NATURAL RESOURCES

WILDFIRE-ASSOCIATED LANDSLIDE EMERGENCY RESPONSE TEAM REPORT

Schneider Springs Fire

Yakima County, Washington

by Trevor A. Contreras, William N. Gallin, Katherine A. Mickelson, and Kara E. Jacobacci

WASHINGTON
GEOLOGICAL SURVEY
WALERT Report
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INTRODUCTION

The Wildfire-Associated Landslide Emergency Response Team (WALERT) at the Washington Geological Survey conducted an assessment to evaluate the potential risk posed by landslides and debris flows from a fire 20 miles northwest of Naches, Washington. Wildfires can significantly change the hydrologic response of a watershed so that even modest rainstorms can produce dangerous flash floods and debris flows. On steep, rocky cliffs, rock fall can become a hazard after fires, as burnt trees cannot support rocks on a slope in the way that healthy trees can.

In coordination with the U.S. Forest Service (USFS), WALERT assisted in assessing soil burn severity and areas downstream of slopes burned by wildfires to determine whether rock fall, debris flows, or flooding 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, lidar interpretation, Burned Area Reflectance Classification (BARC) maps, and orthoimagery. The USFS Burned Area Emergency Response (BAER) team finalized soil burn severity maps for the fire based on satellite data, and these maps were provided to partners and will be posted online at: http://www.centralwashingtonfirerecovery.info/. WALERT mapped alluvial fans using lidar data and can provide this mapping to interested parties and emergency managers to assist in preparation for potential future flooding and debris flow impacts.

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.

SCHNEIDER SPRINGS FIRE OVERVIEW

Lightning strikes on the evening of August 4, 2021 ignited a fire in the Schneider Springs area. Record hot and dry conditions and limited access for ground resources allowed the fire to grow rapidly in the following days. As of October 21, 2021, the fire has burned 107,322 acres, primarily in short grass, timber, and brush (InciWeb, 2021).

The majority of the land that burned is on USFS land (88.6% of the total burned area). See Table 1 for land ownership information.

Table 1. Ownership distribution of burned area for Schneider Springs Fire

Land owner/manager	Acres	Percent of burned area
U.S. Forest Service (USFS)	95,092	88.6
WA State Dept. of Natural Resources (WADNR)	11,736	10.9
Private Ownership	500	0.5
Total	107,328[1]	100

[1] This value does not match the number of burned acres as reported by INCI Web. The reported burned acreage was 107,322. The acreage reported here reflects a deviation from the INCI Web value of approximately 0.01%.

OBSERVATIONS AND INTERPRETATIONS

WALERT field assessments were performed October 11–14, 2021, coincident with wildfire mop-up operations and the beginning of USFS BAER operations. WALERT's work focused on areas where wildfire effects on watershed hydrology could put life and property at risk.

Soil burn severity and Burned Area Reflectance Classification (BARC) data

OBSERVATIONS

The USFS BAER team assessed soil burn severity using BARC data. The BAER team field-checked BARC data using guidance from Parsons and others (2010), and calibrated and posted their results online at: http://www.centralwashingtonfirerecovery.info/, where they also provided a short report. In their report, the BAER team outlines burn severity in acres by ownership. We encourage interested parties to consult their report and maps. If you need assistance accessing or analyzing the data, please contact us and we can provide some support.

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

MODELING RESULTS

The USGS provided a debris flow assessment for the Schneider Springs 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/.

There are various outputs and ways to view the data using the website. Here we'll 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 will focus on locations where public safety could be impacted.

INTERPRETATIONS

The USGS modeling suggests that there are Low, Moderate, and High debris flow hazards 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, or 24 mm/hr. According to the USFS, a storm with this intensity is less than a 2-year storm for the area, meaning that the modeled storm has a return interval of less than 2 years (Molly Hanson, U.S. Forest Service, written commun., 2021). The 2-year, 1-hour storm for the area is greater than the modeled storm event with peak rainfall intensities of 0.35 inches in 15 minutes. Storms with greater peak rainfall intensities than the modeled storm would have a greater probability of debris flows.

Below we outline the various drainages where debris flows and flooding could impact the property and infrastructure that we reviewed during our limited reconnaissance field work. Overall, we didn't find evidence suggesting that debris flows are likely to impact homes or significant infrastructure directly from the burned area. It's possible that flooding could transport debris from the major drainages given the amount of high and moderate soil burn severity throughout the burned area. Some areas of concern are discussed below in relation to the debris flow modeling.

Bumping River area

CABINS AT CEDAR FLATS

Cabins at Cedar Flats with addresses between 2121 and 2191 on Bumping River Road are below a basin about 1,000 feet to the northwest that was modeled as Moderate debris flow hazard with a 25 percent probability of a debris flow. However, the basin appears to include predominantly low burn severity or is unburned. The cabins are on the distal edge of an alluvial fan that has multiple channels, suggesting some historic flooding activity. While the probability of a debris flow occurring is low, residents should be warned that debris flows are possible.

The USGS models the basin that lies about 1,800 feet to the west–northwest of the cabins with Moderate debris flow hazard, with a 40 percent probability of a debris flow. Portions of this drainage have high and moderate soil burn severity on steep slopes with prehistoric landslide deposits present. Landslide deposits are typically less stable than other deposits and more likely to fail when saturated. There are no homes downstream of this basin but potential debris flows could impact Bumping River Road.

DISPERSED CAMPSITES BETWEEN CEDAR CREEK AND FIFES CREEK

A large debris flow event in the Fifes Creek drainage could impact dispersed campsites along Bumping River between Cedar Creek and Fifes Creek. The Fifes Creek drainage has a Moderate debris flow hazard with an 11 percent probability of a debris flow occurring. The channel exits at an alluvial fan at the north end of the dispersed campground along the Bumping River. Currently, the channel is diverted to the north of the campsites but a small channel could activate and deposit material in the campground.

An unnamed drainage on the south side of Bumping River has a High debris flow hazard with a 68 percent probability of a debris flow occurring. A large debris flow in this drainage could push the Bumping River north into the campground.

SCAB CREEK

A historic landslide is visible in aerial photos going back to at least 1949. The landslide material traveled nearly 2 miles down Scab Creek and deposited on an alluvial fan at Bumping River downstream of Goose Prairie. It appears to have initiated within a large landslide on a southern tributary of Scab Creek at about 5,000 feet in elevation. The Schneider Springs Fire burned this large landslide with high soil burn severity. The USGS models the basin with a Moderate debris flow hazard and a 42 percent probability of a debris flow occurring. No homes appear to be near this alluvial fan but potential impact to the county road could occur if a large volume of material pushes the river north into the road.

Cliffdell and Edgar Rock area

There are many cabins on the west side of Naches River along Old River Road and a few cabins along Lost Creek Road below Edgar Rock. The USGS models the area with both Low and Moderate debris flow hazard, with approximately 14 to 40 percent probability of debris flows occurring in the various basins above the cabins. While the probability of a debris flow may be Low to Moderate, many cabins are in close proximity to the steep cliffs of Edgar Rock. Rock fall may be a hazard post-fire and in the coming years as burned tree roots rot and lose their strength to hold rocks. Cabin owners should be warned of the increased risk of rock fall and debris flows.

Lost Creek area

The Lost Creek Camp has two drainages above it with Low debris flow hazard, with 32 to 39 percent probability of a debris flow occurring. At the time of our brief field review of the area, we were not concerned about the risk of debris flows due to low soil burn severity and the lack of obvious channels that would directly channel debris to buildings. However, due to the proximity of the steep slopes to buildings and the later results of the USGS debris flow model, there may be an elevated risk of debris flow hazards.

Access to Lost Creek Camp could be impacted if there are debris flows in Lost Creek or its tributaries. Lost Creek has many drainages with Low and Moderate debris flow hazard, and the basin with the highest probability of generating a debris flow (40 percent) is approximately 900 feet upstream of the road crossing to Lost Creek Camp. Evidence for pre-historic debris flows exists in the area around the culvert crossing and trailhead to Edgar Rock. Warning hikers and travelers of the debris flow hazard that exists along the access road to Lost Creek Camp is warranted.

A cabin just south of Lost Creek is just above a channel that is modeled as a Moderate debris flow hazard with a 20 percent probability of a debris flow. There is evidence of historic flood or debris flow deposits in the channel, however they appear to be small deposits that may not be large enough to exit the current channel and impact the cabin. If a larger debris flow occurs it could impact the cabin, while smaller events may just impact the culvert. We did not take the time to observe the size of the culvert where this drainage crosses the access road to Lost Creek Camp.

Rattlesnake Creek

CABINS ALONG RATTLESNAKE CREEK NEAR RIVER MILE 5

Multiple cabins exist on both sides of Rattlesnake Creek with addresses in the 3700 block of Bethel Ridge Road. The access road to these cabins traverses areas with high soil burn severity. Culverts on this road should be inspected and maintained to ensure they can pass additional flow and sediment, should the need occur.

A drainage on the south side of the creek has a Low debris flow hazard with a 14 percent probability of a debris flow. The drainage exits the hillside approximately 170 feet from the cabins to the north. We were unable to determine the addresses of the cabins located on the south side of Rattlesnake Creek. Small debris flows and sediment likely wouldn’t impact the cabins due to the distance and ability for sediment to be deposited.

On the north side of Rattlesnake Creek, a few cabins exist on alluvial fans that have basins upslope that are modeled as Moderate debris flow hazard with probabilities between 61 to 72 percent of generating debris flows.

Rock fall may also be a hazard for the cabins on the north side of the creek that are adjacent to steep cliffs. This hazard may continue for the coming years as burned tree roots rot and lose their strength to hold rocks. Cabin owners should be warned of the increased risk of rock fall, debris flows, and access road flooding during intense rainstorms.

RECOMMENDATIONS

Landowners and managers may choose to take action to protect their homes, 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. Landowners should consult the USGS debris flow model in relation to their homes. We are willing to provide the data in various formats as needed.

Our assessment suggests that flash flooding, rock fall, and debris flows are most likely to impact the areas evaluated downstream of the burned area. In drainages where the USGS modeled High and Moderate debris flow hazards, debris flow activity may occur, especially 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.

The roads, parking lots, trailheads, and dispersed camping areas in and surrounding the burned area may need signs to warn the public of flash flood and debris flow hazards during heavy rainstorms. Some campsites may need to be restricted due to the hazard and we expect the USFS is working on this in conjunction with other land managers.

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 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.

REFERENCES

InciWeb, 2021, Schneider Springs [webpage]: National Wildfire Coordinating Group. [accessed Oct. 25, 2021 at https://inciweb.nwcg.gov/incident/7775/].

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 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.

ACKNOWLEDGMENTS

We'd like to thank the USFS BAER team for their cooperation and sharing their data throughout the assessment process. We also thank local landowners who provided access to their land and information on previous flooding events.

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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).