GCS Geoscience

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October 12, 2016
File No: GCS 2016.13

Owen Fisher
Fisher Family Holdings LLC
351 E Oak Lane
Kaysville, Utah 84037

ATTN: Mr. Owen Fisher

Subject: Report
Professional Geologist Site Reconnaissance and Review
Fisher Property, 5.26 Acre Parcel Subdivision
Weber County Parcels # 16-001-0022 and # 16-001-0023
Approximately 6500 N. North Fork Road
Eden, Weber County, Utah

In response to your request, GCS Geoscience (GCS) has prepared this Professional Geologist site reconnaissance review report for the above referenced site.

Introduction

The 5.26 Acre Parcel Subdivision property consists of an approximately 4.39 acre property (parcel 16-001-0022), and a contagious 0.85 acre property (parcel 16-001-0023) located in the North Fork Area of Ogden Valley, in Weber County, Utah, as shown on attached Figure 1. The two parcels and surrounding properties are zoned by Weber County as Forest Zone F-5. *The intent of the Forest Zones is to protect and preserve the natural environment of those areas of the County that are characterized by mountainous, forest or naturalistic land, and to permit development compatible to the preservation of these areas.* Minimum building lot size in the F-5 zone is five acres, with single family dwellings included as a premited use. Aerial Coverage of the site is provided on Figure 2, Aerial Coverage.

It is our understanding the owner(s) intend to consolidate the two parcels through subdivision procedures into a single unit for single family homesite use. Although plans are not at this time available, we anticipate that a single family residence will be constructed on the site. The proposed structure is likely to be constructed with a basement level and supported on conventional spread and strip footings. Above grade levels will consist of wood frame construction one to three levels in height. Projected site grading is anticipated to consist primarily of cutting into the existing ground to construct the residence, with very little fill projected for the site.

Because the proposed subdivision appears to be located on a hill slope area in the vicinity of mapped landslide hazards, marginal soil conditions, and natural floodplain areas, Weber County is requesting that this geological site reconnaissance be performed to asses whether all or parts of the site are exposed to the hazards that are included in the Weber County Code, Chapter 27, Natural Hazards Overlay District. These hazards include, but are not limited to: Surface-Fault Rupture, Landslide, Tectonic Subsidence, Rock Fall, Debris Flows, Liquefaction Areas, Flood, or other Hazardous Areas.

The purpose of this proposed **Professional Geologist Site Reconnaissance Review** is to evaluate if the proposed development is outside or within areas identified as Natural Hazards Overlay District, and if within a hazard area, to recommend appropriate additional studies that comply with the purpose and intent of the Weber County Hillside Development Review Procedures and Standards to evaluate and/or mitigate the hazard exposure.

Literature and Resource Review

To evaluate the potential exposure of sites to geological hazards that impact sites or site improvements, Weber County has compiled a series of Geographic Information Systems (GIS) data mapping layers of geological hazard related information. These data may be queried on-line using the Weber County Geo-Gizmo application at http://www.co.weber.ut.us/gis/maps/gizmo/. Using the Geo-Gizmo application, under the Engineering Layers category is listed geological hazard related layers that may be toggled on and off to determine potential hazards exposure to sites in the county. These mapping layers include the following categories; *Quake Epicenters, FEMA Flood Zone Line, FEMA Base Flood Elevation, Wasatch Faults, Landslide Scarps, Geologic Faults, Faults, Quaternary Faults, FEMA Flood Zone, FEMA LOMR, Engineering Problems; Liquefaction Potential, Landslide, FEMA Letters of Map Change, and FEMA Flood Zones.* These layers have been compiled from the respective agencies including the Federal Emergency Management Agency (FEMA), the Utah Geological Survey (UGS), and the U.S. Geological Survey (USGS). These mapping layers consist of regional compilation hazards data, but are not compiled at scales that are necessarily relevant for site specific usage. When hazard layer data on the Geo-Gizmo are found to interact with Applicant site improvement locations, Weber County Engineers and Planners will request that the Applicant have a Professional Geologist Site Reconnaissance Review, such as presented herein, conducted for the site.

Our preliminary review of the Geo-Gizmo indicated that the two parcels showed no direct exposure to any of the aforementioned hazard layer areas, however the properties are in close proximity to *Engineering Problems*, *Landslide* and *FEMA Flood Zone* mapped areas.

Our review consisted of a GIS data integration effort that included reviews of previous mapping and literature pertaining to site geology including Coogan and King (2016),

King (2014), and Crittenden and Sorensen (1985); an analysis of vertical and stereoscopic aerial photography for the site including a 1946 1:20,000 stereoscopic sequence, a 2014 1.0 meter digital NAIP coverage, and a 2012 5.0 inch digital HRO coverage of the site; and a GIS analysis using the QGIS® GIS platform to geoprocess and analyze 2011 1.0 meter LiDAR digital elevation data made available for the site by the Utah Automated Geographic Reference Center (AGRC). The GIS analysis included using the QGIS® platform Geospatial Data Abstraction Library (GDAL, 2013) Contour; the GRASS® (Geographic Resources Analysis Support System, 2013) r.slope and r.shaded.relief modules.

For the best site specific documentation for this review we used geologic mapping by Coogan and King (2016), which provided the most up-to-date rendering of geological mapping for the site location. Supporting documentation by King (2014), Crittenden and Sorensen (1985) and FEMA (2015) was also used for conducting this review. The geological and flood hazard mapping for this review is provided on Figure 3, Geologic and Flood Hazard Map. Topographic, slope, and elevation data for this review was supported through the aforementioned LiDAR analysis which is presented on Figure 4, LiDAR Analysis.

Review Findings

Topographically the site is located on the upper reaches of the North Fork of the Ogden River, on the east side of Ben Lomond Peak, in an area that includes the confluence of Durfee Creek and the North Fork River. The site and surrounding area consists of bedrock-controlled sloping areas and alluvium mantled benches that are dissected by alluvial stream and floodplain areas, that have been eroded by Durfee Creek and the North Fork River. The lower areas of the site include west side of the site where Durfee Creek has formed an alluvial corridor north to south across the site, and the upper areas of the site include the alluvial mantled benches on the east side of the site.

Figure 3 shows the location of the site relative to GIS overlays including geological mapping prepared by Coogan and King (2016) and documented floodplain risks by FEMA (2015) and Weber County (1994). A summary of the geological mapping of the site vicinity is provided as follows:

> The lower-lying alluvial floodplain areas of the site include geological units classified as **Qal**, and **Qafy**. The **Qal** deposits consist of stream alluvium and flood-plain deposits, Holocene and uppermost Pleistocene in age - 0 to 15,000 years before present (ybp), comprised of sand, silt, clay, and gravel, related to flood plain deposition along the North Fork River. The **Qal** areas should be considered exposed to potential flood hazards, and liquefaction potential hazards.
>
> The **Qafy** deposits are younger alluvial-fan deposits are Holocene and uppermost Pleistocene in age (0 to 15,000 ybp), consisting mostly of sand, silt, and gravel that is poorly bedded and poorly sorted. These deposits are found along Durfee Creek,

where higher energy bedload-dominated flooding appears to have occurred periodically during the past.

The **Qaf** deposits are alluvial-fan deposits are Holocene and Pleistocene in age (0 to 30,000 ybp), consisting mostly of sand, silt, and gravel that is poorly bedded and poorly sorted. These deposits are found along the margins of the North Fork River, downstream from the site.

The **Qafp** and **Qab** deposits are Lake Bonneville-age alluvial fan deposits and alluvium, upper Pleistocene in age (10,000 to 30,000 ybp). These are older, no longer active, alluvial deposits related to present bench surfaces graded to shorelines of ancient Lake Bonneville which inundated parts of Ogden Valley 15,000 to 19,000 years ago (Currey and Oviatt, 1985).

The **Qaoe** deposits include older eroded alluvium, older than Lake Bonneville age alluvium, believed to be middle and lower Pleistocene in age (15,000 to 30,000 ybp).

The **Qmc** deposits include landslide and colluvial deposits, undivided Holocene and Pleistocene in age (0 to 30,000 ybp), consisting of poorly sorted to unsorted clay- to boulder-sized materials, including slopewash and soil creep processes.

The **Qms** deposits include landslide and colluvial deposits associated with failed or moving slope surfaces, Holocene and Pleistocene in age (0 to 30,000 ybp), consisting of poorly sorted to unsorted clay- to boulder-sized material.

The **Qmc** and **Qms** classified areas should be considered exposed to landslide and slope-creep hazards. On Figure 3 these deposits are shown to occur roughly 350 feet west of the site.

The Norwood Formation **Tn**, lower Oligocene and upper Eocene in age, roughly 30 million years (ma), consists of light-gray to light-brown altered tuff, altered tuffaceous siltstone and sandstone, and conglomerate. Expansive soil conditions are often related to exposures of this formation.

A bedrock exposure approximately 700 feet northeast of the site is mapped as consisting of **Zcc** - Caddy Canyon Quartzite, which is Neoproterozoic in age (750 ma), consisting of cliff-forming quartzite; tan, light-gray, pinkish-gray, greenish-gray, and purplish-gray (Coogan and King, 2016).

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

1. **Landsliding:** The nearest landslide units mapped as **Qms** or **Qmc** deposits are located approximately 350 feet to the east of the site location, and should not potentially impact the proposed subdivision.

2. **Alluvial fan debris flow processes** including flash flooding and debris flow hazard: The **Qafy** deposits mapped on the western and southern margins of the site are indicative of past flash flooding and debris flow processes. The areas of the site where the **Qafy** deposits are mapped should be considered potentially hazardous for future debris flow events.

3 Surface fault rupture hazards, strong earthquake ground motion, and liquefaction:

Active Earthquake Faults: The nearest active (Holocene) earthquake fault to the site is the Weber City segment of the Wasatch fault zone (UT2351E) which is located 3.5 miles southwest of the site, thus fault rupture hazards are not considered present on the site (Black et al., 2004). The Ogden Valley North Fork fault (UT2376) is located much closer to the site, approximately 3,100 feet to the west, however the most recent movement along this fault is estimated to be pre-Holocene (greater than 15,000 ybp), and presently is not considered an active risk (Black, et al., 1999).

Strong earthquake ground motion originating from the Wasatch fault or other near-by seismic sources is capable of impacting the site. The Wasatch fault zone is considered active and capable of generating earthquakes as large as magnitude 7.3 (Arabasz et al., 1992). Based on probabilistic estimates (Peterson, et al., 2008) queried for the site , the expected peak horizontal ground acceleration on rock from a large earthquake with a ten-percent probability of exceedance in 50 years is as high as 0.19*g,* and for a two-percent probability of exceedance in 50 years is as high as 0.43*g* for the site.

The a ten-percent probability of exceedance in 50 years event has a return period of 475 years, and the 0.18*g* acceleration for this event corresponds "very strong" perceived shaking with "moderate" potential damage based on instrument intensity correlations (Wald et al., 1999).

The two-percent probability of exceedance in 50 years event has a return period of 2475 years, and the 0.43*g* acceleration for this event corresponds "severe" perceived shaking with "moderate to heavy" potential damage based on instrument intensity correlations (Wald et al., 1999).

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

Liquefaction Potential Hazards: In conjunction with strong earthquake ground motion potential of large magnitude seismic events as discussed previously, certain soil units may also possess a potential for liquefaction during a large magnitude event. Liquefaction is a phenomenon whereby loose, saturated, granular soil units lose a significant portion of their shear strength due to excess pore water pressure buildup resulting from dynamic loading, such as that caused

by an earthquake. Among other effects, liquefaction can result in densification of such deposits causing settlements of overlying layers after an earthquake as excess pore water pressures are dissipated. Horizontally continuous liquefied layers may also have a potential to spread laterally where sufficient slope or free-face conditions exist. The primary factors affecting liquefaction potential of a soil deposit are: (1) magnitude and duration of seismic ground motions; (2) soil type and consistency; and (3) occurrence and depth to groundwater.

Liquefaction potential hazards have not been studied or mapped for the Ogden Valley area, as has occurred in other parts of northern Utah (Anderson, et al., 1994).

Because this phenomena is known to occur in susceptible alluvial sediments in conjunction with shallow groundwater conditions, we consider areas mapped as **Qal** on Figure 3 as potentially susceptible to liquefaction during a future earthquake event. We recommend that liquefaction hazard studies be considered for structural improvements that may occur on the areas mapped as **Qal** on Figure 3.

5. **Rockfall and Avalanche hazards**: The site is over a mile from steep slope areas where such hazards may originate.

6. **Flooding:** Mapping by Federal Emergency Management Agency (FEMA, 2015) is shown on Figure 3. The Zone AE shown on Figure 3, includes the 100-year flood hazard zone as delimited by recent FEMA studies conducted in the Ogden Valley area. On the basis of the FEMA determination *...mandatory flood insurance purchase requirements and floodplain management standards apply...* for improvements made in the Zone AE area shown on Figure 3. Shown on Figure 3, the Zone AE FEMA mapping for the North Fork Ogden River does not appear to contact the site where the river passes the south boundary of the site.

   UTABA Dam Failure inundation mapping has been prepared by Weber county to evaluate the area of inundation should dam failure occur at the UTABA Dam which is located approximately 1.3 miles up-stream from the site on the North Fork Ogden River (Bridges, 1977). The estimated inundation area from failure of the UTABA Dam is shown on Figure 3, and is presumed to be the worst-case scenario calculated by the County Engineers (Weber County Engineering, 1994). Shown on Figure 3, the UTABA Dam Failure inundation mapping for the North Fork Ogden River does appear to slightly contact the site where the river passes the south boundary of the site.

   Durfee Creek crosses the approximately 1,000 foot north-south length of the irregular-shaped site on two areas. A riparian zone, including phreatic vegetation, conforming to the mapping of the **Qafy** deposits on Figure 3, buffers the creek on both sides, where the creek crosses the site. The Durfee creek

drainage above the site is approximately 3.6 square miles in area, and we are not aware of any flood control upstream of the site location.

Because the zone where Durfee Creek crosses the site location includes evidence of recent alluvial deposition indicated by the presence of **Qafy** deposits, and because Durfee Creek is not controlled upstream of the site, we believe that the areas mapped as **Qafy** deposits on the site, as shown on Figure 3, should be considered exposed to flood hazards.

7. **Sloping Surfaces:** The surface of site slopes developed from our LiDAR analysis range from level to well over 50-percent as shown on Figure 4. For the overall 5.26 acre area of the site, slope gradients averaged 19.75 percent, with the slopes ranging from 0.0 to 99.0 percent. Steeper slope areas in excess of 25 percent are shown on Figure 4. The threshold gradient for slope development considerations and hillside review according to the Weber County Section 108-14-3. (Weber County Code, 2016), includes slopes greater that 25-percent.

8. **Expansive Soil and Rock and Collapsible Soils:** No subsurface observations were made during our reconnaissance, however from our experience of soil conditions in the Ogden Valley area we believe that both expansive collapsible soils and may be encountered on the site. Expansive soils may be present at depth beneath the **Qab** alluvial deposits on the upper bench areas where Norwood Formation Rocks (**Tn**) are likely to underlie the **Qab** deposits. Collapsible soils may exist within the debris-flow deposits that comprise the **Qafy** deposits mapped along Durfee Creek.

   We strongly advise that a geotechnical engineer inspect the foundation excavations for expansive and/collapsible soils, for all habitable structures to be constructed on the site.

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

Site Reconnaissance

The site was reconnoitered on October 10, 2016. The site was observed to consist of a lower riparian area surface along Durfee Creek, and an upper bench surface on the east side of the creek that is elevated 25.0 to 50.0 feet above the lower surface. Cover on the lower areas of the site was observed to consist of dense to moderately dense maple, river birch, willow, and cottonwood trees, with grasses, sedges and equisetum dominating the surface. Sub-angular to rounded cobbles and boulders were observed on the surface and on the Durfee Creek stream channel area. A slow flow of water was flowing in the creek bed at the time of our reconnaissance.

The upper the areas of the site were covered with dense to moderately dense stands of scrub oak, juniper, and maple, with an understory of Oregon grape and herbaceous cover plants. Sagebrush, tall fescue grasses and weeds occupied the open areas of the site.. Sub-angular cobbles and boulders were observed on the surface of the upper bench areas. Overall, the site soils appeared to be well-drained. The steeper slopes on the site appeared to be stable under existing natural conditions.

Conclusions

Based upon the findings of this review we believe that the proposed subdivision of the 5.26 Acre Parcel location is not excessively exposed to the geological hazards specified by the Weber County Hillside Ordinance to preclude subdivision of the two parcels for single family dwelling homesite use, provided that no habitable dwelling structures are placed within the areas of the site mapped as **Qafy** on Figure 3 of this report. It is our opinion that the areas on the site mapped as **Qafy** on Figure 3, are exposed to both debris flow hazards and flood hazards, as these hazards are related to Durfee Creek processes.

Should placement of habitable structures be considered within the zone mapped as **Qafy on Figure 3**, appropriate site specific hydrological and debris flow studies for the Durfee Creek drainage will need to be conducted to evaluate and mitigate the hazards that exist in these areas.

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

Because expansive and or collapsible soils may be present on the site, we suggest that a site specific geotechnical engineering soils and groundwater study be considered for selected structural construction locations on the site.

Limitations

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

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

References

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Weber County Engineering, 1994, Weber County, Utah UTABA Dam Failure Inundation Map: Weber County Engineering unpublished mapping, scale 1:24,000

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

Respectfully submitted,

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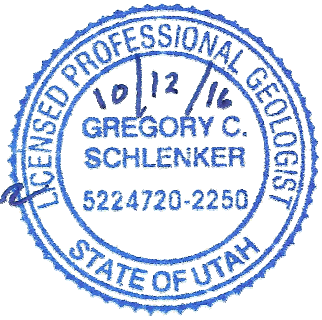

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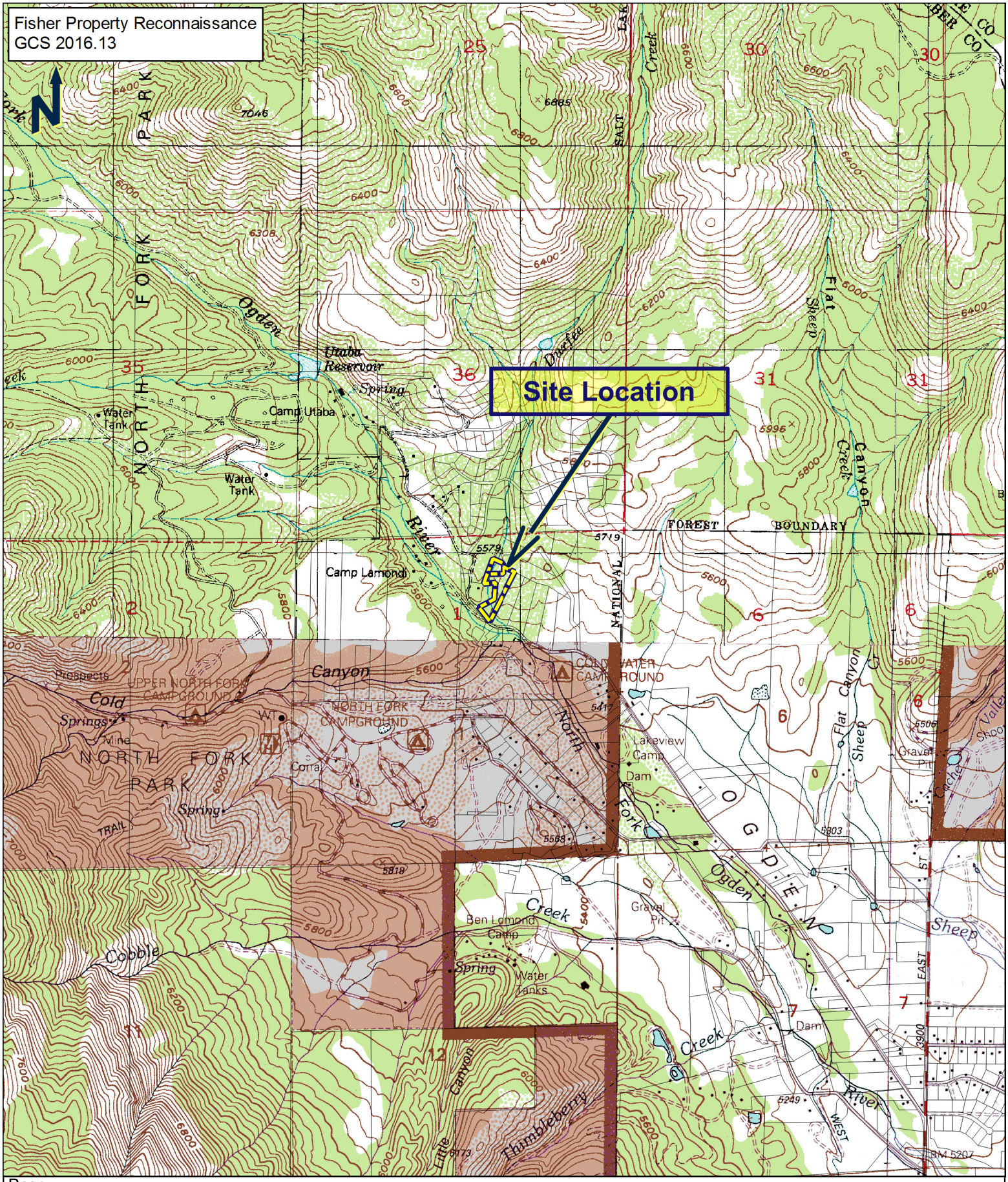
Encl. Figure 1, Site Vicinity Map
Figure 2, Aerial Coverage
Figure 3, Geologic and Flood Hazard Map
Figure 4, LiDAR Analysis



Base:
USGS 7.5 Minute topographic maps titled "North Ogden, Utah 1998; Mantua, Utah, 1991; James Peak , Utah 1991; and Huntsville, Utah 1998" from Utah AGRC; http://gis.utah.gov/

0 2000 4000 ft

1:24,000

FIGURE 1
SITE VICINITY MAP

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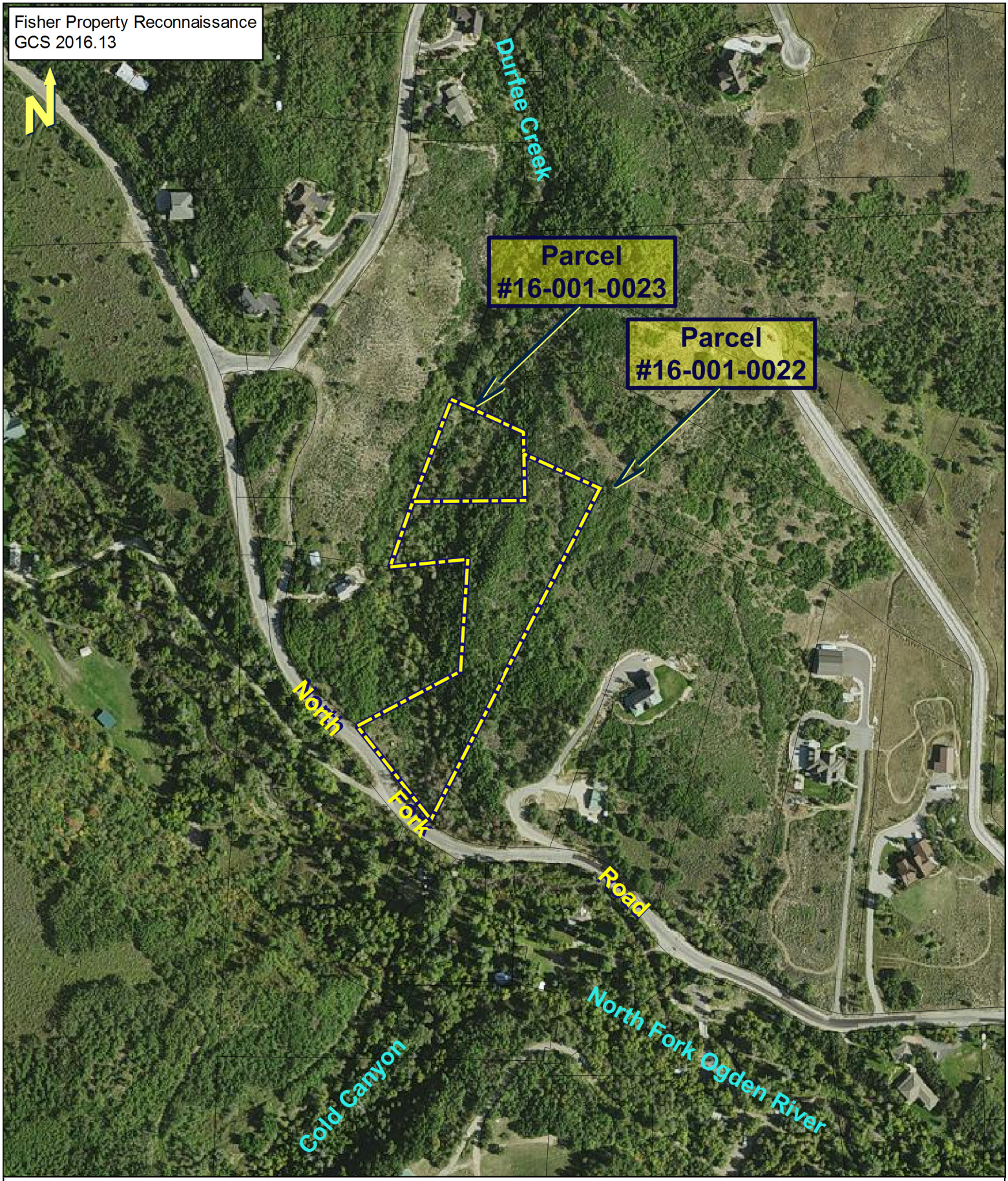

Base:
2014 1.0m NAIP Color Orthoimagery,
from Utah AGRC; http://gis.utah.gov/

0 300 600 ft

1:3,600

FIGURE 2
AERIAL COVERAGE

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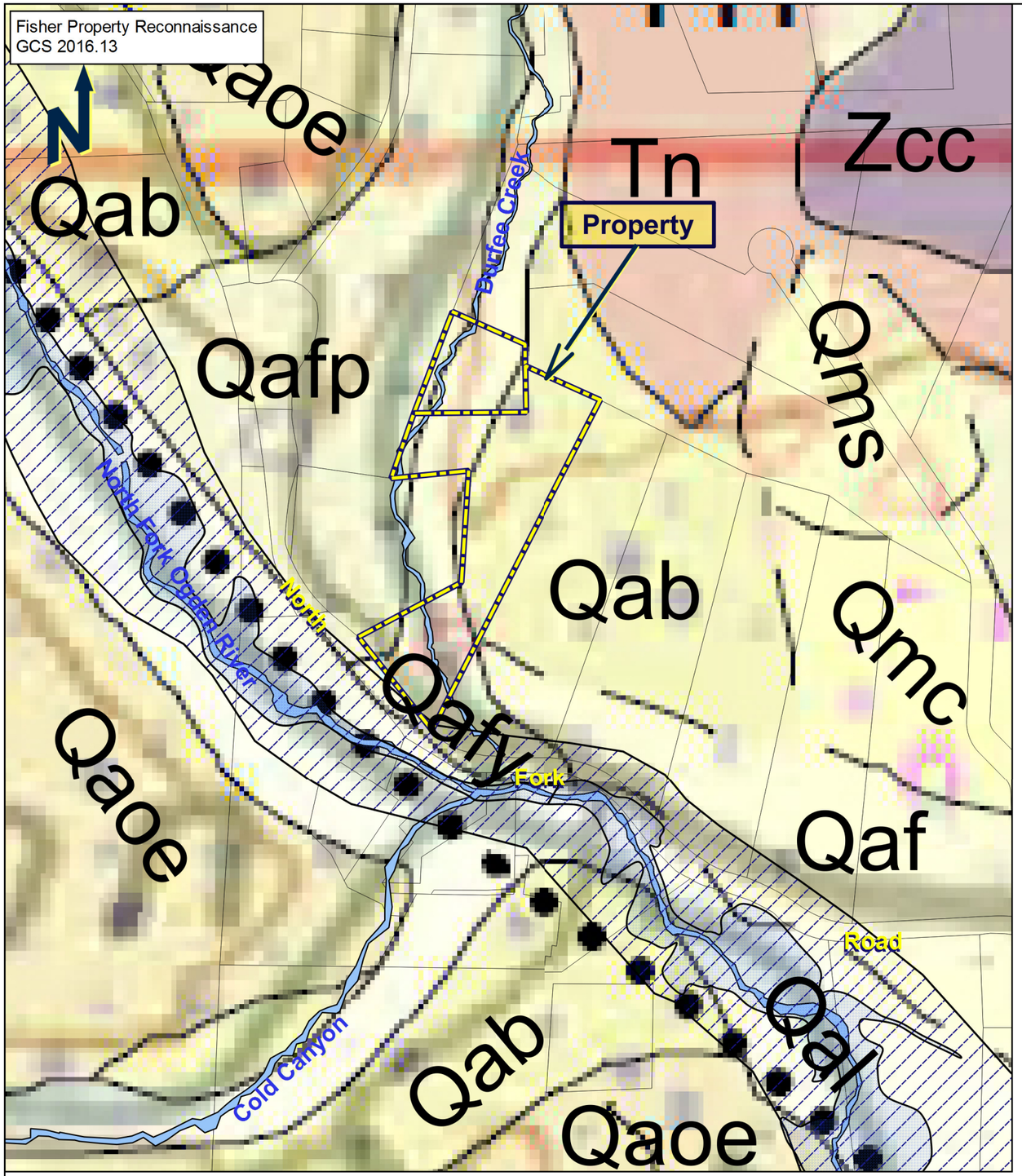

Base:
Coogan and King, 2016.

0 300 600 900 ft

1:3,600

Geologic Classification

Geology after Coogan and King, 2016

Qal -Stream alluvium and flood-plain deposits (Holocene and uppermost Pleistocene) – Sand, silt, clay, and gravel in channels, flood plains, and terraces...

Qafy - Younger alluvial-fan deposits (Holocene and uppermost Pleistocene) – Mostly sand, silt, and gravel that is poorly bedded and poorly sorted...

Qaf - Alluvial-fan deposits (Holocene and Pleistocene) – Mostly sand, silt, and gravel that is poorly bedded and poorly sorted...

Qafp - Lake Bonneville-age alluvial-fan deposits (upper Pleistocene) — Related to shorelines of Lake Bonneville, Mostly sand, silt, and gravel that is poorly bedded and poorly sorted...

Qab - Lake Bonneville-age alluvium (upper Pleistocene) – Related to shorelines of Lake Bonneville, unconsolidated to weakly consolidated; alluvium...

Qaoe - Older eroded alluvium (middle and lower Pleistocene) – Eroded alluvium located above Bonneville shoreline...

Qmc - Landslide and colluvial deposits, undivided (Holocene and Pleistocene) – Poorly sorted to unsorted clay- to boulder-sized material...(slopewash and soil creep)

Qms - Landslide deposits (Holocene and upper and middle? Pleistocene) – Poorly sorted clay- to boulder sized material; includes slides, slumps, and locally flows and floods...

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...

Zcc - Caddy Canyon Quartzite (Neoproterozoic) – Cliff-forming quartzite; tan, light-gray, pinkish-gray, greenish-gray, and purplish-gray...

Flood Hazards

FEMA - Flood Insurance Rating Zones (2015)

Zone AE - Areas subject to inundation by the 1-percent-annual-chance flood event generally determined using approximate methodologies. Because detailed hydraulic analyses have not been performed, no Base Flood Elevations (BFEs) or flood depths are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply.

Weber County Engineering UTABA Dam Failure Innundation Mapping (1994)

Rainy Day Inundation Zone

FIGURE 3
GEOLOGIC AND
FLOOD HAZARD MAP

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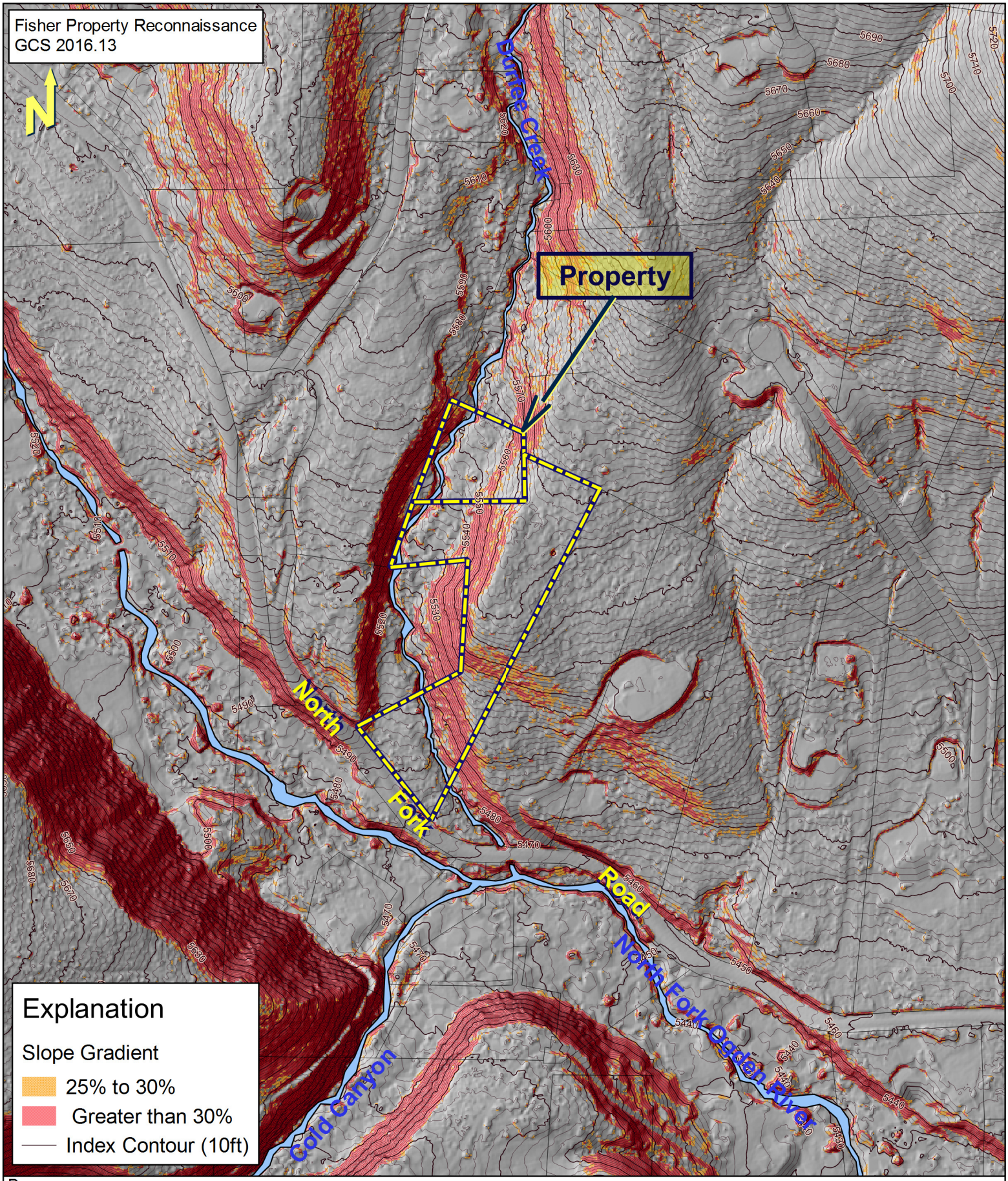

Base:
2011 1.0m LiDAR Imagery
from Utah AGRC; http://gis.utah.gov/

0 300 600 ft

1:3,600

FIGURE 4
LiDAR ANALYSIS

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