N A T U R A L R E S O U R C E S

WILDFIRE-ASSOCIATED LANDSLIDE EMERGENCY RESPONSE TEAM REPORT

Muckamuck Fire

Okanogan County, Washington

by Trevor A. Contreras and Katherine A. Mickelson

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GEOLOGICAL SURVEY
WALERT Report
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Wildfire-Associated Landslide Emergency Response Team Report for the Muckamuck Fire

by Trevor Contreras[1] and Katherine A. Mickelson[1]

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INTRODUCTION

A Wildfire-Associated Landslide Emergency Response Team (WALERT) assessment was conducted to evaluate the potential risk posed by landslides and debris flows from the Muckamuck Fire which burned in and around the town of Conconully, Washington**.** Wildfires can significantly change the hydrologic response of a watershed so that even modest rainstorms can produce dangerous flash floods and debris flows.

WALERT assessed soil burn severity and areas downstream of slopes burned by wildfires to determine whether debris flows could impact roads, structures, and other areas where public safety is a concern. Further information about these hazards is provided in Appendix A.

WALERT looked for historical evidence of debris flows using field reconnaissance, Burned Area Reflectance Classification (BARC) maps, and orthoimagery. This report is primarily a qualitative assessment of post-wildfire landslide hazards based on our professional judgment and experience. The assessment was performed as part of emergency response with the intent to produce a rapid report for decision-makers, land managers, landowners, and other stakeholders.

MUCKAMUCK FIRE OVERVIEW

Lightning started the Muckamuck Fire on August 4, 2021. As of September 5, 2021, the fire had burned 13,314 acres, mainly within brush, timber, and timber litter (InciWeb, 2021).

The majority of the land that burned is U.S. Forest Service land (56% of the total burned area). See Table 1 for land ownership information.

Table 1. Ownership distribution of burned area for the Muckamuck Fire.

Land owner/manager	Acres	Percent of burned area
U.S. Forest Service (USFS)	7,448	56
Private ownership	3,510	26.3
Bureau of Land Management (BLM)	1,366	10.2
WA State Dept. of Natural Resources (WADNR)	796	6
U.S. Bureau of Reclamation	156	1.2
U.S. Dept. of Fish and Wildlife	36	0.3
Total	13,312[1]	100

[1] This value does not match the number of burned acres as reported by InciWeb. The reported burned acreage was 13,314. The acreage as reported here reflects a deviation of approximately 0.01%.

OBSERVATIONS AND INTERPRETATIONS

Field assessments were performed on October 7 while mop-up operations were occurring. The field work focused on locations where wildfire effects on watershed hydrology could put life and property at risk.

Satellite-derived data in the form of a calibrated Soil Burn Severity map was available for the Muckamuck Fire and was provided by the USFS Burned Area Emergency Response (BAER) team. The BAER team reviewed the map for the federal lands and calibrated the data for application throughout the burned area. At the time this report was written, the BAER team had not yet made their maps available for download. If you need access to the mapping, please contact us or the USFS Tonasket Ranger District.

U.S. Geological Survey (USGS) post-fire debris flow hazard assessment

MODELING RESULTS

The USGS provided a debris flow assessment for the Muckamuck Fire based on the field-validated soil burn severity data provided by the USFS. The data can be viewed directly at their website (https://landslides.usgs.gov/hazards/postfire_debrisflow/detail.php?objectid=377).

There are various outputs and ways to view the data using the website. Here we discuss the combined relative debris flow hazard, which uses both probability and volume from the USGS model to provide three different hazard ratings: Low, Moderate, and High. We focus on locations where public safety could be impacted.

INTERPRETATIONS

The USGS modeling suggests that there is Low, Moderate, and High debris flow hazard in drainages throughout the burned area. This is based on a modeled storm event with a peak rainfall intensity of approximately one quarter of an inch of rain in a 15-minute period. Below we outline the various drainages where debris flows could impact the property and infrastructure that we reviewed during the limited reconnaissance field work. We provide the USGS modeling on Plate 1 along with our coarsely mapped alluvial fans and locations discussed in the following sections. We would expect that if debris flows occur in the basins, they would deposit material on the alluvial fans below.

SALMON CREEK AREA

Recreation cabins upstream of Oriole Campground (Site 1)

Multiple recreation cabins exist along the northeast side of Salmon Creek. At this site, there is an alluvial fan that has a Moderate debris flow hazard with a 54 percent probability of a debris flow. Cabins on the north end of the fan could be impacted if a debris flow comes down the channel and crosses the road. Culverts should be evaluated to ensure they can pass material during smaller flooding events.

Unnamed drainage below Mineral Hill (Site 2)

Construction of a building was occurring at this site during the field assessment. We did not directly evaluate the proximity of the house pad to the nearby channel due to the posted ‘no trespassing’ signs. The channel to the west–northwest has a High debris flow hazard with an 84 percent probability of a debris flow. Further evaluation of the site may be needed to determine if the new structure could be impacted by debris flows generated in the drainage.

Unnamed drainage near the 100 block of North Fork Salmon Creek Road (Site 3)

There is a basin to the northeast of Site 3 with a Moderate debris flow hazard and a 42 percent probability of debris flows. There is a home on the east side of the road that may need additional review to determine if it could be impacted by debris flows generated in the channel. There appears to be an alluvial fan in the vicinity of the house and road, so we coarsely mapped the fan on Plate 1.

MINERAL HILL ROAD (SITE 4)

There appears to be a home on an alluvial fan, though we did not evaluate the area during field work due to ‘no trespassing’ signs on the access road. The basin above the fan has a Moderate debris flow hazard with a 65 percent probability of debris flows.

CONCONULLY

Conconully has a history of fires and debris flows in North Salmon Creek. A flash flood and debris flow impacted Conconully on May 27, 1894, almost 2 years after a fire burned the area in August 1892 (Wilma, 2006). We did not model potential flooding to Conconully and instead leave this analysis for Natural Resources Conservation Service (NRCS) experts.

Western edge of Conconully (Site 5)

There is an alluvial fan on the western edge of Conconully near Silver Street and Bernice Avenue. The basin above this fan has a Moderate debris flow hazard with a 41 percent probability of debris flows. Homes nearest to the top of the alluvial fan may need additional review to evaluate the potential hazards and the neighborhood should be warned of debris flow potential.

ALLUVIAL FANS ALONG THE NORTH SHORE OF CONCONULLY LAKE

There are alluvial fans along Sinlahekin Road where drainages on the north side of the road drain to Conconully Lake. A few of these fans have been historically active after fires, flooding homes and depositing sediment. The basins above these fans were modeled as Low and Moderate debris flow hazard with probabilities as low as 20 percent and as high as 44 percent of generating debris flows. Below we give an overview of each site and its modeled debris flow probability using the modeled storm event.

Site 6

At this site multiple homes sit on an alluvial fan along Conconully Lake. The basin above the fan is modeled with a Moderate debris flow hazard with a probability of 35 percent of generating debris flows.

Site 7

At this site multiple homes sit on an alluvial fan along Conconully Lake. The basins above the fan are modeled with a Moderate debris flow hazard with a probability of 33 percent of generating debris flows.

Site 8

At this site, the campground of Upper Conconully Lake Park is situated on an alluvial fan. The basin above the fan is modeled with a Low debris flow hazard with a probability of 29 percent of generating debris flows.

Site 9

At this site the boat ramp and water well for Upper Conconully Lake Park sit on an alluvial fan. The basin above the fan is modeled with a Moderate debris flow hazard with a probability of 44 percent of generating debris flows.

Site 10

At this site there is an alluvial fan with multiple homes on it along Conconully Lake. The two basins above the fan are modeled with both Low and Moderate debris flow hazard with probabilities of 27 to 31 percent of generating debris flows, respectively. According to one resident, the eastern side of the fan was active approximately 30 years ago.

Site 11

At this site there is an alluvial fan with multiple homes on it along Conconully Lake. The basin above the fan is modeled with Moderate debris flow hazard with a probability of 39 percent of generating debris flows.

Site 12

At this site there is an alluvial fan with multiple homes on it along Conconully Lake. The basins above the fan are modeled with Low and Moderate debris flow hazard with probabilities of 27 to 20 percent of generating debris flows, respectively. This alluvial fan has been active twice in the recent past, flooding homes and depositing material on the fan as recently as April 2017.

RECOMMENDATIONS

Landowners and managers may choose to take action to prevent excessive soil erosion, reduce flooding, and promote revegetation to meet their management and economic goals. Utilizing the soil burn severity map provided by the USFS as a tool to find areas of high and moderate burn severity should assist in this evaluation. We are willing to provide the data in various formats as needed.

Our assessment suggests that flash flooding and debris flows are most likely to impact the areas evaluated downstream of the burned area. In drainages where High and Moderate debris flow hazards exist, debris flow activity may occur during periods of intense precipitation (approximately one quarter of an inch of rain in a 15-minute period). Residents of homes built on alluvial fans and (or) adjacent to streams flowing from burned areas should be informed of potential post-fire flash flood and debris flow hazards. Parking lots and camping areas such as

Upper Conconully Lake Park may need signs to warn the public of flash flood and debris flow hazards during heavy rainstorms.

Managers of transportation networks should be reminded of the increased likelihood of sediment transport, sediment deposition, and (or) erosion to roads, as well as potential issues with blocked culverts. We suggest reminding transportation network managers and land owners to inspect culverts from channels draining areas impacted by the fires both before and after storm events, otherwise culverts could be blocked, causing additional flooding and damage.

We did not evaluate the future flooding potential to the town of Conconully, as we expect that the USFS and NRCS may evaluate this potential.

REFERENCES

Wilma, David, 2006, North fork Salmon Creek flood destroys Conconully on May 27, 1894 [webpage]: HistoryLink.org Essay 7609. [accessed Oct. 29, 2021 at https://www.historylink.org/File/7609].

InciWeb, 2021, Muckamuck [webpage]: National Wildfire Coordinating Group. [accessed Oct. 25, 2021 at https://inciweb.nwcg.gov/incident/7786/].

Parsons, Annette; Robichaud, P. R.; Lewis, S. A.; Napper, Carolyn; Clark, J. T., 2010, Field guide for mapping post-fire soil burn severity: U.S. Department of Agriculture General Technical Report RMRS-GTR-243, 49 p. [https://www.fs.fed.us/rm/pubs/rmrs_gtr243.pdf]

LIMITATIONS

WALERT aims to quickly identify and assess geologic hazards associated with wildfires in order to inform decision making and to help focus the efforts of local officials and residents who may be impacted by post-wildfire hazards. All observations and interpretations are based on empirical evidence and local knowledge. Not all areas or hazards were evaluated. We specifically did not evaluate increased stream flows and flooding. We encourage landowners, land managers, and those potentially at risk from post-wildfire hazards to consult qualified professionals for site-specific analysis of geological hazards and flood risk and prepare accordingly.

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APPENDIX A: GEOLOGICAL BACKGROUND

Hillslope processes

A variety of factors contribute to the probability of debris flows occurring in burned areas. These include hillslope gradient, channel convergence, availability of fine sediments, severity of hydrophobic (water repellant) soil conditions, burn severity, and the removal of a protective canopy and diminished root strength caused by fire.

Hydrophobic soil conditions in burned areas can increase water runoff potential on hillslopes during a storm by preventing water from infiltrating into the subsurface. Overland flow can result in rills and gullies that further channel water downhill.

When effective ground cover has been denuded after intense fire, soils are also exposed to erosive forces such as raindrop impact and wind. The steepest slopes are most prone to erosion, particularly where soils are shallow or where there is a restrictive subsurface layer such as bedrock. Soils that have developed in volcanic ash and glacial till are easily detachable, having low cohesion and structure, and contain relatively low amounts of organics, resulting in moderately thin topsoil horizons.

Flash floods and debris flows

Debris flows have a specific geologic definition that is often misused by the media, the public, and scientists. Most observed "debris flows" are actually sediment-laden flash floods known as hyperconcentrated flows (HCFs). In the following sections, we explain the differences between these two types of flows.

FLASH FLOODS

Flash floods, especially those that originate from recently burned areas, are often described as "debris flows" due to the sediment-laden water transporting woody and vegetative debris, trash, gravel, cobbles, and occasionally boulders. Though "debris flow" may be an observer's description of the event, a true debris flow has specific properties, behaviors, and characteristics that differentiate it from a flash flood. An HCF is the transition between a flash flood and a debris flow. One way geologists differentiate the three is by the percent of sediment (by volume) carried by the flowing water. A flood contains less than 5 percent sediment by volume, an HCF carries around 5 to 60 percent sediment by volume, and a debris flow exceeds 50 percent sediment by volume.

DEBRIS FLOWS

Debris flows are often described as having the appearance of flowing, wet concrete. These flows travel quickly in steep, convergent channels. A moving debris flow can be very loud because it can buoy cobbles, boulders, and debris to the front and sides of the flow. The sound is often compared to that of a freight train and may cause the ground to vibrate. In a post-fire situation, a debris flow may start as a flash flood surge that picks up sufficient sediment to transform into an HCF and, if soil and slope conditions are suitable, can transform into a debris flow.

Debris flow deposits tend to be distinct and include channel-adjacent levees of gravel, cobbles, and boulders. Channel-adjacent trees display upslope damage such as scarring on bark from rock or debris impact. Mud and gravel may be splashed onto trees and other channel-adjacent objects. Because of the ability of a debris flow to buoy these materials to the front of the moving mass, debris flows are extremely dangerous to public safety and infrastructure.

Alluvial fans

Alluvial fans are low-gradient, cone-shaped deposits that consist of sediment and debris. These features often accumulate immediately below a significant change in channel gradient and (or) valley confinement. This might occur at the mouth of a canyon or steep channel that drains from mountainous terrain and emerges onto a low gradient area such as a flood plain. Sediment on the alluvial fan is deposited by streams, floods, HCFs, and (or) debris flows and is typically sourced from a single channel.

Alluvial fans are attractive locations to build cabins and homes due to the slight elevation above the flood plain. However, alluvial fans are active depositional areas that accumulate sediment over time. The sediment can be deposited both slowly, such as during a spring melt when high streamflow transports and deposits fine sediment on the fan, or quickly, when a flash flood, HCF, or debris flow transports sediment and debris to the fan.

An information flyer about alluvial fan hazards is available on our website in both English (https://www.dnr.wa.gov/publications/ger_fs_alluvial_fans.pdf) and Spanish (https://www.dnr.wa.gov/publications/ger_fs_alluvial_fans_esp.pdf).

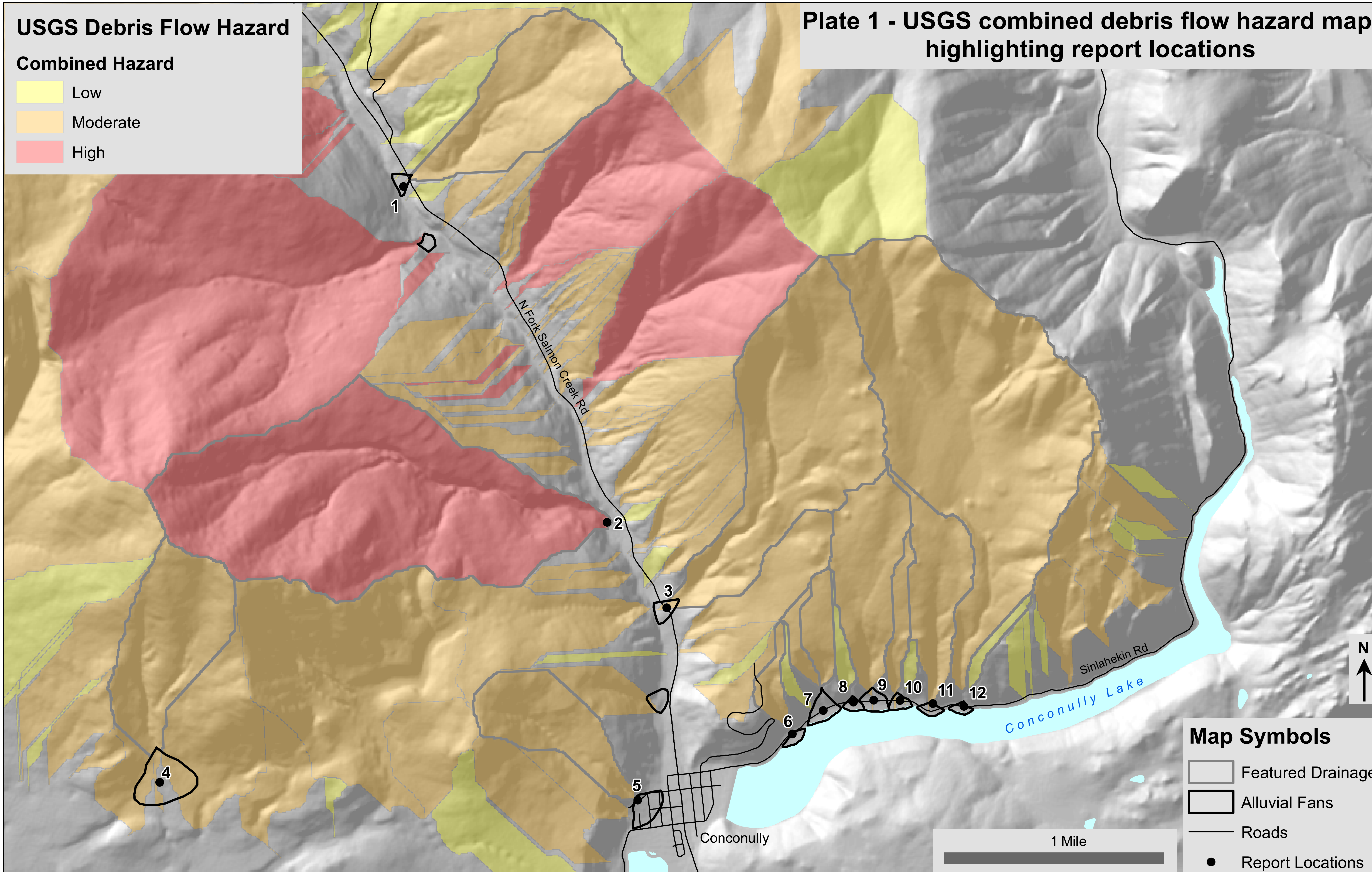

Plate 1 - USGS combined debris flow hazard map highlighting report locations
USGS Debris Flow Hazard
Combined Hazard
Low
Moderate
High
N Fork Salmon Creek Rd
Sinlahekin Rd
Conconully Lake
Conconully
1
2
3
4
5
6
7
8
9
10
11
12
N
Map Symbols
Featured Drainage
Alluvial Fans
Roads
Report Locations
1 Mile