NATURAL RESOURCES

WILDFIRE-ASSOCIATED LANDSLIDE EMERGENCY RESPONSE TEAM REPORT

Twentyfive Mile Fire

Chelan County, Washington

by Trevor A. Contreras and Katherine A. Mickelson

WASHINGTON
GEOLOGICAL SURVEY
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Wildfire-Associated Landslide Emergency Response Team Report for the Twentyfive Mile Fire

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

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INTRODUCTION

A limited Wildfire-Associated Landslide Emergency Response Team (WALERT) assessment was conducted to evaluate the potential risk posed by landslides and debris flows from a fire 12 miles northwest of Chelan, 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 assessed 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 the soil burn severity map based on satellite data, which was provided to partners and will be posted online at: http://www.centralwashingtonfirerecovery.info/.

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. We focused on a limited area around Twentyfive Mile Creek near the state park campground, and residences along Shady Pass Road, outside of National Forest jurisdiction.

TWENTYFIVE MILE FIRE OVERVIEW

The Twentyfive Mile Fire was first reported on August 15, 2021, and the cause is still under investigation. As of October 5, the fire has burned 22,217 acres, mainly within the Twentyfive Mile Creek watershed, which drains into Lake Chelan. The fire burned primarily in short grass, timber, and brush (InciWeb, 2021).

The majority of the land that burned is on USFS land (93.5% of the total burned area). See Table 1 for land ownership information.

Table 1. Ownership distribution of burned area for Twentyfive Mile Fire

Land owner/manager	Acres	Percent of burned area
U.S. Forest Service (USFS)	20,684	93.5
Private ownership	651	3
WA State Dept. of Natural Resources (WADNR)	558	2.5
U.S. Dept. of Fish and Wildlife	201	0.9
Washington Dept. of Fish and Wildlife (WDFW)	24	0.1
Total	22,118[1]	100

[1] This value does not match the number of burned acres as reported by InciWeb. The reported burned acreage was 22,217. The acreage as reported here reflects a deviation of approximately 0.01%.

OBSERVATIONS AND INTERPRETATIONS

A very limited field assessment was performed on September 10 while mop-up operations were occurring. The work focused on areas where wildfire effects on watershed hydrology could put life and property at risk, specifically along Shady Pass Road, South Lakeshore Road, and at Twenty-Five Mile Creek State Park.

Satellite-derived data in the form of a calibrated Soil Burn Severity map was available for the Twentyfive Mile Fire and was provided by the USFS BAER team. They reviewed it for the federal lands and calibrated it for application throughout the burned area.

The Washington Geological Survey's Lidar Program was able to acquire preliminary lidar data for use in this post-fire assessment. These data assisted in visually estimating potential debris flow runout locations.

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

MODELING RESULTS

The USGS provided a debris flow assessment for the Twentyfive Mile Fire as requested by the USFS and 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=390).

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 and infrastructure 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 0.25 inches of rain in a 15-minute period. USFS hydrologists suggest that a higher peak rainfall intensity of 0.4 inches in 15-minutes may be more appropriate for this area based on local climatic data. This greater rainfall intensity produces higher debris flow probabilities and may be more realistic when planning for intense rainfall events. However, we discuss the lower rainfall intensity here for consistency among other burned areas and for consistency with the default view of data on the USGS website.

We recognize that debris flow probabilities would be higher for higher storm intensities, and that this is especially probable for this area, so we encourage interested parties to consult the USFS BAER team debris flow hazard and runoff potential maps (U.S. Forest Service, 2021)(https://inciweb.nwcg.gov/photos/WAOWF/2021-09-16-1042-TwentyFive-Mile-BAER/related_files/pict20210908-182445-0.pdf) for additional information on debris flow modeling and flooding potential.

In the sections below we outline the various drainages where debris flows and flooding could impact the property and infrastructure that we reviewed during the limited reconnaissance field work. We didn't evaluate the area above the confluence of North Fork and the main stem of Twentyfive Mile Creek. This area is within the National Forest and was evaluated as part of the USFS BAER team evaluation. Additionally, below the confluence, the valley that Twentyfive Mile Creek flows in is relatively wide and flat, encouraging deposition of debris flow material. We do not expect debris flows triggered above the confluence to be directly transported downstream to the mouth of Twentyfive Mile Creek.

Twenty-Five Mile Creek State Park and South Lakeshore Road

We conducted a rapid visual assessment of Twenty-Five Mile Creek State Park. Of note were campsites along the creek on a lower terrace that are more prone to flooding than an upper terrace approximately 9 feet higher. The marina, docks, fuel tank, and store all exist on the distal edge of the fan, near Lake Chelan.

Boulders on the alluvial fan at the State Park suggest past debris flow activity. Based on a few old growth Douglas fir trees growing on an older debris flow deposit on the upstream portion of the park, the activity was likely over a hundred years ago.

We expect flooding, logs, and sediment would likely be the impact to the State Park and South Lakeshore Road during heavy precipitation events. Debris flows are not as likely here, though we do expect that debris flows could occur farther upstream in the watershed where drainages modeled with High and Moderate debris flow probability exit along steep and confined channels.

Debris flows need steep, confined channels to continue moving downstream. The channel upstream of South Lakeshore Road is broad and flat enough that most debris flows should attenuate and deposit larger boulders prior to impacting the road and park. Much of the lower 2.5 miles of Twentyfive Mile Creek has a low gradient and is not confined below the confluence with the North Fork of Twentyfive Mile Creek.

The marina and fuel tank appear to be situated on the distal edge of the alluvial fan. Alluvial fans can be dynamic landforms during flooding events. While the marina store and fuel tank appear to be tucked away on the extreme east flank of the fan, approximately 300 feet from the current channel of the creek, wood debris and flood waters could impact the area during intense flooding events.

Shady Pass Road

Our rapid assessment relies on limited visual assessment of homes along Shady Pass Road. We reviewed the locations of homes to verify that they were not in channels that could transmit debris flows. While we did not observe homes in drainage channels, some outbuildings, driveways, and irrigation infrastructure may be vulnerable. Consulting the USGS debris flow modeling is advised to help assess site specific hazards (https://landslides.usgs.gov/hazards/postfire_debrisflow/detail.php?objectid=390).

The USGS debris flow model depicts drainages that cross Shady Pass Road as a combination of hazards, from Low to High. The two highest modeled drainages are near the 1500 and 1600 blocks of Shady Pass Road. Some homes may need assistance with minor flooding and sedimentation issues and some homeowners are currently working with Cascadia Conservation District to assess replanting and recovery efforts.

Homeowners have reported rocks impacting structures and landscaping equipment. Rock fall may be a hazard post-fire and in the coming years to homes and along roads as burned tree roots rot and lose their strength to hold rocks back.

RECOMMENDATIONS

Our assessment suggests that flash flooding, debris flows, and rock fall could impact the areas evaluated downstream of the burned area during intense rainstorms. According to previous reports from the USFS of post-fire flooding to nearby drainages (Safety Harbor and Big Creek), past floods have destroyed campgrounds and deposited logs and debris into Lake Chelan in 1972 and 2006. Based on previous flooding events in nearby drainages and calculations by the National Resource Conservation Service (NRCS) and the USFS BAER team, log jams could be a hazard during flooding events along the main channel of Twentyfive Mile Creek. Twenty-Five Mile Creek State Park may need additional review to better assess possible hazards to public safety and the environment.

Homeowners are encouraged to seek additional advice pertaining to future flooding, sedimentation, and debris flow impacts. Residents and visitors of the area should be informed of potential post-fire rock fall, flash flood, and debris flow hazards. If debris flows occur, they would make roads impassable. If you have questions or need additional assistance, please contact the authors of this report.

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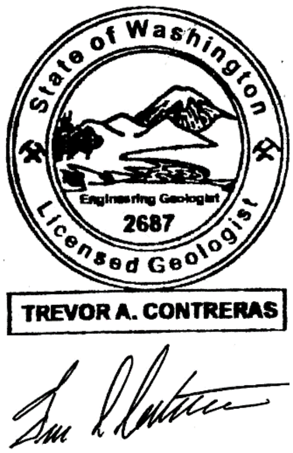
LIMITATIONS

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. 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, NRCS, and the Cascadia Conservation District for their cooperation and for sharing data throughout the preliminary assessment process.



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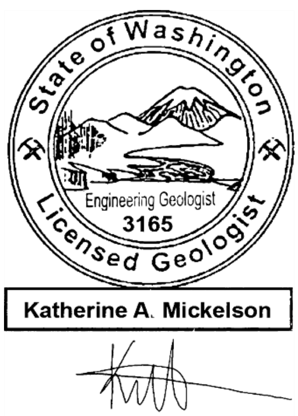

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APPENDIX A: GEOLOGICAL BACKGROUND

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).