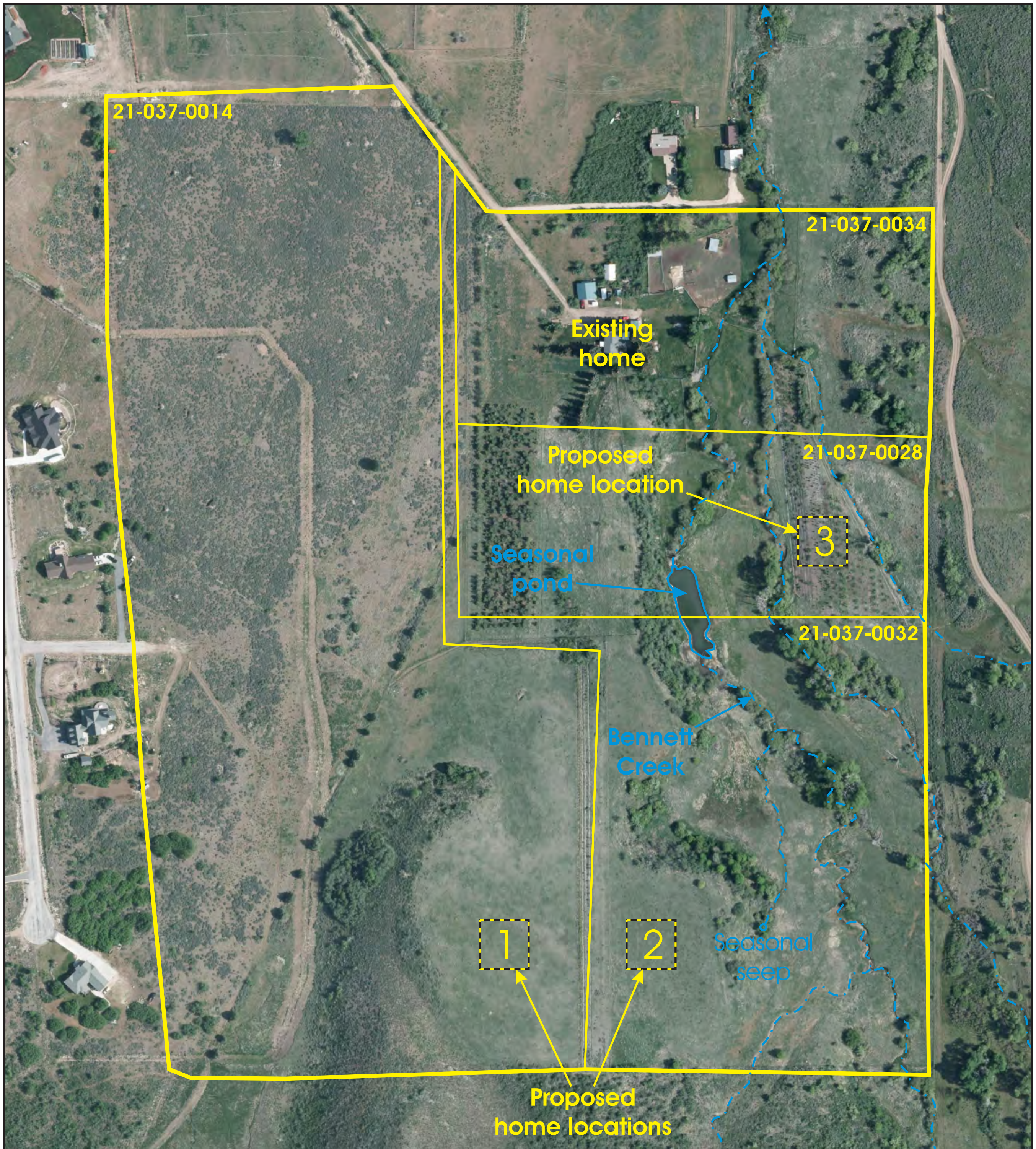
0 150 300 feet

Scale 1:3,600
(1 inch = 300 feet)

1997 AERIAL PHOTO

GEOLOGIC HAZARDS RECONNAISSANCE
Eden Development Group Land
About 9379 East 1800 South
Huntsville, Weber County, Utah

FIGURE 3A



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

WESTERN GEOLOGIC

N W E S

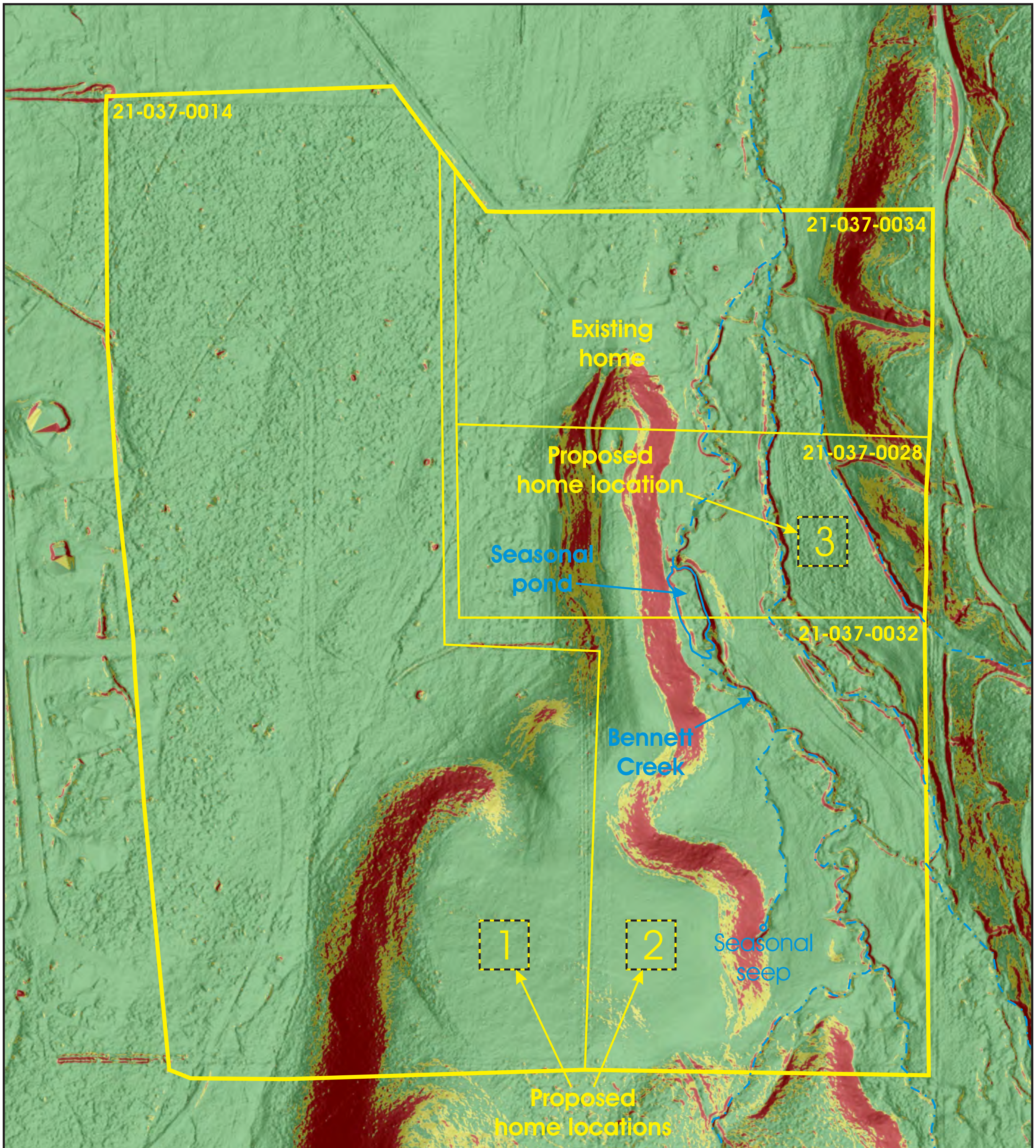
0 150 300 feet

Scale 1:3,600
(1 inch = 300 feet)

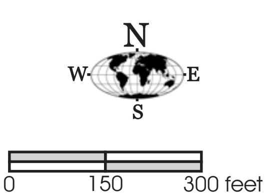
2012 AIR PHOTO

GEOLOGIC HAZARDS RECONNAISSANCE
Eden Development Group Land
About 9379 East 1800 South
Huntsville, Weber County, Utah

FIGURE 3B



Source: Utah AGRC, 2016 LIDAR Bare Earth DEM, 50 cm resolution; slope gradients <20% shaded in green, 20-30% in yellow, and >30% in red.



Scale 1:3,600
(1 inch = 300 feet)

LIDAR ANALYSIS

GEOLOGIC HAZARDS RECONNAISSANCE

Eden Development Group Land
About 9379 East 1800 South
Huntsville, Weber County, Utah

FIGURE 3C

WESTERN GEOLOGIC

APPENDIX

Photographic Record of Site Reconnaissance
Eden Development Group Land
About 9379 East 1800 South, Huntsville, Weber County, Utah

Photo 1. View north across Project.

Photo 2. Proposed home site 1.

Photographic Record of Site Reconnaissance
Eden Development Group Land
About 9379 East 1800 South, Huntsville, Weber County, Utah

Photo 3. Proposed home site 2.

Photo 4. View east across Project.

Photographic Record of Site Reconnaissance
Eden Development Group Land
About 9379 East 1800 South, Huntsville, Weber County, Utah

Photo 5. View south from Project.

Photo 6. View west from Project.

Photographic Record of Site Reconnaissance
Eden Development Group Land
About 9379 East 1800 South, Huntsville, Weber County, Utah

Photo 7. Proposed home site 3.

Photo 8. Bennett Creek.