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DETAILED MAPPING OF THE WASATCH FAULT ZONE, UTAH AND IDAHO—USING NEW HIGH-RESOLUTION LIDAR DATA TO REDUCE EARTHQUAKE RISK

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ABSTRACT

The Wasatch fault zone (WFZ) is a 220 mile-long (350 km) fault zone comprised of 10 segments in southeastern Idaho and central-northern Utah. The central five segments of the WFZ are densely populated with the majority of Utah's population and economy proximal to the fault zone. The West Valley fault zone (WVFZ) extends through the densely developed and populated Salt Lake basin. Communities on or adjacent to the WFZ and WVFZ are at risk of earthquake damage due to their proximity to these fault zones. During 2016-2017, the Utah Geological Survey performed updated fault mapping of thirty-nine 7.5' quadrangles along the WFZ and WVFZ using recently acquired high-resolution topographic data derived from airborne light detection and ranging (lidar) data. Additionally, fault mapping was completed using previous geologic mapping, paleoseismic studies, historic aerial photography, and field investigations. These maps presented in this report represent the best known complete fault geometry of the WFZ and WVFZ at this time. Additionally, special study-zones were delineated around fault traces in order to facilitate understanding of surface-faulting hazard and associated risk and encourage the creation and success of municipal and county geologic-hazard ordinances dealing with hazardous faults. Paleoseismic sites were identified as potential investigation areas where additional earthquake timing data would be fruitful to the continued research on the mechanisms and characteristics of earthquakes on the WFZ and WVFZ in Utah and Idaho. This work is critical as the population of Utah continues to grow into undeveloped areas along the WFZ.

INTRODUCTION

The Wasatch fault zone (WFZ) and West Valley fault zone (WVFZ) extend through the densely developed and populated Wasatch Front region. About 85 percent of Utah's population of 3.0 million (2015 Census estimate) lives within 15 miles of the WFZ, for which abundant paleoseismic data provide evidence of repeated surface-faulting earthquakes during the late Pleistocene and the Holocene. Estimates of future growth predict that the state's population will exceed 5.3 million by 2050 with rapid growth spreading outward from existing communities and encroaching on the already partially urbanized and hazardous fault zone. The immediate proximity of Utah's growing populous regions to the WFZ results in substantial risk to the population and economy.

The Wasatch Front region, which currently includes over 2.6 million residents in municipalities, such as Salt Lake City, Provo, and Ogden, faces the greatest earthquake risk in the Intermountain West. Three factors contribute to the earthquake risk in Utah: (1) high population density, (2) a large number of unreinforced masonry buildings (URMs, approximately 185,000 in the Wasatch Front region [unpublished tax-assessment data from the Utah Division of Emergency Management]), and (3) proximity to the active WFZ (figures 1 and 2; see EERI, 2015; Working Group on Utah Earthquake Probabilities [WGUEP], 2016). The WFZ is composed of ten segments. The five central segments have evidence of recurrent, large-magnitude (M ~7), surface-faulting earthquakes in the Holocene (Machette and others, 1992; Lund, 2005). A majority of previous geologic mapping of the WFZ and WVFZ was completed prior to the availability of lidar elevation data. Most of this mapping was published at a coarse scale of 1:50,000 (Personius, 1990; Machette, 1992; Personius and Scott, 1992; Nelson and Personius, 1993; Harty and others, 1997; Hylland and Machette, 2008) or on various 1:24,000-scale geologic quadrangles using limited available aerial photography.

For this NEHRP-funded project, we have produced thirty-nine 7.5' quadrangle maps (plates 1–39) showing updated surface fault trace mapping of the eight central and northern segments of the WFZ largely using airborne lidar-derived imagery. The southernmost two segments, the Levan and Fayette, were mapped in 2014-2015 (Hiscock and Hylland, 2015). Each map displays the surface fault geometries mapped at 1:10,000 scale or greater, approximate age categories determined from previous geologic mapping and visual inspection, and special-study zones (Lund and others, 2016). Age categories are based on the *Utah Quaternary Fault and Fold Database* and will ensure a seamless integration of fault geometries and attributes into the Utah database as well as the U.S. Geological Survey's national *Quaternary Fault and Fold Database of the United States*. New fault trace mapping allowed for the delineation of surface-fault-rupture hazard areas used in local government geologic hazard ordinances (building setbacks, critical infrastructure avoidance, etc.) to reduce risk from surface faulting hazard. In addition to the maps, potential paleoseismic trenching sites were identified (table 1) prioritizing urban areas that may soon be developed, areas or segments where sparse or no paleoseismic data exists in addition to basic criteria that potentially make a paleoseismic site viable. This mapping is timely as Utah's population and urban footprint continue to grow into undeveloped areas.

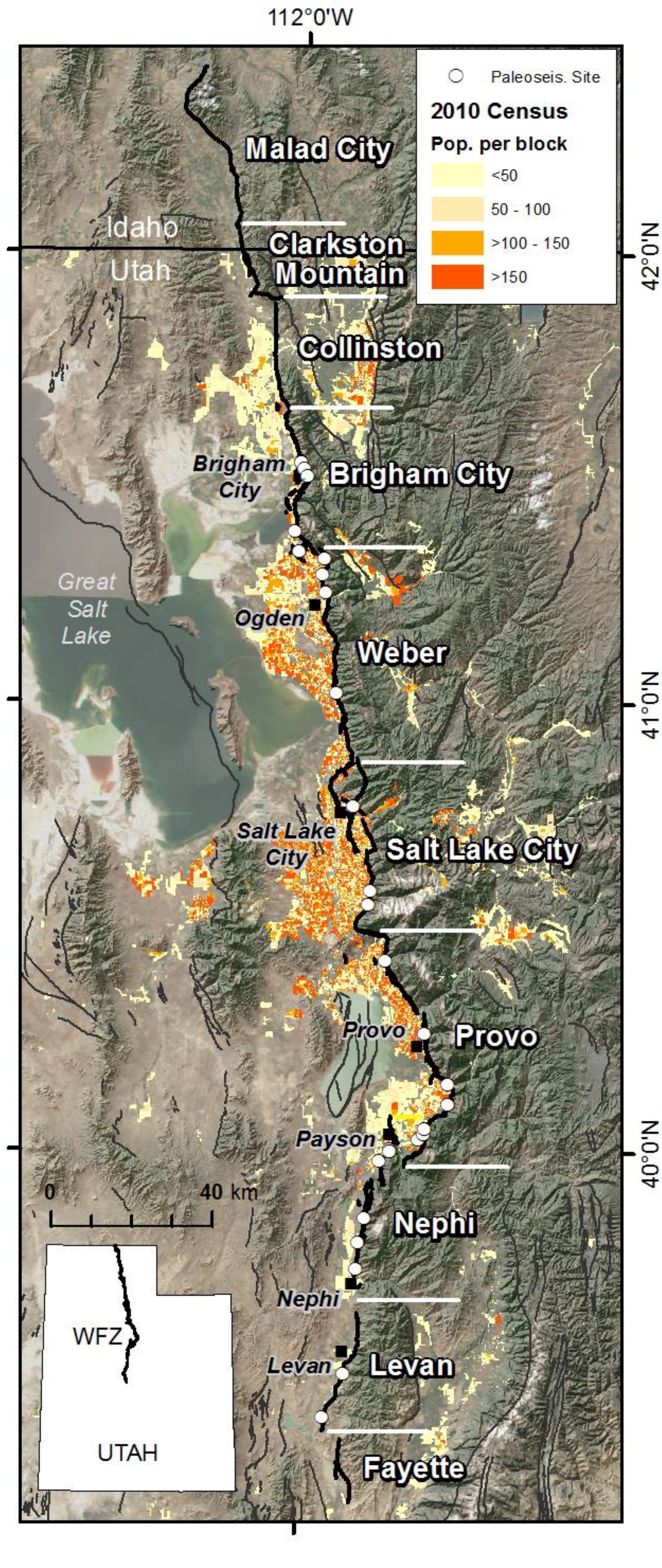

***Figure 1**. Segments of the Wasatch fault zone in northern Utah and southern Idaho and population density along the Wasatch Front, Utah. White dots indicate prior paleoseismic research sites. 2010 Census data are approximate population per census block. Figure developed by Chris DuRoss, U.S. Geological Survey.*

DATA SOURCES

Lidar Elevation Data

High-resolution 0.5-meter, U.S. Geological Survey (USGS) Quality Level 1 lidar data of the entire WFZ and WVFZ were acquired by the Utah Geological Survey and the Utah Automated Geographic Reference Center (AGRC) in 2013–2014 specifically for fault mapping, urban planning, and other purposes by the State of Utah and funded by various local and federal partners, including the USGS Earthquake Hazards Program. We also used 0.5-meter lidar data from a 2008 Intermountain Seismic Belt Earthscope-funded dataset, where portions of the Nephi segment were acquired.

Lidar derivative products were used for identifying surficial fault traces. These include slope-shade images (figure 2), as well as various hill shade images with different light directions and altitudes. GlobalMapper (v.18) software was used to generate these images, as well as to generate topographic profiles perpendicular to scarps to investigate fault-scarp morphologies.

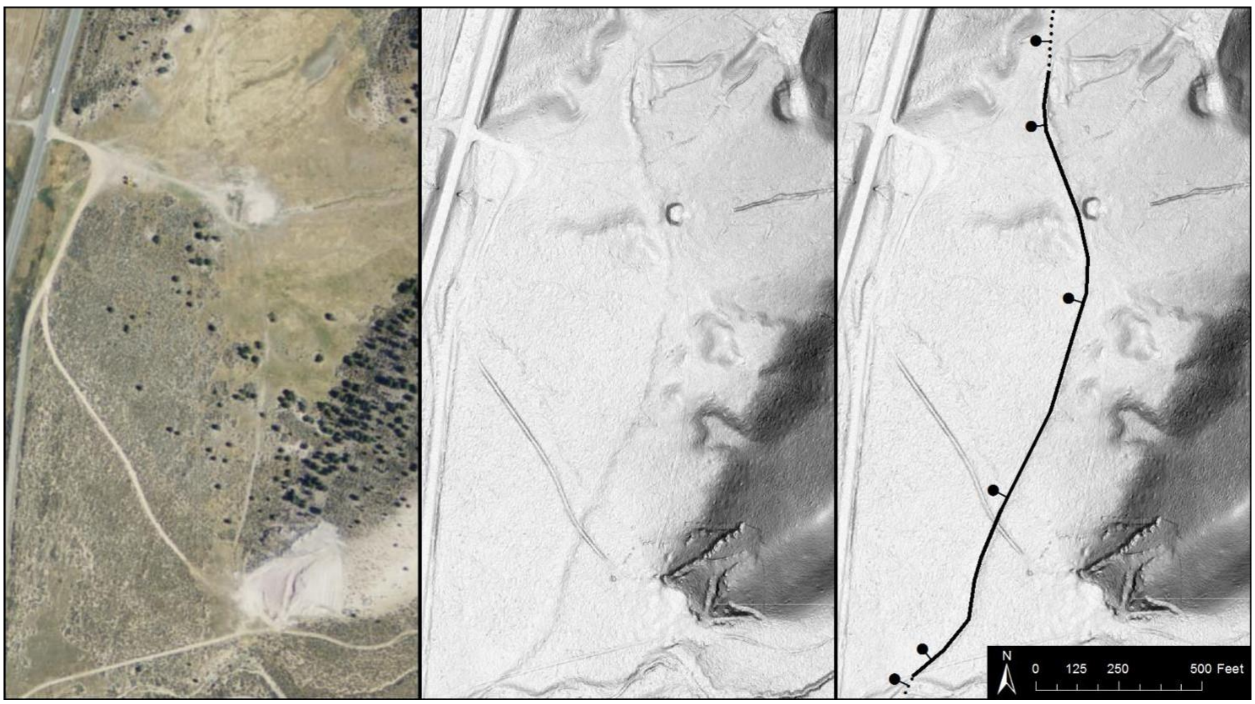

Figure 2. *Comparison between aerial photography and lidar slope-shade images. The fault trace is faintly visible in the aerial photo on the left, but far more visible on the slope-shade images. The far right image shows the mapped trace of the fault based on the slope-shade image.*

Aerial Photography

Historical aerial photography from the UGS Aerial Imagery Collection (https://geodata.geology.utah.gov/imagery/) was used to map in urban areas where surface fault traces have been obscured by modern development. This collection includes low-sun-angle photographs of the fault zone, taken in the early 1970s that predate much of the development along these fault zones (Cluff and others, 1970, compiled in Bowman and others, 2015). Additionally, for the Salt Lake Valley and other urbanized areas along the WFZ, the UGS collection includes historical aerial photos dating from 1937.

Previous Geologic Mapping

Previous surficial geologic mapping was also useful for this project. UGS and USGS surficial geologic strip maps of the five central segments of the WFZ (Personius, 1990; Machette, 1992; Personius and Scott, 1992; Nelson and Personius, 1993; Harty and others, 1997) were valuable references for our new lidar mapping. Additionally, geologic 7.5-minute quadrangle mapping from Utah and Idaho were used as a check our fault-trace mapping. Some of the quadrangles are presently unpublished, specifically maps along the Salt Lake City segment (see individual plates for references). Draft surficial fault mapping from Scott E. K. Bennett from the U.S. Geological Survey was used along the Provo and northernmost Nephi segment.

FAULT MAPPING

Fault Traces

Fault traces were mapped according to standards and experience of the UGS mappers and authors of each map. Each mapper employed a number of different techniques to best represent fault scarps indicative of previous surface-fault rupture or deformation over time. The lidar imagery proved to be the most useful tool when mapping most of the WFZ; however, it was not exclusively used. In areas of extensive urban development, pre-development stereo-paired images were used to identify and map fault traces. These photos were particularly useful in identifying fault traces that have been obscured by development, among other uses. For the Salt Lake City segment in particular, due to extensive urban surface disturbance in some areas, 1:10,000-scale mapping was not possible and mapping was performed at no greater than 1:24,000 scale in those areas. Additionally, derivative lidar products such as slope-angle maps, slope-aspect maps, and topographic contours were used to discern fault scarps. Topographic contours were particularly useful when trying to discern a fault scarp from a paleo-shoreline, especially for the northern segments of the WFZ.

Special-Study Zone Delineation

Special-study areas were delineated along the WFZ and WVFZ that define areas where additional investigation is recommended to evaluate the risk from surface faulting prior to development. Together with the fault traces, these delineated areas are critical to the creation and success of municipal and county geologic-hazard ordinances dealing with hazardous faults, and understanding surface-faulting hazard and associated risk.

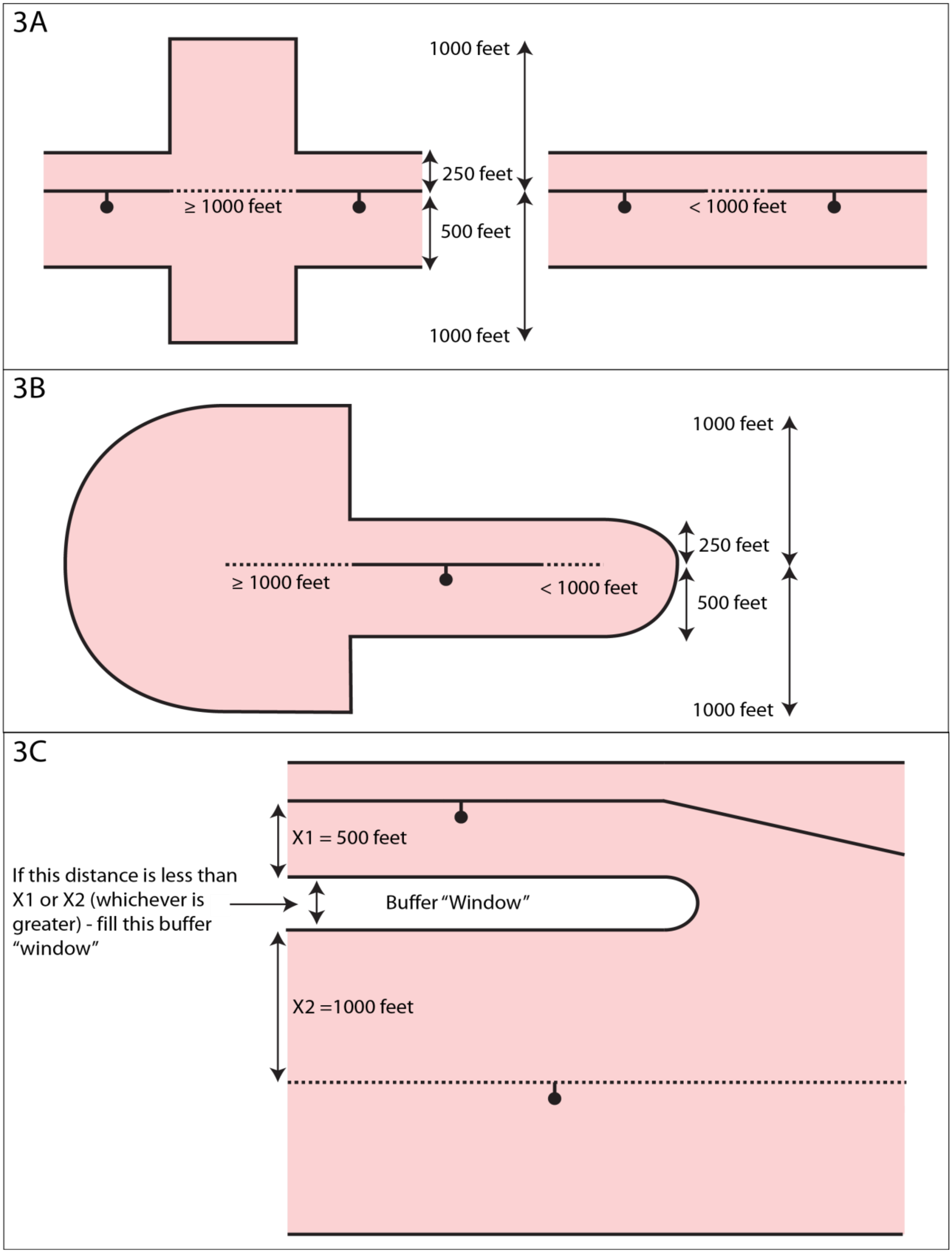

Figure 3 – Examples of special circumstances used when creating surface-fault-rupture special-study zones

We categorized Quaternary faults along the Wasatch fault zone as "well defined," "moderately defined," or "buried or inferred" fault traces. We considered a fault well defined if its trace is clearly detectable by a trained geologist as a physical feature on the ground surface (Bryant and Hart, 2007). For well-defined faults, the special-study-area zones extend 500 feet (152 m) on the downthrown side and 250 feet (76 m) on the upthrown side of each fault. For moderately defined and buried or inferred faults, the special study zones extend 1000 feet (305 m) on each side of the suspected trace of the fault. The special-study area dimensions are based on the *Guidelines for Evaluating Surface-Fault-Rupture Hazards in Utah* (Lund and others, 2016).

Several criteria were created for distinct circumstances pertaining to special-study zones. For traces of buried or inferred faults less than 1000 feet long that lie between and on-trend with well-defined faults, the well-defined fault special-study-area zone was used (figure 3A). In areas where a buffer "window" exists, we filled in the window if its width is less than the greater of the two surrounding buffers (figure 3C). In situations where the ground expression of the fault scarp is larger than the special-study zone, in which case the zone does not cover the entire fault scarp, the 1000-foot buffer was used. This is only applicable in one location on the southern end of the Weber segment east of Bountiful and two locations on the Salt Lake City segment along the East Bench fault (shown on the Fort Douglas and Sugar House quadrangles [plates 22 and 25]).

POTENTIAL PALEOSEISMIC INVESTIGATION SITES

We analyzed each fault segment of the WFZ for potential paleoseismic investigation sites as part of our fault-trace

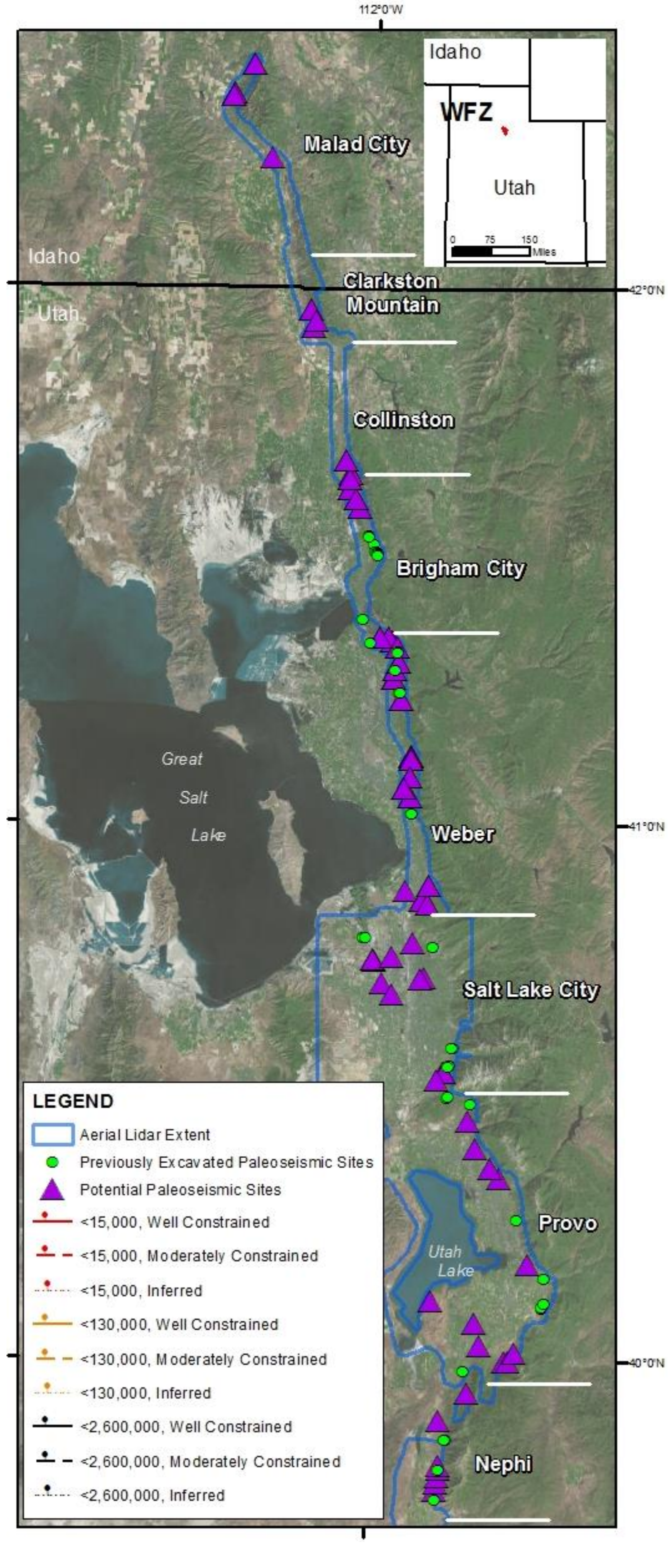

Figure 4. *Potential paleoseismic trenching sites identified in this study along the Wasatch fault zone. Previous studies from the UGS Paleoseismology of Utah series are highlighted in green.*

mapping (figure 4). Sites were selected based on: (1) presence of a normal fault scarp, (2) scarp height that is reasonable for paleoseismic investigation (roughly 2–30 ft. [0.5–10 m]), (3) scarp cutting young deposits (late Pleistocene to Holocene), and (4) mostly undisturbed. Sites that could fill in data gaps between previous paleoseismic studies and sites that may soon be developed were considered even if they did not meet all four criteria. Due to the rural and undeveloped nature of several of the segments of the WFZ, many sites exist and are not discussed in detail in this report. Below are descriptions of specific site selection considerations for each WFZ segment as well as some preferred sites we have identified. Many sites along the WFZ have been developed, so a detailed assessment of each potential site will be performed before proposing excavation. A list of potential paleoseismic site locations is in table 1.

The UGS works to maintain a relationship with local geologic engineering firms and consultants who conduct trenching studies for clients along the fault, particularly in the Salt Lake Valley. The UGS is often invited to visit consultant trenches for a few hours to observe and document faulting. While not as useful as a full paleoseismic research investigation, these site visits still provide useful information in areas we will most likely never be able to conduct a full research-level investigation.

Malad City Segment

The Malad City segment is the northernmost segment of the WFZ. Previously, Machette and others (1992) had ended the fault at the northern end of the Malad Range. More recent mapping (Pope and others, 2001) indicates the fault extends farther north and west along the western flank of Elkhorn Mountain.

We found no well-defined fault scarps along the southern part of the Malad City segment west of the Malad Range. We did map several well-defined traces along the northern part west of Elkhorn Mountain. These scarps are on alluvial-fan deposits likely mid to late Pleistocene in age, however, the fan ages are not well constrained. We identified at least four potential paleoseismic investigation sites near the northern end of the segment west of Elkhorn Mountain. To date, there have been no paleoseismic investigations performed for the Malad City segment, making it a good candidate for future studies.

Clarkston Mountain Segment

The Clarkston Mountain segment is the shortest of the WFZ segments and is mostly defined by a steep, linear range front escarpment with predominantly moderately-located or inferred faults. There are occasional and relatively short well-defined fault traces towards the southern end of the segment where we identified three potential paleoseismic investigation sites. Our preferred site is at the mouth of Elgrove Canyon where a 3.2-foot-high (1-meter-high) scarp offsets alluvium and has potentially correlative surfaces on both the footwall and hanging wall (figure 5). To date, paleoseismic data for the Clarkston Mountain segment are limited to field reconnaissance and scarp profiling (Hylland, 2007), making it a good candidate for future studies.

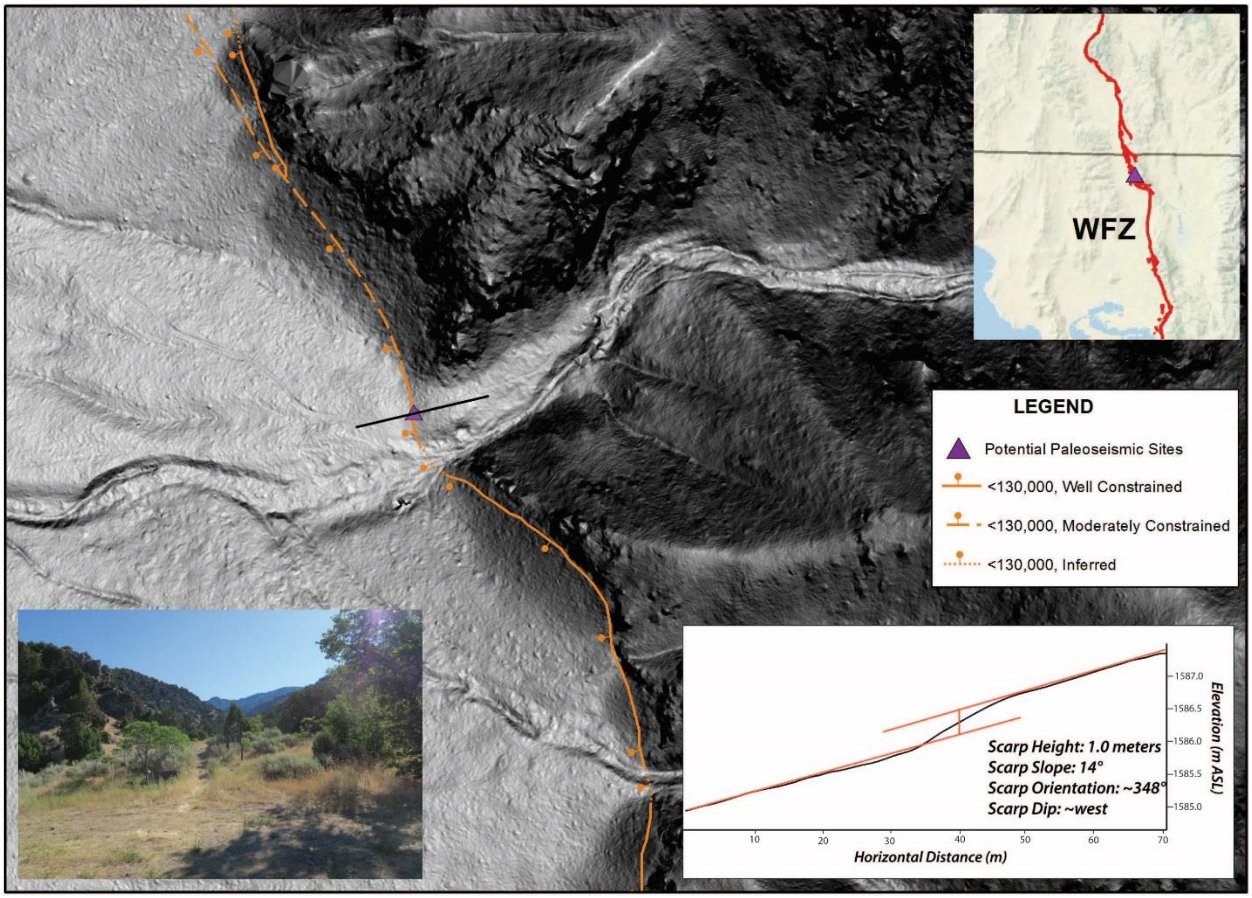

***Figure 5**. Potential paleoseismic trench site at the mouth of Elgrove Canyon on the Clarkston Mountain segment, Wasatch fault zone.*

Collinston Segment

The Collinston segment is poorly defined and mostly expressed as an inferred or moderately-located fault zone. The lidar data did not reveal any previously unrecognized fault traces for most of the segment. There are several scarps east of Honeyville in an area of complex faulting near the segment's boundary with the Brigham City segment where we identified three potential paleoseismic trench sites. The scarps are on likely late Pleistocene or older alluvial-fan deposits, but appear relatively well preserved. As with the Clarkston Mountain segment, paleoseismic data for the Collinston segment are limited to field reconnaissance and scarp profiling (Hylland, 2007), making it a good candidate for future studies.

Brigham City Segment

The Brigham City segment has been the subject of several previous paleoseismic investigations (Personius, 1991; McCalpin and Forman, 2002; DuRoss and others, 2012). However, both spatial and temporal data gaps still exist for the segment. We identified five potential paleoseismic trench sites focusing on the ends of the segment where data are lacking and may provide information about partial- and multi-segment ruptures. The Brigham City segment is locally developed in several places but many undisturbed scarps remain, so additional sites not identified in this study likely exist.

Weber Segment

Much of the Weber segment is urbanizing or already developed, limiting potential paleoseismic trench sites. Previous studies (Swan and others, 1979; Nelson and others, 2006; DuRoss and others, 2009) have improved the paleoseismic record of the segment, but like the Brigham City segment, spatial and temporal data gaps still exist. More data are also needed near segment boundaries, particularly the southern end, to improve our understanding of segment boundaries including possible partial- and multi-segment ruptures. We identified several potential trench sites, including several in developed areas that appear relatively undisturbed. Additional field reconnaissance and scarp analysis needs to be performed to better determine their viability and to further evaluate particular site's geologic and paleoseismic context.

Salt Lake City Segment

The Salt Lake City segment (SLCS) has been the subject of numerous paleoseismic studies (Swan and others, 1981; Black and others, 1996; Schwartz and Lund, 1988; McCalpin, 2002; DuRoss and others, 2014; Hiscock and DuRoss, 2016). However, data gaps still exist for the SLCS and because it is extensively developed, relatively few potential paleoseismic sites exist. Current NEHRP-funded research conducted by Boise State University using shallow seismic methods to collect subsurface fault-location data is ongoing on the northern SLCS within and near downtown Salt Lake City (Liberty, 2016). Data from that project are not included in this report, but will be integrated into our maps upon publication of that project. Data from that project will help us identify new or more accurately map fault traces in this densely-populated and highly-developed area.

Several potential paleoseismic investigation sites exist on the West Valley fault zone (WVFZ; plates 20, 21, 23, 24, and table 1). Most of these sites are not ideal for paleoseismic trenching because the scarps have been disturbed by modern development, but may be the only option for further study of the WVFZ. Several paleoseismic studies have been performed for the WVFZ (Keaton and others, 1987; Keaton and Currey, 1989; Solomon, 1998; Hylland and others, 2014; Hylland and others, 2017; Hylland and others, 2017), but more data are needed to further understand faulting behavior of the WVFZ and its relation to faulting on the SLCS.

Provo Segment

The Provo segment is largely developed and relatively few potential paleoseismic sites exist. Past paleoseismic trenches on the Provo segment have provided timing information for earthquakes in the late Pleistocene and Holocene. The northern Provo segment and the Fort Canyon fault area have been recently successfully trenched (Bennett and others, 2015; Toké and others, 2017). Other trenches on the central Provo segment were excavated in the 1990s and earlier (Lund and others, 1991; Lund and Black, 1998; Olig and others, 2011, compiled in Bowman and Lund, 2013). Paleoseismic sites selected for this report focus on areas of the Provo segment that have sparse paleoseismic data or that are undergoing rapid development. However, many sites on the central Provo segment have extensive disturbance and need to be further assessed before trenching is proposed. The most promising site in terms of accessibility and feasibility is on land administered by the Utah Division of Wildlife Resources near the old Springville Fish Hatchery (plate 31; figure 6). This scarp was briefly excavated by a geotechnical company in December 2017 and revealed buried, fault-offset late Pleistocene to Holocene alluvium.

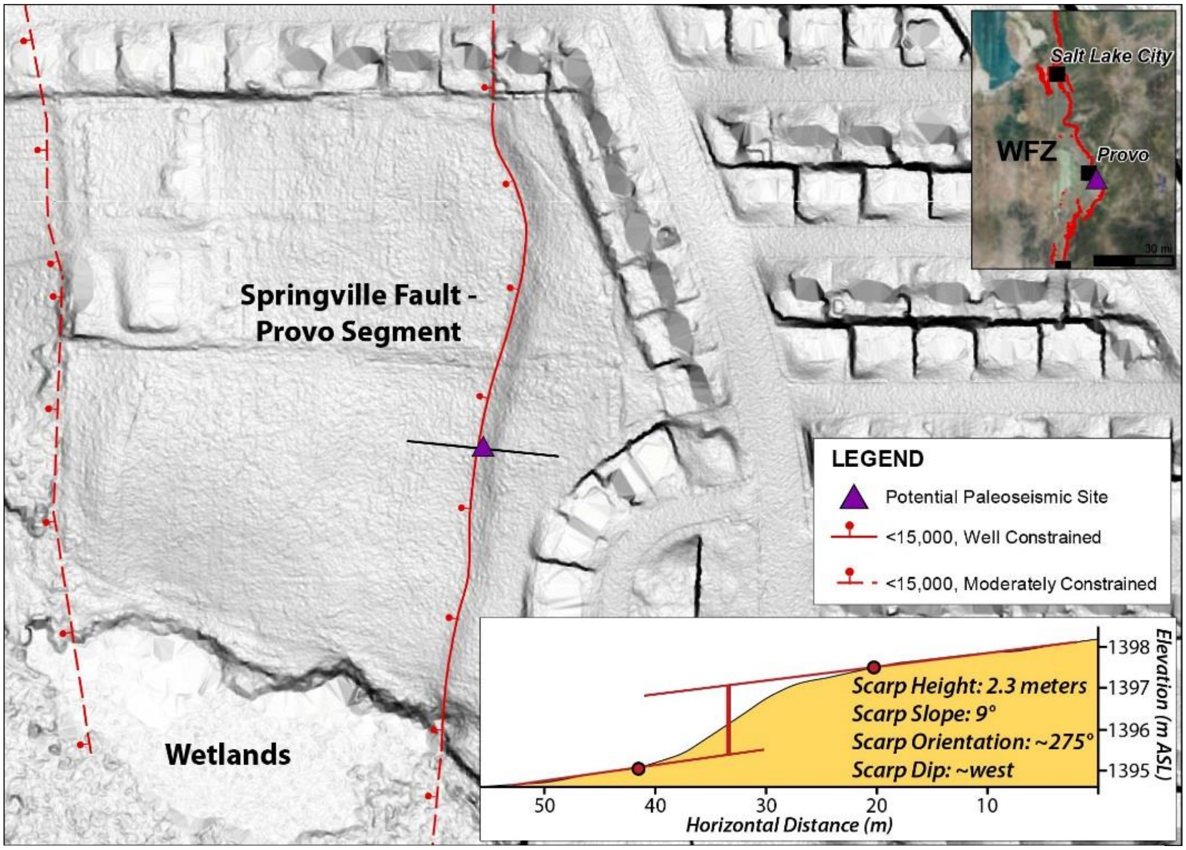

***Figure 6**. Example of a potential paleoseismic site on the Springville fault, Provo segment, Wasatch fault zone. This lot is owned by the State of Utah making it logistically amenable for excavation.*

Nephi Segment

The Nephi segment is largely undeveloped so many potential paleoseismic investigation sites exist. The WFZ along this segment cuts numerous Holocene and older fans so trenching opportunities targeting spatially beneficial sites or specific-age deposits are possible. This segment has been the focus of several recent paleoseismic studies (Jackson, 1991; Machette and others, 2007; DuRoss and others, 2017).

The Juab Valley (West Side) faults (see plates 36 and 37) show evidence for late Quaternary faulting at the eastern base of Long Ridge in northwestern Juab Valley. This fault zone was originally identified in draft mapping by the Utah County geologist (Robison, 1989). Our new mapping greatly expands this fault zone. This approximately 8-mile-long zone of complex faulting is mostly undeveloped and offers many sites for paleoseismic investigations in the future. No earthquake timing data exist for this fault zone, making it a great target for future paleoseismic research.

CONCLUSIONS

This report presents the motivation, process, and products funded by USGS NEHRP External Grant Award Number G17AP00001 conducted over one year by the UGS. We present thirty-nine 7.5' quadrangle plates with detailed mapping of the WFZ in Utah and Idaho created using high-resolution airborne lidar-derived products, historical aerial photos, previous geologic mapping, and field investigations. The motivation for this work was timely due to the availability of the high-resolution lidar data, the increasing growth of population and development along the Wasatch Front, and the immediate proximity of Utah's growing populous regions along the WFZ.

Special-study zones are defined based on the certainty of the fault trace mapping, and fault geometry. The special-study area dimensions are based on the *Guidelines for Evaluating Surface-Fault-Rupture Hazards in Utah* (Lund and others, 2016). These special-study zones are delineated in order to assist in land-use planning and regulation for local governments. Paleoseismic sites were identified along the WFZ and WVFZ in Utah and Idaho in order to foster future paleoseismic research in areas that are being rapidly developed or are in areas lacking good earthquake timing and recurrence information. We identified 60 potential sites with varying geologic conditions deemed potentially suitable for paleoseismic investigation. The 60 identified potential paleoseismic sites should not be considered a complete list of all sites on the WFZ. Additional sites likely exist, and for segments along more rural, undeveloped areas, potential sites are too numerous to account for in the table. We focused on identifying sites where the fault scarps are sparse given the nature of the fault and in areas where development and ongoing disturbance have obscured fault scarps. This dataset is designed to assist the UGS and other potential investigators in determining future sites for paleoseismic study.

The results of this work will be implemented in the form of a peer-reviewed UGS special study publication. Once this publication is complete, the UGS will contact local governments to present them with the mapping, and offer assistance in developing local ordinances based on special-study zones. These maps will serve as a critical tool to helping communities assess their earthquake risk and become more resilient to earthquake effects and geologic hazards.

Table 1. *Potential paleoseismic sites along the Wasatch fault zone. The table identifies 60 sites along the WFZ and includes the potential site location as well as a cursory comment regarding good or poor qualities of the site for paleoseismic investigation.*

Site Number	Fault Segment	Comments	UTM Easting	UTM Northing
MCS-01	MaladCity	Scarp on inset surface; may be one of 2 or 3 strands	392081	4696742
MCS-02	MaladCity	Good scarp with antithetic; footwall surface graded up drainage	387904	4690810
MCS-03	MaladCity	Fault cuts inset surface; complex site	387635	4690308
MCS-04	MaladCity	Approximately 3-meter high, west-facing scarp on alluvium	395705	4677308
CMS-01	Clarkston Mtn	Subtle scarp on alluvium. Footwall may be af2 or older	403697	4645874
CMS-02	Clarkston Mtn	Elgrove Canyon trailhead; best potential Clarkston Mountian site (figure 5)	404720	4643537
CMS-03	Clarkston Mtn	Potential scarp on older fan deposits	404395	4642114
CS-01	Collinston	Scarp(s) in post-Bonneville fan deposits	410885	4614606
CS-02	Collinston	Short scarp on older deposits	411967	4611755
BCS-01	Brigham City	Scarp on late Pleistocene(?) fan, possible graben; at BrihamCity/Collinston segment	411825	4610699
BCS-02	Brigham City	Subtle scarp on young alluvial fan; possible shoreline	411792	4608713
BCS-03	Brigham City	Offset shoreline crest; scarps on post-Bonneville fan to south	413116	4606461
BCS-04	Brigham City	Graben in older fan deposits	413877	4604829
BCS-05	Brigham City	Scarp cutting young fan alluvium; near BrighamCity/Weber segment boundary	418056	4577860
WS-01	Weber	Scarp cutting young fan alluvium; at BrighamCity/Weber segment boundary	419802	4577848
WS-02	Weber	Several well-defined scarps in area; cutting alluvial fans of various ages	420573	4577120
WS-03	Weber	Several scarps cutting young alluvium	421590	4575796
WS-04	Weber	Well-defined scarp sheltered in drainage; potentially shoreline escarpment	421857	4572700
WS-05	Weber	Scarp cutting young alluvium	420964	4571111
WS-06	Weber	Graben with well-defined antithetic scarp	420743	4569379
WS-07	Weber	Two well-defined scarps cutting alluvium	422259	4564935
WS-08	Weber	Graben in Lake Bonneville deposits	424457	4553147
WS-09	Weber	Well-defined scarp in younger alluvium	424308	4552616
WS-10	Weber	Several relatively undisturbed scarps	424216	4548870
WS-11	Weber	Scarp cutting younger alluvium	424189	4544771
WS-12	Weber	Well-defined scarp on undeveloped lot in residential area	428071	4526478
WS-13	Weber	Relatively undisturbed scarp in residential area	426595	4523256
WS-14	Weber	Well-defined scarp in colluvium; potential for older events	427768	4522560
WS-15	Weber	Possible site on northern extent of Warm Springs fault, very subtle scarp in lateral	423041	4525352
WVFZ-01	West Valley	Scarp in waste dump lot, could be slightly modified, only northern west-dipping	420352	4511870
WVFZ-02	West Valley	Empty lot, undisturbed scarp, best sites on northern Granger fault	416322	4511332
WVFZ-03	West Valley	Empty lot, undisturbed scarp, best sites on northern Granger fault	416353	4511122
WVFZ-04	West Valley	Empty lot, undisturbed scarp, best sites on northern Granger fault	416628	4510950
WVFZ-05	West Valley	Empty lot, undisturbed scarp, southern Granger fault	418214	4506218
WVFZ-06	West Valley	Redwood Road, previously trenched, disturbed site, southern Taylorsville fault	420315	4504079
SLCS-01	Salt Lake City	Empty lot, southern Warm Springs fault	424652	4514586
SLCS-02	Salt Lake City	Golf course on East Bench Fault, need GPR	427105	4507446
SLCS-03	Salt Lake City	Golf course on fault west of East Bench Fault, need GPR	426236	4507165
SLCS-04	Salt Lake City	Photomapped scarp, city park land	430986	4487689
SLCS-05	Salt Lake City	Clean scarp, city park land, undisturbed	431034	4487678
SLCS-06	Salt Lake City	Clean scarp, city park land, undisturbed	431077	4487656
SLCS-07	Salt Lake City	Open lot, uncomplicated zone of faulting	429631	4486279
PS-01	Provo	Scarp in complex zone of faulting cutting older fan. Vegetated area	436151	4477748
PS-02	Provo	Scarp at mouth of canyon in young alluvium. Disturbance from roads, but seems minimal	437543	4472085
PS-03	Provo	Scarp in complex zone of faulting cutting older fan. Vegetated area	440712	4467831
PS-04	Provo	Scarp at mouth of canyon in alluvium. Vegetated area. Close to parking lot	442570	4465897
PS-05	Provo	Scarp in young alluvium just north of wetlands (figure 6); State owned land	448517	4447889
PS-06	Provo	Scarp on west side of West Mountain, scarp cutting young alluvium, could also trench	428306	4440624
PS-07	Provo	Slightly disturbed site on Benjamin Fault, near canal in field, could trench north or south	437257	4435738
PS-08	Provo	Relatively undisturbed trench site on Benjamin Fault, in zone of distributed faulting	438452	4431076
PS-09	Provo	Narrow graben near Woodland Hills, clean scarp, could trench across entire graben. Potential for shallow bedrock; Could also likely trench north or south	444219	4427955
PS-10	Provo	Scarp on young alluvium in Loafer Canyon, undisturbed, forested	443450	4427761
PS-11	Provo	Large scarp cutting young alluvium, slight disturbance near base of scarp.	445552	4429731
PS-12	Provo	Scarp on alluvium in Santaquin Canyon, good site near Provo/Nephi segment boundary	435776	4421313
NS-01	Nephi	Undisturbed scarp on alluvium, potential for shallow bedrock	429074	4401274
NS-02	Nephi	Large scarp on alluvim, undisturbed, eastern fault in small graben	429439	4402680
NS-03	Nephi	Large undisturbed scarp (8-10 m high), small drainage basin, potential for shallow	429557	4404118
NS-04	Nephi	Undisturbed scarp in mouth of Willow Creek, previously trenched	429921	4405699
NS-05	Nephi	Scarp on alluvium, mouth of small drainage, potential for shallow bedrock	429743	4406460
NS-06	Nephi	Scarp away from range front on Mendenhall fault, undisturbed	429769	4415621

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