



Holiday Farm Fire

Erosion Threat Assessment/Reduction Team (ETART)
Extended Report

December 2020



FEMA

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Executive Summary

This report summarizes a rapid characterization of post-fire conditions resulting from the Holiday Farm Fire and identifies critical values potentially at risk from threats commonly associated with burned areas. In addition, the ETART assessment of drinking water threats from the Holiday Farm and other fires are captured in the ETART Water Quality/Drinking Water Supply Resource Report. The area of interest for this report consists of non-federal lands within and downstream of the Holiday Farm Fire perimeter. Critical values include human life and safety; improved properties/assets such as roads, bridges, buildings and water systems; important natural resources (soil productivity, water quality and municipal water sources, habitats for wildlife and fish); and cultural resources. Threats that exist or are recognized to amplify in a post-fire setting include accelerated soil erosion and hillslope water runoff that results in increased sediment transport, high stream flows, floods or debris flows; landslides and rock fall; hazard trees; mobilization of hazardous materials; and expansion of invasive or noxious plants.

The essential findings of this evaluation are: 1) to identify emergency conditions as defined by critical values at unacceptable risk from imminent post-fire threats; and 2) to recommend emergency response actions that reduce risk or minimize impacts to critical values. In addition to the emergency response actions, the data, analysis and conclusions supporting this report can be used to develop restoration opportunities leading to long-term recovery of the fire-damaged landscape. Multiple “Specialist Reports” encompassing soils, hydrology and water quality, engineering, fish and wildlife, botany and cultural resources were used to complete this assessment.

The 2020 fire season in Oregon State affected lands across all jurisdictions and ownerships: tribal, federal, state, local and private. Fires on federal and tribal lands are assessed through the U.S. Forest Service (USFS) Burned Area Emergency Response (BAER) or Department of Interior (DOI) Emergency Stabilization and Rehabilitation (ESR) programs. Given the size and severity of the fires’ impacts to state, local and private lands throughout Oregon, the State of Oregon requested the Federal Emergency Management Agency (FEMA) form a multi-jurisdiction assessment team to assess the state, local and private lands of several fires. FEMA coordinated with Oregon Emergency Management (OEM) and Department of Forestry (ODF), National Weather Service (NWS), U.S. Army Corps of Engineers (USACE) and the USFS to staff the Erosion Threat Assessment and Reduction Team (ETART) to evaluate the fire-affected state and private lands.

The team used the USFS BAER and DOI Emergency Stabilization & Rehabilitation (ESR) assessments for several fires, which established the foundation for the ETART and allowed for comprehensive evaluation of all lands burned within the fires.

2020 Oregon ETART is comprised of personnel from Lane County, Linn County, OR Department of Environmental Quality (DEQ), OR Department of Fish & Wildlife (ODFW), ODF, OR Department of Geology and Mineral Industries (DOGAMI), OR Department of Transportation (ODOT), OR Water Resources Department (OWRD), Bureau of Land Management (BLM), Environmental Protection Agency (EPA), FEMA, USFS, U.S. Geological Survey (USGS), NWS and the Natural Resources Conservation Service (NRCS). These resource specialists completed the assessments while safely managing COVID-related protections, navigating interagency data sharing barriers, operating in a hazardous post-fire field environment and working across a broad geographic area. ETART members went above and beyond the demands of their normal duties to carry out critical emergency assessments in service of local communities.



1. Overview

1.1. Burned Area Characterization

- Fire Name: Holiday Farm
- State: Oregon
- Date Fire Started: September 7, 2020
- Date Fire Contained: October 29, 2020 (estimate, ICS-209 dated 10/25/2020)
- Suppression Cost: \$42,000,000 (estimate, ICS-209 dated 10/25/2020)
- Fire Number: OR-WIF-200430
- County: Lane and Linn

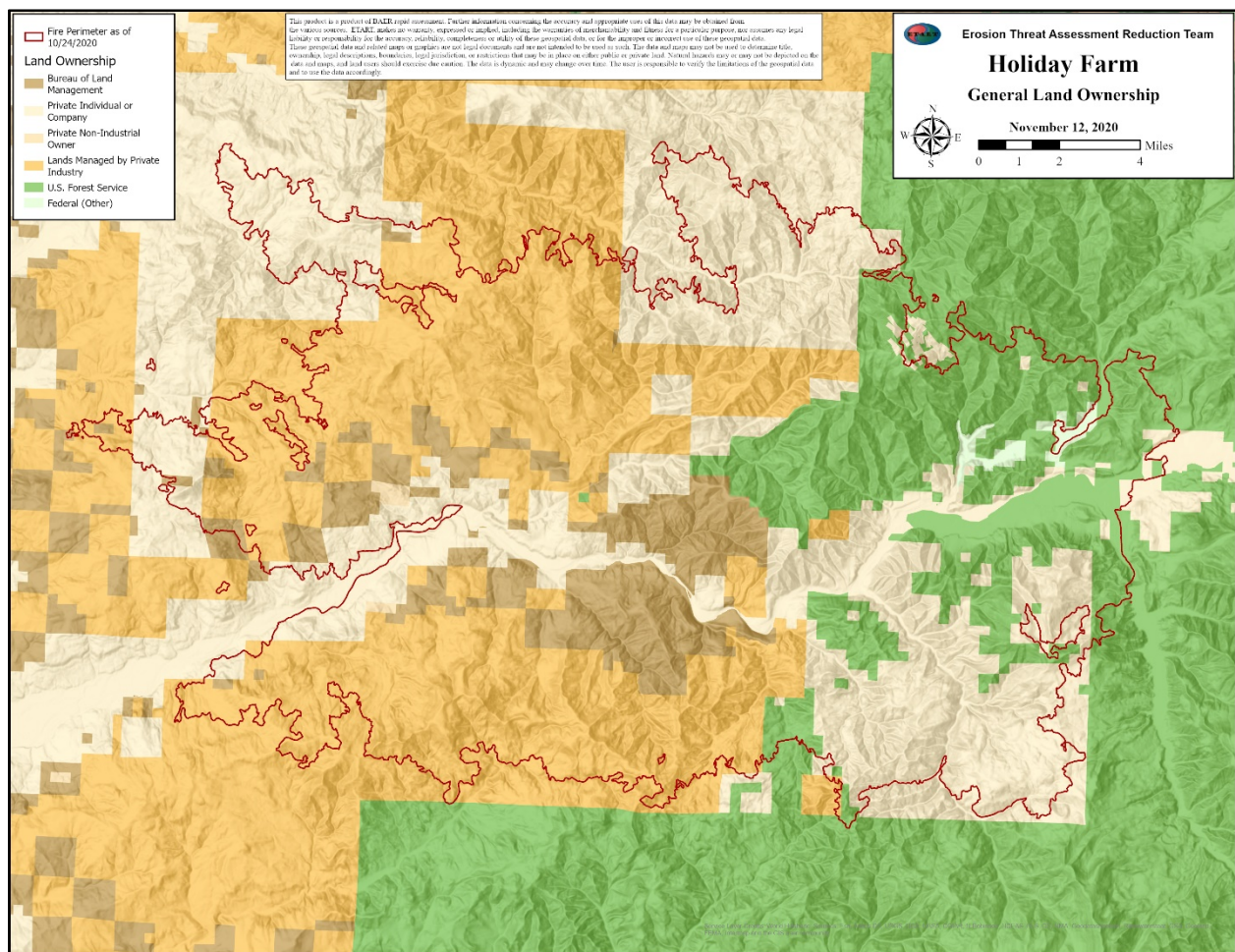


Figure 1. Land Ownership - Holiday Farm Fire

The Holiday Farm Fire began on September 7, 2020, about 3 miles west of McKenzie Bridge, OR during a strong east wind event that passed through the area. Pushed westward by strong winds, the fire grew from 37,000 acres on September 8th to over 100,000 acres in a 24-hour period. The fire burned through the communities of Blue River, Finn Rock, Nimrod, Vida and Leaburg, damaging and destroying homes, businesses and facilities. The fire burned an estimated 173,393 acres across multiple entities, including the Willamette National Forest, BLM, and commercial and private forest lands under authority of the State of Oregon Department of Forestry (ODF). (Figure 1, Table 1 and Table 2.)

Table 1. Holiday Farm Fire Total Acres Burned – 173,393 (based on post-fire analysis perimeter)

Ownership	Acres	Sq.Mi.	Percent
Private	121,467	190	70
State	-	-	-
Tribal	-	-	-
Federal	51,926	81	30
Total	173,393	271	

Table 1. Holiday Farm Fire – Acres Burned by County

Lane County	Acres	Sq.Mi.	Percent	Linn County	Acres	Sq.Mi.	Percent
Private	109,464	171	68%	Private	12,004	2	89%
State	-	-	-	State	-	-	-
Tribal	-	-	-	Tribal	-	-	-
Federal	50,453	79	32%	Federal	1,473	11	11%
Total	159,917	250		Total	13,477	21	

1.1.1. CLIMATE

The burned area is in a region that experiences wet winters and dry summers, with elevations less than 1,000 ft along the McKenzie River corridor to 4,500 ft atop Jimbo Mountain. Annual precipitation ranges from about 60 inches along valley bottoms to more than 90 inches at higher elevations, with most of the precipitation occurring from October through May. In the lower elevations (<2,000 feet), precipitation is dominated by rainfall. Precipitation for the higher elevations of the burned area, between 2,000 and 4,500 ft, is a mix of rain and snow. This rain-on-snow zone can produce very high peak flows during long-duration rainstorms falling on a shallow snowpack. The first wetting fall storms occur in late October into November and are generally characterized by lower

intensity, longer duration events. Wetting rains fell over the burned area from October 10-12, with some areas receiving nearly 3.5 inches (measured at several temporary RAWs set up for the fire). Field reconnaissance reported no observations of overland flow or apparent water quality concerns.

La Niña conditions are present in the tropical Pacific, with an approximately 85% chance of lasting through the winter. Forecasters currently predict this La Niña will be on the stronger side and peak in November–January, with higher precipitation and snowpack expected.

1.1.2. GEOLOGIC TYPES

The bulk of the burned area falls within the Western Cascades geologic unit known as the Little Butte Volcanics, which is composed largely of Miocene and Oligocene igneous rocks, ranging in age from 30 to 40 million years. Rock types include lava flows, pyroclastic deposits such as ash-flow tuffs and lahars (volcanic mudflows) and volcaniclastic sedimentary rocks. An intrusive igneous body that is unusually large for the Cascades, known as the Nimrod Stock, occupies a central portion of the burned area. Younger Western Cascade volcanic rocks make up the remainder of the bedrock geology, with local ridge-capping lavas of the younger (Pliocene-Pleistocene) High Cascades present, and abundant Quaternary deposits, including glacial till and outwash fluvial deposits. Evidence of debris flows from steep and unstable hillslopes with linear drainages exists across much of the burned area. Historic and recent pre-fire landslide processes and deposits are present across much of the landscape.

1.1.3. DOMINANT SOILS

Lands within the fire perimeter are largely in the Cirque Basin Mountain Landform Association. Soils are derived from glacial materials composed of tuffs, breccias and basalts. Slopes range from 0 to 70%, with an average of 35%. Soils are generally Inceptisols (Dystric Cryandepts) with loamy surface textures. Soil climate regimes are typically cryic. Soil depths range from 24 to 70 cm on mountain slopes to very deep in fluvial valleys. Pre-fire litter depth was typically 4 cm; soils were largely covered with mosses and bryophytes.

1.1.4. VEGETATION TYPES

The vegetation types within the Holiday Farm Fire are comprised of Western hemlock (71%), mixed conifer (13%), non-forested (8%), Douglas-fir/mixed conifer (5%), true fir (1%) and mountain hemlock (0.1%). Understory composition is dominated by salal/Oregon grape/oceanspray/sword fern and Alaskan huckleberry. Many non-forested areas are considered unique and special habitats including wet, mesic and dry meadows, rock gardens, wetlands which support rare and sensitive plant populations within them.

1.1.5. WATERSHEDS (HYDROLOGIC UNITS)

The fire perimeter occurs in eight 5th level hydrologic units (watersheds) and nineteen 6th level hydrologic units (subwatersheds). The percent area burned for the 6th Level subwatersheds are displayed in Figure 2 and summarized in Table 3. The primary drainages within or downstream of the

Holiday Farm Fire are the McKenzie River, Calapooia River and Mohawk River, with approximately 1,500 miles of intermittent and perennial streams (Table 4).

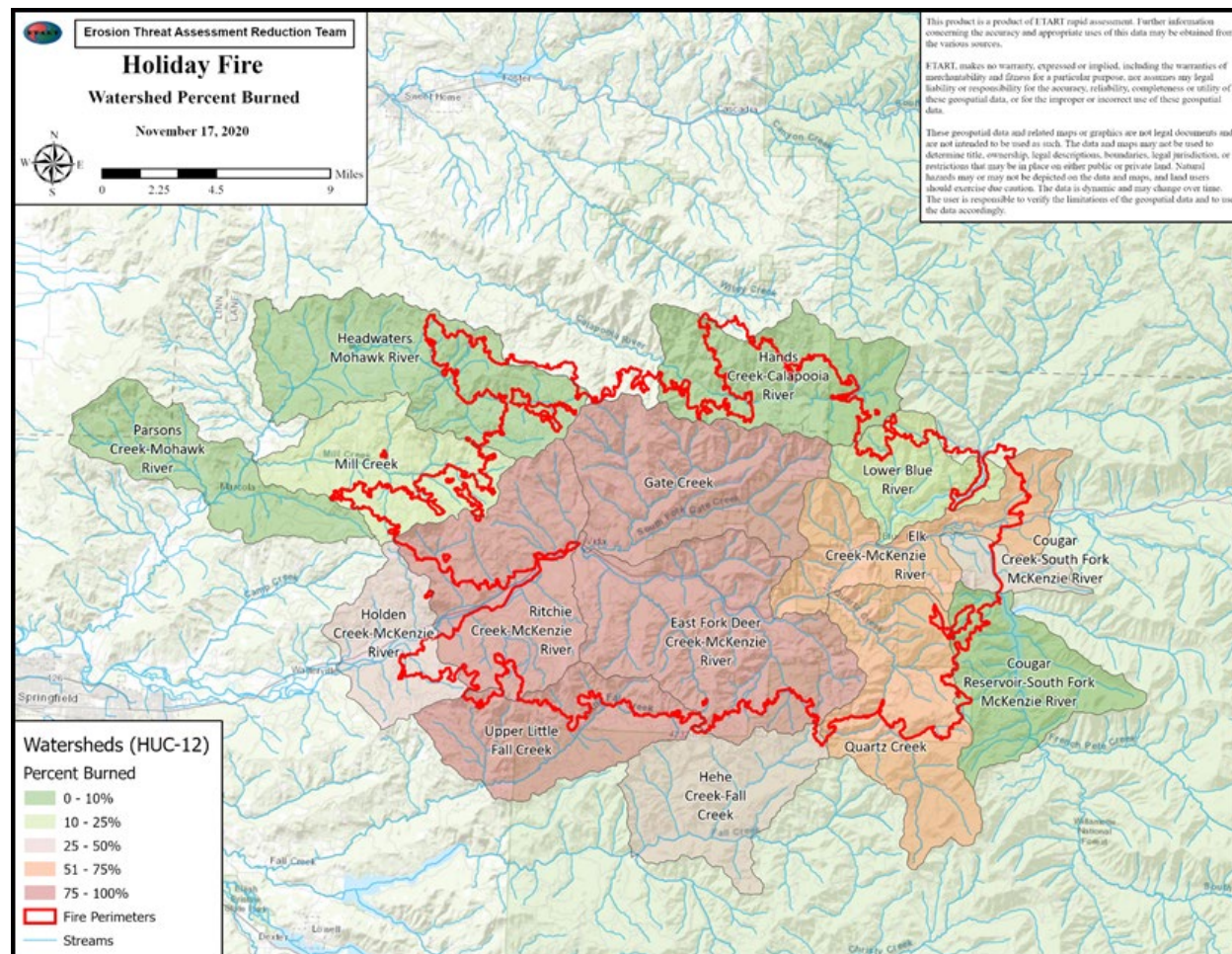


Figure 2. Watersheds Percent Area Burned – Holiday Farm Fire

Flow in the McKenzie River is controlled to varying degrees by several dams, reservoirs diversions (Carmen Diversion Dam, Smith River Reservoir, Trail Bridge Regulating Reservoir, Cougar Dam, Blue River Dam and Reservoir, Leaburg Dam and Diversion, Walterville Diversion). These facilities occur along a 60-mile stretch of river from Walterville upstream to near the headwaters at Clear Lake.

Table 2. Affected Watersheds (5th and 6th Level Hydrologic Unit Name)

5th Level Watershed	6th Level Subwatershed	Total Acres	Acres Burned	Percent Burned
Blue River	Lookout Creek	15,724	171	1%
	Lower Blue River	12,788	10,016	78%
	Upper Blue River	30,398	204	1%
Fall Creek	Hehe Creek-Fall Creek	20,925	161	1%

5th Level Watershed	6th Level Subwatershed	Total Acres	Acres Burned	Percent Burned
Little Fall Creek	Upper Little Fall Creek	22,318	4,716	21%
McKenzie River	East Fork Deer Creek-McKenzie River	38,897	35,260	91%
	Gate Creek	30,800	30,426	99%
	Holden Creek-McKenzie River	14,132	1,004	7%
	Ritchie Creek-McKenzie River	30,670	24,576	80%
	Headwaters Mohawk River	33,312	7,947	24%
	Mill Creek	20,813	4,526	22%
Quartz Creek-McKenzie River	Elk Creek-McKenzie River	20,828	16,427	79%
	Quartz Creek	26,923	14,152	53%
South Fork McKenzie River	Cougar Creek-SF McKenzie River	5,095	2,251	44%
	Cougar Reservoir-SF McKenzie River	19,499	1,610	8%
Upper Calapooia River	Bigs Creek-Calapooia River	15,594	1,174	8%
	Hands Creek-Calapooia River	24,448	10,595	43%
Wiley Creek	Jackson Creek-Wiley Creek	29,767	353	1%

Table 3. Miles of Stream by Flow Regime and Soil Burn Severity^a

Flow Regime	High	Moderate	Low	Unburned	Total
Intermittent Stream	62	497	206	108	873
Perennial Stream	13	316	145	91	565
Perennial River	<1	14	26	21	61
Grand Total	75	827	377	220	1,499

a: Does not account for streams below the fire perimeter that may be a "Value" as domestic or municipal source water, or for aquatic habitat.

Table 4. Road Miles by Ownership Designation within Fire Perimeter

Owner Designation	Miles ^a
Bureau of Land Management	80.8
County Route	12.2
Forest Service	117.1
Private Route	731.2
State Highway	22.2
Unknown	151.2
Total Miles	1,114.7

a: Does not account for priority travel routes below the fire perimeter that may be a “Value” or threatened by flooding or debris flows.

1.2. Post-fire Watershed Condition

1.2.1. SOIL BURN SEVERITY (SBS):

The post-fire watershed conditions are mostly driven by fire behavior, which is largely a function of pre-fire fuel conditions (vegetation types, volumes, arrangement and moisture content) as influenced by weather and topography. Soil Burn Severity (SBS) is the fundamental post-fire factor for evaluating changes in soil processes and hydrologic function, which are used to evaluate watershed response, identify post-fire threats and assess the level of risk to critical values.

Prior to the ETART effort, the Forest Service produced a Soil Burn Severity (SBS) map as part of their Holiday Farm BAER Assessment. Field validation of the SBS was conducted across the burned area through coordination with ACOE and BLM. The initial Forest Service SBS mapping did not field-validate soil conditions on private or state lands. The ETART soils team completed soil burn severity validation on state and private lands with on-the-ground data collection and visual observations (Table 6, Figure 3).

Table 6. Soil Burn Severity (SBS) Acres.

Soil Burn Severity Class	All Lands		Federal Lands		Private Lands	
	Acres	Percent	Acres	Percent	Acres	Percent
High	16,116	9	4,621	3	11,496	6
Moderate	107,314	62	32,010	19	75,304	43
Low	42,265	25	13,952	8	28,313	17
Unburned	7,485	4	1,244	<1	6,240	4
Total	173,180		51,827		123,353	

The fire was fast moving and left high vegetation mortality and moderate soil burn severity across the burned area. Being a wind driven there are distinct differences from west to east due to pre-fire vegetation conditions (management disturbance, fuel loading and forest canopy cover). The most concentrated areas of high SBS are found in the Gate Creek, East Fork Deer Creek-McKenzie River, Lower Blue River and Elk Creek-McKenzie River watersheds.

1.2.2. WATER-REPELLENT SOIL (ACRES)

Natural water repellency is present on almost all of the soils in the fire perimeter and was found to be highly variable during field verification in unburned, low moderate burn severities. Fire-induced or altered hydrophobicity occurred only in pockets of high severity burned soils, which is less than 10 percent of the burned area.

1.2.3. SOIL EROSION INDEX:

The soil erosion index (SEI) describes the sensitivity for soil loss after disturbance removes the protective vegetation and litter cover. The SEI is primarily a function of hillslope soil processes and hydrologic function, as influenced by disturbance, such as fire, and slope. The SEI is described as “low”, “moderate”, “high” or “very high”. Low erosion index indicates soil erosion is unlikely.

Moderate erosion index indicates soil erosion is likely with a potential decrease in soil productivity.

High erosion index indicates soil erosion is very likely with likely decrease in soil productivity. Very high erosion index indicates a high probability for soil loss and decreased soil productivity, where erosion control measures are impractical and cost prohibitive.

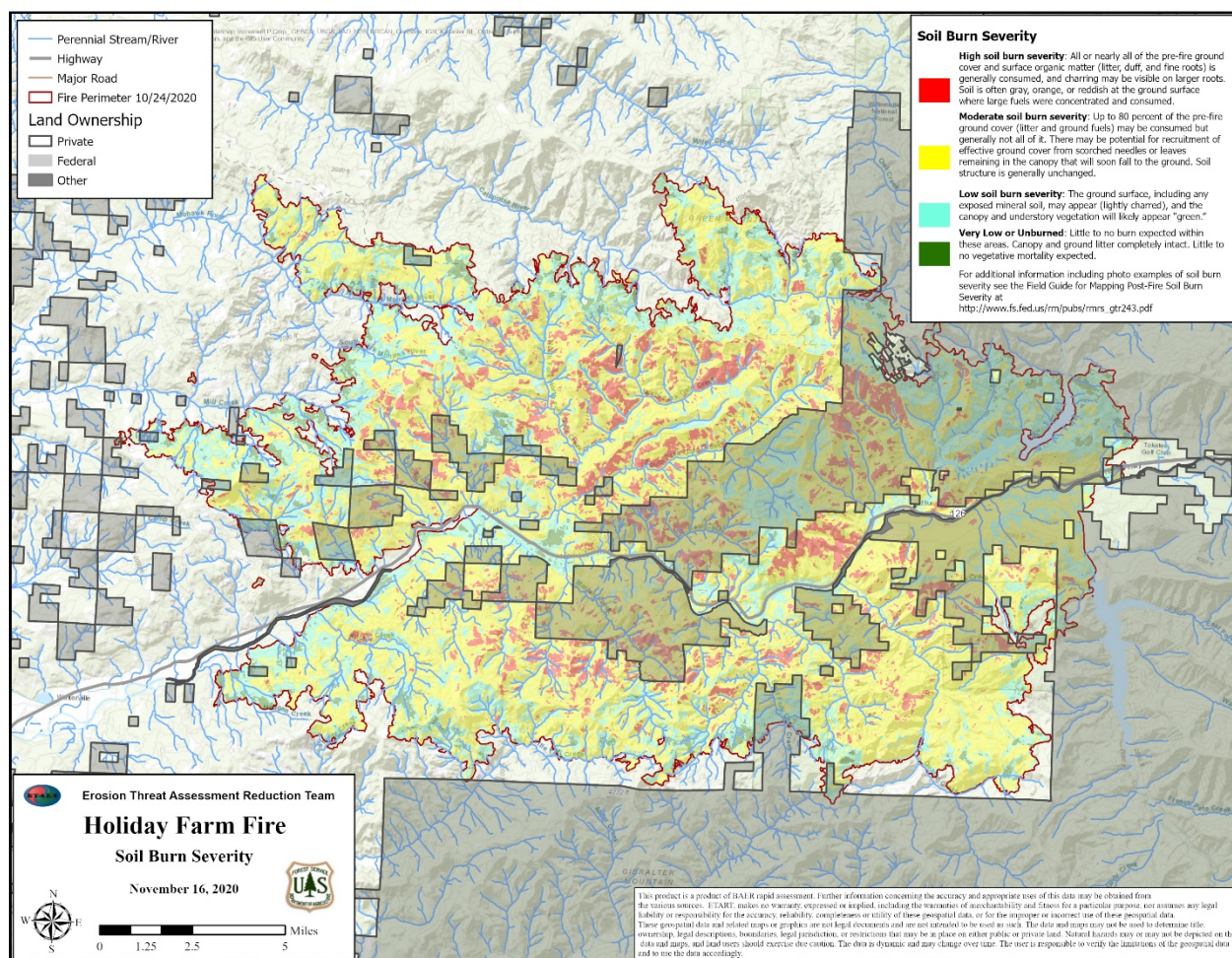


Figure 2. Soil Burn Severity - Holiday Farm Fire

Figure 4 displays the spatial distribution and acres by SEI for the area burned by Holiday Farm Fire. The matrix values in the map table represent combinations of inherent SEI with SBS. The analysis estimates 94% of the burned area has increased potential for accelerated soil erosion. The “very high” SEI is generally attributed to over-steepened slopes where SBS has minor influence to change soil erosion.

1.2.4. EROSION POTENTIAL

This analysis is used to identify hillslopes where post-fire accelerated erosion elevates the level of threat to downslope critical values. The potential for soil movement was estimated using the Water Erosion Prediction Project Cloud -Disturbed (WEPPCloud - Disturbed) Model (Robichaud and others 2019). This model uses NRCS Soil Survey data, land cover, land use climate data to predict the potential for soil movement. The model is run using pre-burn conditions, then using the burn severity map to estimate soil loss following the fire. The estimated soil loss per watershed unit area ranges from about 0.25 tons/acre up to 8 tons/acre the first year after the fire, averaging about 5 tons/acre across the burned watersheds of interest. On average this equates to roughly a 5-times increase in potential soil erosion post-fire over undisturbed conditions.

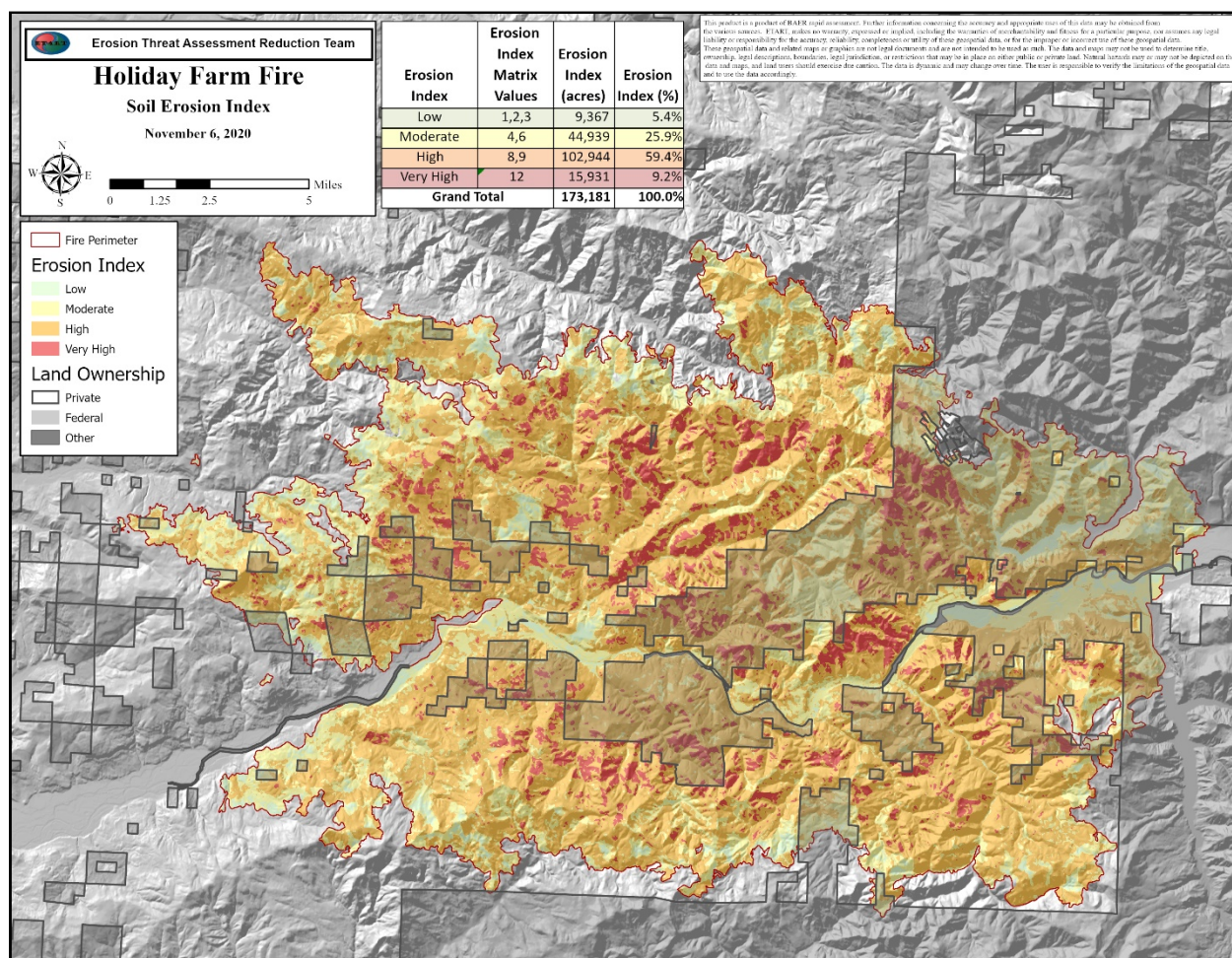


Figure 3. Soil Erosion Index - Holiday Farm Fire

1.2.5. ESTIMATED VEGETATIVE RECOVERY PERIOD (YEARS)

Vegetation recovery varies depending on plant association group, soil type, aspect soil burn severity. Areas that burned at low severity will generally recover within two years. Areas that burned with moderate soil severity may recover the understory and shrub layer in 3-5 years. For areas having high SBS, stand-replacement fire, and loss of overhead canopy from conifer tree species, ecosystem recovery will take up to 2-3 decades.

1.2.6. ESTIMATED HYDROLOGIC RESPONSE

Regional regression equations were used to estimate pre- and post-fire peak flows for a number of watersheds. The greatest increases in peak flows are estimated to be a magnitude 1.5 times over the 5-year recurrence interval (Figure 5). These elevated peak flow responses are predicted for the Simmonds Creek, Cone Creek and Rough Creek watersheds, where 85 to 100% of the source areas were burned at moderate to high SBS. Higher peak flows from these watersheds could lead to damage of road crossings that are unable to pass the additional water and debris. Also, homes along streams such as Gate Creek and Cone Creek maybe at increased risk of flooding.

The analysis of post-fire peak flows should only be used as a tool to better understand relative stream response levels for various drainages throughout the fire area. Post-fire stream response in smaller watersheds tends to be much greater than those in large watersheds because of the relative volume of water it takes to show an amplified increase from pre-fire flow and the spatial scale of continuous high-severity fire patches in relation to the extent of a storm event in the Cascades.

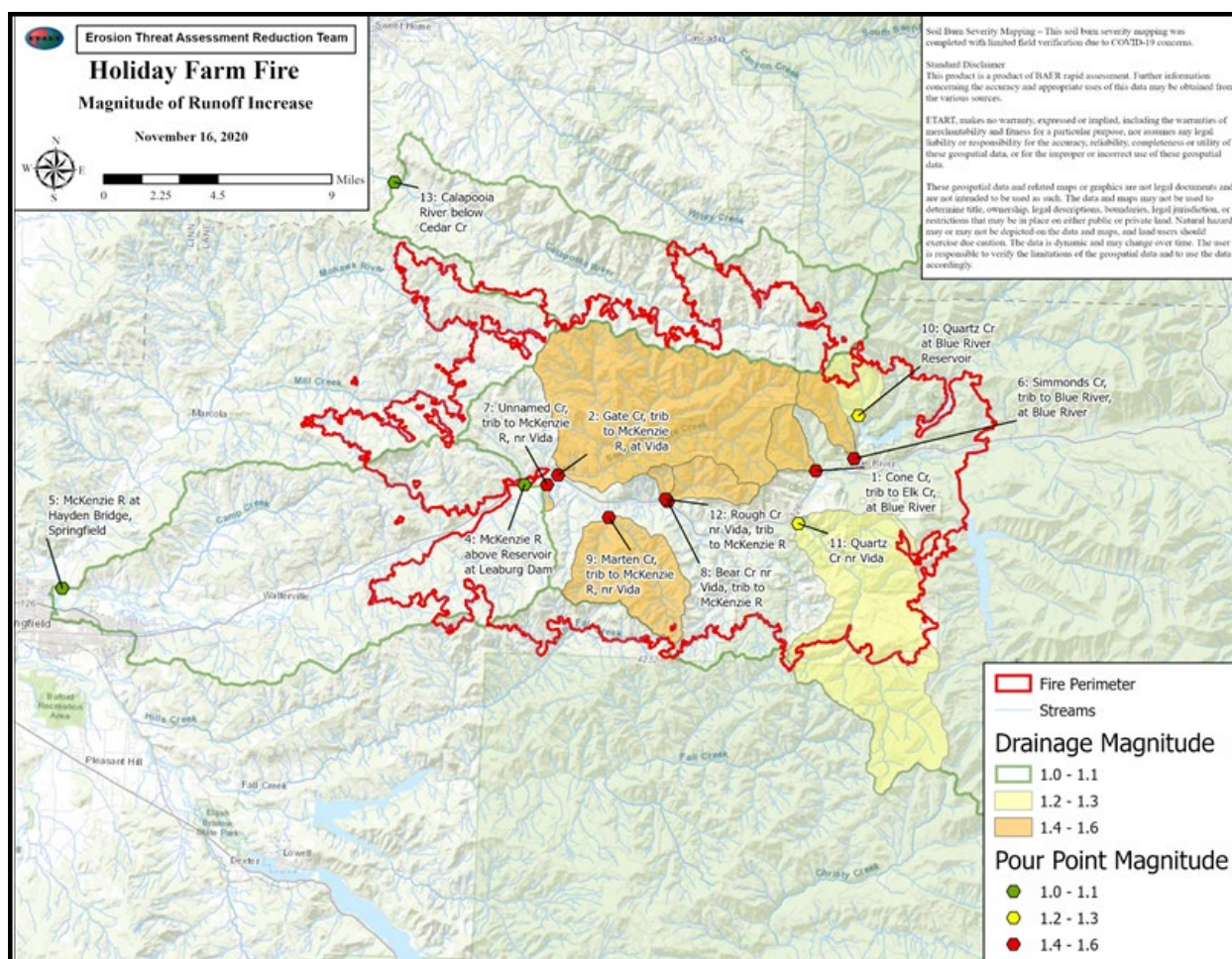


Figure 4. Watershed Response in Runoff Magnitude Increase – Holiday Farm Fire

2. Risk Assessment and Recommendations

The ETART resource groups identified several values having varying degrees and types of threats, which are listed in the ETART Holiday Farm Fire Values Table. The post-fire watershed conditions determined through field assessment and data analysis were used by the ETART to validate post-fire threats and, subsequently, using the Risk Assessment Matrix assign each value a level of risk defined by the probability of damage or loss coupled with the magnitude of consequences (Figure 6). A burned area emergency exists when a value has a rating of “very high” or “high” for all values and an “intermediate” risk for life and safety. These values are prioritized for emergency response or stabilization actions known to mitigate potential threats or minimize expected damage.

Probability of Damage or Loss	Magnitude of Consequences		
	Major	Moderate	Minor
Very Likely	Very High Risk	Very High Risk	Low Risk
Likely	Very High Risk	High Risk	Low Risk
Possible	High Risk	Intermediate Risk	Low Risk
Unlikely	Intermediate Risk	Low Risk	Very Low Risk

Figure 6. Risk Matrix

2.1. Human Life and Safety Summary

2.1.1. HAZARD TREES

Very High risk to motorists along roadways, people near structures, and visitors and employees at recreation areas from falling of hazardous trees killed or damaged by fire. These locations have large numbers of dead and fire damaged trees (>75% basal area (BA) mortality). There is “Very High” risk (likely, major) in areas having 1-75% BA mortality, as well. Although there are generally lower numbers of dead and fire damaged trees, the threat will result in major consequences to human life and safety (and property). Specific locations needing hazard trees mitigated include Blue River Park, Forest Glenn Boat Landing, homes along Gate Creek, Goodpasture road, and Simmonds Creek and Old McKenzie Fish Hatchery and County Park. With respect to travel routes, of the roughly 1,213 of assessed miles on state, county and non-industrial private land (including unspecified private), an estimated 811 road miles have moderate to high levels of basal area mortality, where fire-killed or damaged trees are within falling distance to reach a road. There are roughly 800 acres of hazard trees within a 100-foot buffer surrounding 882 structures. There are 478 structures in areas that suffered 50% or greater basal area mortality. Another 404 structures are located in areas that suffered less than 50% basal area mortality.

Recommendation: Temporary road and sites closures until hazard trees are mitigated, minimize exposure to buildings, fell danger trees within striking distance of roadways and structures. Post hazard warning signs. Inform county emergency management, stakeholders and private landowners. Complete site-specific assessments for specific treatment recommendations.

Available resources for on-the-ground assessment of danger/hazard trees

- OSU Fire Extension has recorded several post-fire webinars. Link to webinars and an extensive summary of available resources: <https://extension.oregonstate.edu/fire-program>.
- ODF post-fire resources, including information on locating stewardship foresters: (<https://www.oregon.gov/odf/fire/Pages/afterafire.aspx>).
- Field Guide for Danger Tree Identification and Response along Forest Roads and Work Sites in Oregon and Washington:
- http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd512960.pdf).
- Post-fire tree mortality assessment and marking guidelines: https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd814664.pdf).

To arrange for on-the-ground training contact ODF or OSU Extension Services. USFS State and Private Forestry also has experts on staff to help with post-fire trainings at the request of ODF.

2.1.2. DEBRIS FLOW, ROCK FALL, AND LANDSLIDES

High risk to life and safety at Lazy Dayz Mobile Home Park, Lucky Boy Road, McKenzie K-12 School in Blue River, Old Scout Road, OR-126, Rough Creek and Rail Creek, Shepard's Landing and McMullen's Landing, Simmons Creek - Blue River Bridge, Town of Blue River, Town of Nimrod, and Town of Vida from debris flows, rock fall or landslides. Portions of the communities and/or facilities are built on past debris flow fan deposits.

Recommendation: Further evaluation is needed to define site-specific threats to values and identify appropriate mitigations. Information sharing with County Emergency Management, communities, and property owners on needs for further evaluation or assessment. Facility closures, education, install hazard warning signs, use weather alert systems or monitoring.

Intermediate risk to life and safety at McKenzie Fire & Rescue Station 16-5 (Nimrod, Local Community) from debris flows, rock fall or landslides. Fire station located downslope of low debris flow hazard where the channel bends in the deposition zone. If debris flow is significant enough, it can avulse channel and deposit material at fire station.

Recommendation: Further evaluation is needed to define site-specific threats to values and identify appropriate mitigations. Information sharing with County Emergency Management, communities, and property owners on needs for further evaluation or assessment. Facility closures, education, install hazard warning signs, use weather alert systems or monitoring.

Intermediate risk to employees and visitors at Blue River Dam (USACE) from rock fall and accelerated erosion.

Recommendations: Repair and maintain current rock safety structure. Fence to catch falling rock from slopes above service road is damaged or at capacity in many places. Fencing above emergency spillway has failed in several spots.

Low risk to life and safety at Ben and Kay Doris State Park, H.J. Morton Memorial Park, Marten Rapids and Thomson Parks, Blue River Community Park, Forest Glen County Park, Gates Creek at Vida, McKenzie Fire & Rescue Station 16-4, School in Vida (K-12), Blue River Dam, Blue River Reservoir, Cougar Dam and Facilities, Cougar Dam Electric Transmission, Leaburg Hatchery, Leaburg Reservoir, Leaburg Dam, and Quartz Creek from debris flows, rock fall or landslides. Portions of the communities and/or facilities are built on past debris flow fan deposits.

Recommendation: Further evaluation is needed to define site-specific threats to values and identify appropriate mitigations. Information sharing with County Emergency Management, communities, and property owners on needs for further evaluation or assessment. Facility closures, education, install hazard warning signs, use weather alert systems or monitoring.

2.1.3. POST-FIRE FLOODING, FLOATING DEBRIS, AND OTHERS

Very High risk to boaters and swimmers in the McKenzie River for floating woody debris and additional “strainers” (woody slightly below the water surface). Debris is already observed in river and volumes are expected to increase.

Recommendations: Signage at boat put-ins, outreach and education, communication and coordination with Marine Safety Board.

Very High risk to visitors and employees at Blue River Park (picnic shelter, play structure, picnic tables, sports fields and hiking trails) from rock fall and soil erosion from steep hillslopes; open vertical 4 foot diameter culvert (south of ball field - no increased risk due to fire); ballfield backstop is damaged; increased danger of rock fall along walking trail that follows left bank of Blue River. Also, potential for increased erosion and unstable streambanks along Blue River, but with streamflow regulated by dam probably not a major concern.

Recommendations: Maintain closure, mitigate hazard trees, signage for rock fall along trail. Signage for unstable banks along Blue River. Fill or remove vertical culvert.

Very High risk to people at Forest Glen Boat Landing from an open vault of an outhouse burned by fire.

Recommendations: Ensure outhouse is secure from entry.

High risk to residents along Gate Creek, adjacent to creek from flooding, debris flow, and erosion. High potential for increased peak flows and flood/debris flow to result in injury or loss of life and impact homes. Two or three homes that survived the fire may be in danger of flooding. Expect increased sediment load to McKenzie River. Bridge looks OK for passing high flows and debris.

Recommendations: Inform county Emergency Management, signage.

High risk to occupants in unburned homes along Gate Creek, Goodpasture road, and Simmonds Creek from hazard trees upslope of occupied structures; from sediment bulked flows impacting riverbanks, erosion, and property boundaries along creek. Some unburned homes remain near the outlet of the confined Gate Creek drainage. Egress for people occupying unburned structures may be trapped by hazard trees during sediment or debris-laden flows during major storm events

Recommendations: Inform of property owner of threats elevating the risks.

2.2. Property Summary

Very High risk to Blue River Road and loss of access from bridge failure, specifically in Simmonds Creek vicinity. Bridge failure or damage will also impact life and safety of community. Increased

runoff, erosion and debris flows from high to moderate SBS flood source area and existing debris in channel is likely to damage bridge footings. Blue River Road, MP 0.45. [Road Treatment Cost Estimates](#)

Recommendations: Excavate floatable debris upgradient of bridge. Storm inspection and response.

Very High risk to stream crossing on Angels Flight Road from increased runoff, erosion, and debris flows, and pond holding back water upstream of culvert. Moderate SBS upstream of small dam ponding water upgradient of culvert. Debris dam could plug 18-inch culvert, washing out the road. Angels Flight Road: 44° 8' 46.75" N; 122° 36' 17.33" W. [Road Treatment Cost Estimates](#)

Recommendations: Remove the dam up-gradient of culvert and replace wooden dam retaining wall structure.

Very High risk to stream crossing on North Gate Creek Road from increased runoff, erosion and debris flows. Travel route is a rural minor collector for residents. Moderate SBS in flood source area upstream culvert, located at bottom of steep slope where debris dam could plug 18-inch culvert and wash out the road prism. North Gate Creek Road: 44° 8' 56.18" N; 122° 32' 51.96" W. [Road Treatment Cost Estimates](#)

Recommendations: Replace crossing using higher capacity culvert. Clean inlet and monitor during storm events.

- Storm Proofing. Clean/pull ditches, clean stream crossing culvert inlets/outlets and relief culverts, run out ditches and catchment basins of sediment, debris and rock. Out slope the road prism where appropriate. Replace or repair damaged culverts pending the need of primary maintainers. Slotted riser pipes or culvert end sections could be installed where feasible and appropriate to reduce the potential for sediment and debris plugging of existing culverts.
- Storm Inspection and Response. Monitor road drainage structures and debris flow treatment structures after significant storm events to ensure the maximum drainage capacity is maintained until the natural revegetation of the burned area has occurred. Maintain and/or repair any damage to road surfaces.

Very High risk to 42-inch culvert at stream crossing of Goodpasture Road from increased runoff, erosion and debris flows. Travel route is a rural minor collector for residents. Moderate SBS in flood

source area, culvert located at bottom of steep slope with large volume of existing debris in channel upstream of crossing. Goodpasture Road: 44° 7' 45.15" N; 122° 30' 17.25" W. [Road Treatment Cost Estimates](#)

Recommendations: Construct debris rack up-gradient of both culverts. Clean inlet and monitor during storm events.

Very High risk for damage to **McKenzie Highway near Finn Rock** from sediment and debris deposition into ditches and to road surfaces. Steep slopes and low post-fire ground cover increase potential for sediment mobilization, in possibly substantial amounts. Highway is a main access route with heavy traffic, and damage would likely be substantial and result in temporary loss of use. Without treatment, the highway would be impacted, increasing risk to human life and safety if the route is needed for emergency egress. [Road Treatment Cost Estimates](#)

Recommendations: Establish vegetation, erosion control matting to stabilize slope.

High risk to property and infrastructure at **Lazy Dayz Mobile Home Park, Lucky Boy Road, McKenzie K-12 School in Blue River, Old Scout Road, OR-126, Rough Creek and Rail Creek, Shepard's Landing and McMullen's Landing, Simmons Creek - Blue River Bridge, Town of Blue River, Town of Nimrod, and Town of Vida** from debris flows, rock fall or landslides. Portions of the communities and/or facilities are built on past debris flow fan deposits.

Recommendation: Further evaluation is needed to define site-specific threats to values and identify appropriate mitigations. Information sharing with County Emergency Management, communities, and property owners on needs for further evaluation or assessment. Facility closures, education, install hazard warning signs, use weather alert systems or monitoring.

High risk for damage to **road prism and stormwater management infrastructure on North Gate Creek Road, Blue River Drive, and Goodpasture Road** from increased runoff, erosion and debris flows. Travel route is a rural minor collector for residents. (North Gate Creek Road, MP 0.0 - 2.42; Blue River Drive, MP 0.0 - 1.55; Goodpasture Road MP 0.0 - 5.03) [Road Treatment Cost Estimates](#)

Recommendations: Clean ditches, remove debris from hazard tree mitigation work. Monitor during storm events.

High risk to **Simmonds Creek county bridge (and residential property)** from flooding and debris flows. Extensive burn of the watershed and expected increase in peak flow and delivery of debris. Bridge opening may not be adequate to pass large debris, potential temporary loss of access without complete loss of infrastructure. No structure burned but looks like drain field was being installed for a new house. Depending on where the future building is placed, it might be impacted by flooding.

[Road Treatment Cost Estimates](#)

Recommendations: Channel clearing, storm patrol, information sharing with USACE and Lane County Emergency Management, and inform upstream residents.

High risk from flooding and debris over-whelming an **18-inch culvert on unnamed drainage on Leashore Drive near Vida (lat. 44.148812, long -122.557092)**. Culvert is already partially blocked by vegetation and burned debris. Low traffic volume but single access for homes farther up road. Undersized culvert may repeatedly clog with debris and form a small impoundment. Directly upstream of crossing is a residential property with an exposed bank that may erode and fail delivering material to culvert; streambank failure not likely to impact the physical integrity of the structure. Downstream of crossing is another residential property with similar streambank concerns.

[Road Treatment Cost Estimates](#)

Recommendations: Clear culvert opening and storm patrol as needed to clear debris and provide functionality of crossing. Information sharing with Lane County Emergency Management and inform upstream residents.

High risk to **Marten Creek bridge on Goodpasture road** from debris flows and accumulation of large woody debris. Bridge deck may not be high enough for passage of large woody debris. High percent of burned area in watershed upstream from crossing, estimated considerable peak flow increase and debris flow probability. Low traffic volume but single access to homes farther up road. [Road](#)

[Treatment Cost Estimates](#)

Recommendations: Clear channel and storm patrol as needed to clear debris and provide functionality of crossing. Information sharing with Lane County Emergency Management and inform upstream residents.

Resources for private landowners

The Natural Resources Conservation Service (NRCS) provides information about actions that can be taken on your private property. Please see [this list of fact sheets \(click here\)](#) for details of different treatment options that can be taken to combat erosion risks.

High risk to **private homes and access road/bridge along Gate Creek and tributaries** from flooding, debris flows and erosion. Analysis indicates considerable increases in post-fire peak flows with the potential for flooding or debris flows to impact two or three homes that survived the fire. Hazard trees are also a threat. Expect increased sediment and debris delivery to McKenzie River. Bridge appears to be located to sufficiently pass high flows and debris.

Recommendations: Inform private landowners. Install hazard warning signs communicating post-fire threats. Hazard tree mitigations, remove downed wood (potentially mobilized debris).

High risk to **private homes along Goodpasture Road** from sediment bulked flows impacting riverbanks and erosion of property boundaries along creek. Some unburned homes remain near the outlet of the confined Gate Creek drainage. Unburned structures may be damaged by hazard trees or sediment and debris flows during major storm events.

Recommendations: Inform private landowners. Install hazard warning signs communicating post-fire threats. Hazard tree mitigations, remove downed wood (potentially mobilized debris).

High risk to **private homes along Simmonds Creek** from sediment bulked flows impacting riverbanks and erosion of property boundaries along creek. Some unburned homes remain near the outlet of Simmonds Creek. Unburned structures may be damaged by hazard trees or sediment and debris flows during major storm events.

Recommendations: Inform private landowners. Install hazard warning signs communicating post-fire threats. Hazard tree mitigations, remove downed wood (potentially mobilized debris).

Intermediate risk for damage to **road prism and stormwater management infrastructure on Blue River Road, Angels Flight Road, Elk Creek Road, North Gate Road, and Goodpasture Road** from increased runoff, erosion and debris flows. [Road Treatment Cost Estimates](#)

Recommendations: Clean ditches and culvert inlets, remove debris from hazard tree mitigation work. Storm inspection and response.

- Blue River Road, MP 0.0 - 1.64;
- Angels Flight Road, MP 0.0 - 1.79;
- Elk Creek Road: 12-inch culvert at 44°9'15.77" N; 122°21'48.43" W;
- North Gate Creek Road: 30-inch culvert at 44°8'56.95" N; 122°33'25.58" W;
- Goodpasture Road: 156-inch culvert at 44°8'2.66" N; 122°33'23.54" W

Intermediate risk for damage to **road prism on North Gate Road** from increased runoff, erosion and debris flows. Travel route is a rural minor collector for residents. Moderate SBS in flood source area can potentially impact 36-inch culvert. Goodpasture Road: 44°8'23.65" N; 122°34'45.52" W. [Road Treatment Cost Estimates](#)

Recommendations: Construct debris rack up-gradient of both culverts. Clean inlet and monitor during storm events.

Intermediate risk to **Highway 126 bridge at mouth of Bear Creek** from flooding, debris flows and erosion. The upstream watershed is extensively burned, has high tree mortality and there are expected increases in post-fire peak flow. Currently the bridge structure is not likely compromised from debris impacts. Upstream of the bridge, the channel has over-steepened banks that may slump into creek and incorporate additional debris. Bridge deck may not be high enough to pass large woody debris. All residential properties nearby are burned. Some home debris may wash into creek from flooding and/or overland flow. [Road Treatment Cost Estimates](#)

Recommendations: Clear channel and storm patrol as needed to clear debris and provide functionality of crossing. Information sharing with Lane County Emergency Management and inform upstream residents.

Intermediate risk to **property at McKenzie Fire & Rescue Station 16-5 (Nimrod, Local Community)** from debris flows, rock fall or landslides. Fire station located downslope of low debris flow hazard where the channel bends in the deposition zone. If debris flow is significant enough, it can avulse channel and deposit material at fire station.

Recommendation: Further evaluation is needed to define site-specific threats to values and identify appropriate mitigations. Information sharing with County Emergency Management, communities, and property owners on needs for further evaluation or assessment. Facility closures, education, install hazard warning signs, use weather alert systems or monitoring.

Intermediate risk to **roads at the mouth of Rough Creek, water diversion infrastructure and the Highway 126 bridge** from flooding, debris flow, and erosion. Very small contributing watershed with undersized box culvert may not pass flood flows and debris. High potential for nuisance flooding and sediment across road, no expected loss of crossing structure. Diversion headgate and a couple footbridges upstream were damaged by fire and may be further damaged by flooding. A residential property burned; some home debris may wash into creek due to flooding and/or overland flow. [Road Treatment Cost Estimates](#)

Recommendations: Clear channel and storm patrol as needed to clear debris and provide functionality of crossing. Information sharing with Lane County Emergency Management and inform upstream residents. For protection of water intakes, increase frequency of inspection and debris removal, and outreach to the public on water usage should the increased loading of sediment and debris require a temporary shutdown. For water intakes at Old McKenzie Fish Hatchery County Park and EWEB-Hayden bridge locations, monitor for damaged infrastructure and clear outlet prior to and after storms. Increased awareness by informing inform stakeholders and private landowners of potential threats and recommended mitigations.

Intermediate risk to **McKenzie Elementary School** from falling hazard trees and rolling debris striking the property. Hazard trees adjacent to the structures and on hillslopes would result in property damage. Elementary school is above adjacent stream floodplains, no threat from flooding.

Recommendations: Inform private landowners. Install hazard warning signs communicating post-fire threats. Remove standing dead trees, chip material and apply to soil as mulch. Re-establish native trees in immediate area and on surrounding hillslopes.

Intermediate risk to **residential property near the mouth of Cone Creek** from flooding and debris flows. Extensive burned area in upstream watershed with expected increased peak flows and high debris flow potential; evidence of prior debris flows. Residential property survived fire but may be in danger from flooding and debris flow. Owner remarked that flood insurance has been purchased.

Recommendations: Remove existing debris from channel likely to be mobilized by flooding.

Low risk for damage to **road prism and stormwater management infrastructure on Elk Creek Road, Leashore Drive, and Elk Rock Place** from increased runoff and erosion. [Road Treatment Cost Estimates](#)

Recommendations: Clean ditches of hazard tree removal debris and monitor during storm events.

- Elk Creek Road, MP 0.0 - 0.378.
- Leashore Drive, MP 0.0 - 0.44.
- Elk Rock Place, MP 0.0 - 0.25.

Low risk to **county access road to Blue River Dam** from increased potential for rock fall from extremely steep slopes (over 60% grade). Very low traffic volume, moving objects. [Road Treatment Cost Estimates](#)

Recommendations: General clearing of road, signage, road storm proofing and storm patrol.

Low risk to **Hatchery Creek water intake for Old McKenzie Fish Hatchery County Park** from hazard trees, flooding and debris flows. Water intake and piping delivers water to impoundments for fish rearing. Minor infrastructure damage expected from adjacent slopes having mixed low and unburned SBS. Access trail has hazard trees.

Recommendations: For protection of water intakes, increase frequency of inspection and debris removal, and outreach to the public on water usage should the increased loading of sediment and debris require a temporary shutdown. For water intakes at Old McKenzie Fish Hatchery County Park and EWEB-Hayden bridge locations, monitor for damaged infrastructure and clear outlet prior to and after storms. Increased awareness by informing inform stakeholders and private landowners of potential threats and recommended mitigations. Remove and cap intake prior to damaging storm. Mitigate hazard trees.

Low risk to **Blue River Dam at mouth of Quartz Creek** from increases in sediment and debris and rock fall and erosion. Analysis indicates erosion and sedimentation, but not expected to compromise sediment structure above Blue River Lake. Two bridges that cross the creek appear adequate to pass flood flows and debris. Adjacent slopes have existing rock fall (small rock and low volume). Fence to catch falling rock above service road is damaged or at capacity in many places. Fencing above emergency spillway has failed in several spots.

Recommendations: Information sharing with USACE on post-fire watershed conditions and sediment delivery. USACE is also concerned about sediment delivery to McKenzie River and potential impacts to Leaburg Dam. While there is potential for increased sediment delivery there are limited options for mitigation. Post hazard warning signs. Repair and maintain current rock safety structure.

Low risk to **McKenzie Schools at Blue River** from erosion off burned, steep slopes. Steep slopes on the north side of the school property may experience increased erosion, but minimal indications for rock fall.

Recommendations: Information sharing with County Emergency Management and school district. Green-up is already occurring. Storm-proofing and storm patrol to Elk Creek Road above the school and encourage natural recovery.

Low risk to property at Ben and Kay Doris State Park, H.J. Morton Memorial Park, Marten Rapids and Thomson Parks, Blue River Community Park, Forest Glen County Park, Gates Creek at Vida, McKenzie Fire & Rescue Station 16-4, School in Vida (K-12), Blue River Dam, Blue River Reservoir, Cougar Dam and Facilities, Cougar Dam Electric Transmission, Leaburg Hatchery, Leaburg Reservoir, Transmission Lines along Lucky Dog Road, Transmission Lines along OR126, Leaburg Dam, and Quartz Creek from debris flows, rock fall or landslides. Portions of the communities and/or facilities are built on past debris flow fan deposits.

Recommendation: Further evaluation is needed to define site-specific threats to values and identify appropriate mitigations. Information sharing with County Emergency Management, communities, and property owners on needs for further evaluation or assessment. Facility closures, education, install hazard warning signs, use weather alert systems or monitoring.

Low risk to **Old McKenzie Fish Hatchery** from erosion and sediment deposition onto the hatchery site. There is a terrace between the hatchery and upslope burned area that is expected to intercept eroded material. If sediment did reach the structure, it may result in property damage.

No treatment recommended.

Very Low risk to **Leaburg Hydropower Canal** from sedimentation. Cogswell Creek flows into the canal between Hwy 126 crossing and Leaburg Dam. Minor amount of watershed burned, there is potential

for some sediment and debris being washed into the canal. Otherwise, moderately steep slopes with low SBS adjacent to canal have residual vegetation to buffer overland flow and sediment delivery.

No treatment recommended.

Very Low risk for **damage to road prism and stormwater management infrastructure on Leaburg Dam Road** from increased runoff and erosion. Travel route is a local residential road. Low SBS in flood source area is unlikely to result in impacts to road ditches and all driveway culverts along entire length of road. Leaburg Dam Road, MP 0.0 - 0.82. [Road Treatment Cost Estimates](#)

Recommendations: Clean ditches of hazard tree removal debris and monitor during storm events.

Very low risk to **county roads along Upper Calapooia River** from flooding. Source area is relatively small with mix of low SBS and unburned land. Although considerable increases in post-fire peak flows are not expected, segments of the county road immediately adjacent to the river have an increased risk of damage from nuisance flooding. There is limited road infrastructure and low likelihood for total loss of access, all affected lands appear to be owned by Weyerhaeuser. [Road Treatment Cost Estimates](#)

Recommendations: Information sharing with Lane County Emergency Management and inform private landowners.

2.3. Soil and Water Summary

High risk to **soil productivity in the Deer Creek, Gate Creek, Trout Creek and Quartz Creek drainages** from accelerated erosion. High and moderate SBS on steep slopes increase potential for loss of topsoil. Ground cover in clear-cut areas may take longer than 2-5 years to establish and decrease longer term erosion.

Recommendations: Further evaluation is needed to define site-specific threats to values and identify appropriate mitigations. Apply mulch, preferably by chipping existing dead vegetation. Re-establish vegetation cover.

Low risk to **surface and ground water quality for domestic and municipal water supplies** from transport of burned debris or leaching of hazardous materials into source waters. Single structure (Indian Creek) likely for debris from burned home being transported downstream, debris field already extends down to the creek. Numerous wells and septic systems were burned over raising concerns for impacts to water quality in the immediate timeframe. Groundwater quality may be threatened burned debris and failed septic systems are not properly mitigated or decommissioned. McKenzie River is a municipal water supply for cities of Eugene, Springfield and other communities or properties along river. Increased concerns for water quality impacts from likely increases in sediment load cause by landslides, erosion and debris flows. EWEB has early warning water quality monitoring upstream of intakes. Assessment team visited EWEB intake at Hayden Bridge, noting the physical structure is unlikely to be impacted by increased flooding attributed to the fire.

Recommendations: Ongoing actions are mitigating the hazardous material threats. Information sharing with County Emergency Management, communities, and property owners. OWRD has a brochure on hazards associated with burned wells and how to address the potential effects.

2.4. Fish and Wildlife Habitat Summary

Very High risk to **T&E fisheries habitat** from water quality impairments (temperature). Loss of riparian shading leading to increased stream temperatures. A number of stream reaches experienced complete or partial loss of trees in riparian areas. This will result in increased solar radiation entering streams until vegetation regenerates. Temperature increases are likely to last multiple years (potentially 10+ years in high burn severity areas) thereby impacting several generations. In a number of locations, stream temperatures during summer were already close to the thermal tolerance limits for fish species. The actual magnitude will depend on future climatic conditions and pace of regeneration.

Recommendations: Work with partners to encourage natural regeneration and/or reforestation with mixed hardwood conifer.

High risk to **T&E fisheries habitat** from water quality impairments (contaminants) in McKenzie River near Mason Creek. Runoff incorporating hazardous wastes from burned buildings and vehicles poses risk to sensitive and aquatic species. A number of urban areas were subject to fire damage and are in proximity to waterways. Efforts to remove hazardous wastes are underway but in some instances surface runoff from rains has already occurred or will occur before wastes are removed. Environmentally persistent contaminants introduced to waterways may have multigenerational impacts. Other more transient chemicals will likely impact one to two generations within the area of exposure.

Recommendations: Work with partners to identify prioritize hazardous waste removal in proximity to waterways.

Low risk to T&E fisheries habitat from water quality impairments (turbidity). Runoff of ash and sediment represents a near-term threat to spawning success for salmonids and lamprey. A large portion of several watersheds containing spawning habitat for salmon, trout and lamprey was burned leaving significant ash deposits. Control measures will not be sufficient to prevent this from entering waterways during rain events. Some areas may experience increased redd failure, but likely there is sufficient alternate spawning habitat to sustain populations.

No treatment recommended.

Low risk to T&E fisheries spawning, rearing and refugia habitat access for ESA-listed species. Increased runoff resulting from lack of vegetative cover may result in higher peak flows leading to increased scour of redds and/or displacement of some species. A number of watersheds experienced high levels of vegetative mortality at mid- to low elevations. Winter forecasts suggest a likelihood of wetter weather. This combination of conditions creates higher likelihood of significant rainstorm/runoff events with impacts are likely to be transient (affect 1-2 generations) and spatially heterogenous.

No treatment recommended.

2.4.1. GENERAL FISH AND WILDLIFE RECOMMENDATIONS

Maintain or Restore Connectivity. Work with partners to identify priorities and options for fish passage at stream crossing; implement aquatic organism passage options at culvert blockages or when replacing culverts. Given the scale of fires and the number of culverts on the landscape, it is likely some culverts were or will be impacted. Restoring passage allows fish to access suitable habitat or refugia if primary habitats are impacted by post-fire events.

Large Woody Debris (LWD). Work with partners to encourage salvage logging practices that retain LWD, to the extent practicable, for recruitment into stream channels. Locations are variable depending on extent of post-fire salvage logging within riparian zone. Many of the rivers and streams have historically low levels of LWD. Maintain standing or dead trees within riparian areas could potentially reset the system and provide substantial long-term benefits in terms of creating suitable habitat for aquatic and terrestrial species. As these trees enter streams and rivers, they create high quality habitat for salmonids.

Riparian Shade. Work with partners to identify artificial revegetation and/or natural regeneration practices that rapidly restore riparian shading. Locations are variable depending on burn severity and extent of active management. Many streams within the burn areas have summer temperatures close to thermal tolerance limits. Allowing a mix of hardwood/conifer in riparian areas promotes more rapid recovery of intermediate shading from hardwoods may be key to ensuring these streams remain suitable during summer in the near term.

Keystone species. Work with partners to identify alternative artificial revegetation and/or natural regeneration practices for long-term beaver habitat. Locations are variable depending on management goals. Promoting hardwood regeneration in riparian areas provides conditions for beaver to construct dams that benefit a range of aquatic species. Beaver are ecosystem engineers that create habitats for many aquatic species, including salmonids. To build dams, beavers require suitable plant materials (typically willow, alder etc.).

Early Seral Habitat in East Lane Travel Management Area (TMA). Work with partners on revegetation for forage and invasive plant management. Reseeding burned areas stabilize soil and decrease the likelihood for debris flows, provide valuable forage for deer and elk and reduce invasive plant species in areas of high vegetation mortality. ODFW is working with private landowners to reseed areas within the East Lane TMA to support soil stabilization and game forage. These areas are chosen because they had high vegetation mortality (91 - 100%) and are a high risk of debris flow.

2.5. Native Plant Communities Summary

Invasive Plant Treatment Design and Cost Estimates

Very High risk to native plant communities and wildlife habitat from expected invasive plant infestations in areas with 50-100% loss of basal area. There are expected widespread impacts to native plant communities across the fire without swift mitigation action. Immediately at risk are areas with exposed mineral soil and/or high vegetation mortality adjacent to established noxious weed infestations. Catastrophic, irreversible impacts to native plants communities are possible if ecosystem modifying weeds, such as false brome, aren't managed quickly near high SBS areas or travel corridors into such areas. False brome can expand 1,200% post-fire, and is currently very limited inside the burn area, often just as occasional roadside clumps (as observed in the Quartz Creek Road/Pond Road (NF-809) area). Areas with high vegetation mortality favor the introduction and expansion of harmful invasive plants as they are high in available nutrients and light penetration to forest floor. Weeds thrive in disturbed areas with little other vegetation present.

Recommendations: Early Detection, Rapid Response (EDRR) to survey and control priority invasive plant and noxious weed species, especially those along active forest roads and highways that could quickly spread quickly into severely burned areas. Quickly mitigate threat of priority weed species such as false brome and knapweed by surveying and treating all affected roadside populations, prioritizing those adjacent to high burn severity/veg mortality.

Mandate vehicle wash station to decontaminate equipment and prevent new introductions. Continue survey and monitoring 3-5 years to control target weed species.

Very High risk to **forestlands used for recreation and timber resources** from expected invasive plant infestations in areas with 50-100% loss of basal area. Forests are used extensively for recreation and timber harvesting. In areas with high vegetation mortality, introduction of invasive species is expected as trucks, vehicles, workers and recreation users access these areas. Irreversible impacts and alterations to forestlands are possible if ecosystem-modifying weeds such as false brome and spotted knapweed are not effectively treated. In addition to the threat of false brome, other species such as knapweed can also substantially alter the forest landscape. Spotted knapweed is known in the power corridor from Quartz Creek to NF-19 and could easily flourish in post-fire disturbance.

Recommendations: Early Detection Rapid Response (EDRR) to survey and control priority invasive plant and noxious weed species that could quickly spread into severely burned areas, especially along active roads and highways. Rapidly mitigate threats from priority weed species such as false brome and knapweed by surveying and treating all affected roadside populations. Mandate vehicle wash station to decontaminate equipment and prevent new introductions. Large populations of false brome exist beyond the eastward extent of burned area, hence the need for vehicle wash station. Continue survey and monitoring 3-5 years to control target weed species.

Very High risk to **H.J. Andrews Research Forest** from expansion of established nearby stand of false brome. The threat potential to the long-term ecological monitoring research forest is increased by fire suppression dozer lines and other suppression-related disturbances. While burn severity is low, disturbance from fire suppression operations is high as winds shifted to the east toward the research forest. HJA Research Forest is one of the original national Long-Term Ecological Research Stations managed cooperatively with OSU and Willamette National Forest. Introduction and spread of weeds could jeopardize continuation of 50-years of existing research.

Recommendations: Early Detection, Rapid Response (EDRR) to survey and control priority invasive plant and noxious weed species. Prevention (decontaminate equipment/personnel gear prior to entering site). Focus survey on suppression lines and known locations of false brome. Quickly contain any outbreaks. Survey and monitor for 5-10 years.

Very High risk to **sensitive plant populations, riparian habitats, floodplains, meadows, and botanical areas** from invasive plant populations and rare plant habitat displacement in areas with 50-100% loss of basal area. (See Botany Specialist Report for notes and maps identifying additional focus

locations.) Significant impacts are anticipated, especially when adjacent to known populations of noxious weeds, exposed mineral soil and increased light penetration to forest floor and riparian zones. Possible irreversible loss of natural habitat should invasive species displace rare plants and associated communities. Riparian habitats affected are particularly poised for threats from weeds as these areas often overlapped with not only high SBS, but also from residential development adjacent to the McKenzie River. Furthermore, segments of the McKenzie Highway closely abut these affected riparian habitats, exacerbating introduction and spread of noxious weeds. Knotweed was observed resprouting vigorously post-fire in an otherwise healthy floodplain near Vida.

Recommendations: Early Detection, Rapid Response (EDRR) to survey and control priority invasive plant and noxious weed species to protect sensitive habitats and T&E occurrences. Prevention (decontaminate equipment/personnel gear prior to entering site). Continue survey and monitoring 3-5 years and control target weeds. Focus should be on areas near sensitive plant populations, riparian habitats, floodplains, meadows and botanical areas in areas with 50-100% basal area loss with invasive plant populations nearby.

Very High risk to **native plant communities and wildlife habitat** from introductions of new invasive plants and/or spread of established local weed populations through fire suppression activities. Fire lines, vehicles and equipment were most certainly introducing and spreading new weeds as the fire spread quickly and vehicle wash protocols may have not been followed prior to fire management activities to protect life and property. Depending on the new weed species introduced, there could be substantial, permanent effects to native plant communities and dependent wildlife. Fire equipment from outside the region was brought in to fight unprecedented fires in Oregon. There is a very high likelihood of new weed introductions, including high priority species that may not previously been in the watershed prior to the fire.

Recommendations: Early Detection, Rapid Response (EDRR) to survey and control priority invasive plant and noxious weed species in areas of fire suppression activity. Survey fire suppression lines starting with the fire perimeter, especially where valued native plant communities warrant protection. Identify any new unfamiliar weeds and control as appropriate. Given variability in seed longevity, monitor for 3-5 years, if possible, but certainly in first two years.

Very High risk to **Blue River Conservation Easement (McKenzie River Trust)** from introduction and establishment of invasive plant species that threaten restoration efforts for native plant communities and instream salmonoid habitat. There has been considerable restoration investment in upper McKenzie Watershed, near the community of Blue River. A majority of the restoration site has 50-100% vegetation mortality. Invasive species are poised to significantly impact native plant and salmon recovery efforts with considerable, long-term effects. Adjacent road corridors, fire

suppression repair activities and known weed populations are all potential sources for weed introduction and spread.

Recommendations: Early Detection, Rapid Response (EDRR) to survey and control priority invasive plant and noxious weed species. Prevention (decontaminate equipment/personnel gear prior to entering site). Continue survey and monitoring 3-5 years to control target weed species.

Very High risk to **Finn Rock Reach (McKenzie River Trust)** from introduction and establishment of invasive plant species that threaten restoration efforts for native plant communities and instream salmonoid habitat. This location has significant restoration investment flanking both sides of the mainstem McKenzie River (South Fork). The area includes a public boat launch and is located adjacent to high voltage utility corridor infested with spotted knapweed. Quartz Creek bridge crosses the project area and serves as primary access point for private timberlands south of the McKenzie River. Adjacent forest roads have isolated patches of false brome that are well poised to rapidly spread into the heavily burned riparian restoration lands and associated floodplains.

Recommendations: Early Detection, Rapid Response (EDRR) to survey and control priority invasive plant and noxious weed species. Prevention (decontaminate equipment/personnel gear prior to entering site). Continue survey and monitoring 3-5 years to control target weed species.

Very High risk to **McKenzie School Restoration Site (McKenzie River Trust)** from introduction and establishment of invasive plant species that threaten restoration efforts for native plant communities and instream salmonoid habitat. There has been considerable restoration investment in upper McKenzie Watershed, downstream of Blue River Reservoir and near community of Blue River. A majority of the restoration site has 50-100% vegetation mortality. Invasive species are poised to significantly impact native plant and salmon recovery efforts with considerable, long-term effects. Adjacent road corridors, fire suppression repair activities and known weed populations are all potential sources for weed introduction and spread.

Recommendations: Early Detection, Rapid Response (EDRR) to survey and control priority invasive plant and noxious weed species. Prevention (decontaminate equipment/personnel gear prior to entering site). Continue survey and monitoring 3-5 years to control target weed species.

Very High risk to **forestland used for recreation and timber production** from new introductions and/or spread of established local weed populations through fire suppression activities. Fire lines, vehicles and equipment were most certainly introducing and spreading new weeds as the fire spread quickly and vehicle wash protocols may have not been followed prior to fire management activities to protect life and property. Fire equipment from outside the region was brought in to fight unprecedented fires in Oregon. There is a very high likelihood of new weed introductions, including high priority species that may not previously been in the watershed prior to the fire. Depending on the new weed introduced, there could be substantial effects to timber production and recreation uses in forestlands.

Recommendations: Early Detection, Rapid Response (EDRR) to survey and control priority invasive plant and noxious weed species in areas of fire suppression activity. Survey suppression lines starting with the fire perimeter, especially where they intersect valued forestlands. Identify new unfamiliar weeds and control as appropriate. Given variability in seed longevity, monitor for 3-5 years, if possible, but certainly in first two years.

High risk to **Pure Water Partnership (PWP) Sites, Lane County Parks and small private properties** from invasive plants. Sites are located along the McKenzie Corridor adjacent to known weed dispersal vectors. Invasive plant species threaten native plant restoration efforts on private properties replanted by PWP partnership. Replanting efforts are expected to have considerable long-term threats from invasive plant species. Properties are currently being assessed for enrollment. Replanting of 100 acres is expected the winter following fire. Prioritization process includes proximity to existing restoration, federal land or BAER sites with high erosion potential.

Recommendations: Early Detection, Rapid Response (EDRR) to survey and control priority invasive plant and noxious weed species. Prevention (decontaminate equipment/personnel gear prior to entering site). Continue survey and monitoring 3-5 years to control target weed species.

High risk to **native plant communities adjacent to roads** throughout fire from introductions and/or spread of established local weed populations through fire suppression activities (see Botany Specialist Report for notes and maps identifying additional focus locations). Fire lines, vehicles and equipment were most certainly introducing and spreading new weeds as the fire spread quickly and vehicle wash protocols may have not been followed prior to fire management activities to protect life and property. Weeds threaten sightlines, integrity, erosion, maintenance needs and longevity of forest roads. Quartz Creek and NF-809 are examples of roads that were used in fire suppression, located near known weed infestations (false brome and spotted knapweed) and service access to several miles of forest road corridor. Weed infestations from these locations are expected to spread easily via the road network to other susceptible locations.

Recommendations: Early Detection, Rapid Response (EDRR) to survey and control priority invasive plant and noxious weed species in areas that were used for fire suppression activity. Mandate vehicle wash stations to minimize weed transfer into and around road networks. Survey road networks, especially those that were used during fire suppression, as well as those near known populations of priority weeds.

Intermediate risk to soil processes and hydrologic function from increased weed pressure will negatively impact soil productivity and water quality (accelerated soil erosion and increased sediment delivery with impacts to water quality). There is expected increased weed presence post-fire, especially in moderate and greater SBS locations and riparian areas. Given severity of fire along the mainstem McKenzie River South Fork, soil & water quality resources will be impacted in the medium – to long term timeframes. Many weeds such as knotweed spread along waterways and exacerbate erosion, sedimentation and turbidity by offering few fibrous roots to support soil. These plants enter dormancy during high flow winter months when vegetation cover is most needed to intercept precipitation. Knotweed is known to occur in the mid to lower McKenzie River and can be transported during high water and flooding events.

Recommendations: Early Detection, Rapid Response (EDRR) to survey and control priority invasive plant and noxious weed species. Prevention (decontaminate equipment/personnel gear prior to entering site). Restore and revegetate valued areas where soil and water quality impacts from weeds are particularly concerning. Survey and monitoring 3-5 years to control target weed species.

Intermediate risk to hiking trails and other trail routes throughout burn area from invasive plant species. McKenzie River trails will likely receive increased visitor interest following fire, exacerbating current problem areas with plant seeds easily transported along them. Trails are considered areas of disturbance and are expected to be impacted by increased weed presence post-fire.

Recommendations: Early Detection, Rapid Response (EDRR) to survey and control priority invasive plant and noxious weed species. Prevention (decontaminate equipment/personnel gear prior to entering site). Install signage and boot brush stations. Continue survey and monitoring 3-5 years to control target weed species.

Low risk to native plant communities and wildlife habitat from new introductions and/or spread of established local weed populations through fire suppression activities. Fire lines, vehicles and equipment were most certainly introducing and spreading new weeds as the fire spread quickly and vehicle wash protocols may have not been followed prior to fire management activities to protect life

and property. Spotted knapweed is known in the power corridor from Quartz Creek to NF-19 and could easily flourish in post-fire disturbance. The burned area provides conditions for other opportunistic, quick growing weeds to establish, threatening safe conduction of electricity in high-power utility corridors.

Recommendations: Early Detection, Rapid Response (EDRR) to survey and control priority invasive plant and noxious weed species in areas that were used for fire suppression activity. Survey utility corridors where threats are expected from fire suppression activities or known weed populations.

2.6. Cultural Resources Summary

Cultural resources are non-renewable and can be adversely affected by post-fire erosion and related events, such as debris flows, tree falls, exposure of sites and artifacts to looting and displacement. In addition, proposed ETART treatments can also affect cultural resources and if federal funds are involved then S.106 consultation with Tribes and the Oregon SHPO must also be addressed. Under the ETART process, attempts were made to engage state and local cultural resource specialists to assist in determining critical values, risks and treatments, however no individuals were available to perform this work due to staffing and project workload factors in several state and federal agencies. In addition, the acquisition of GIS (feature data classes) from the Oregon SHPO for state and private lands in the fire area was not timely and thus fine-grained analysis of site locations as compared to moderate to high burn severity in the fire area could not be performed.

Given the lack of cultural resource personnel and completion of a critical values analysis, we recommend that FEMA, State and local agencies seek to acquire GIS data on archaeological and historic sites directly with Oregon SHPO and then apply the ETART process to determine the cultural resource critical values, perceived risks and propose treatments where the likelihood of success is greatest. What follows are some general guidelines for addressing values, risks and treatments.

Cultural resources reflect varying social, cultural, and scientific values to society at large and to specific cultural groups, such as area tribes. Cultural resources can be categorized into four broad types: pre-contact archaeological sites, historic archaeological sites, historic structures and traditional cultural properties/sacred sites. The fire area contains cultural resources spanning at least the last 10,000 years of time. These features include task-specific activity areas and camps such as sites of spiritual and cultural value to tribes, pre-contact lithic scatters, fishing stations, rock shelters, vision quest sites, historic trails, wagon roads and highways, historic mining and logging features and artifacts, historic structures, recreation and administrative sites.

In order to determine which cultural resources should be considered as “critical values” under ETART, a triage process is used to identify critical heritage values based on their listing or eligibility to the National Register of Historic Place, and scientific or cultural values. Not all cultural resource sites should be considered under the ETART process. Ideally a small group of specialists, including

representatives of interested tribes should prioritize the site inventory to reflect (in order of value) sites listed on the National Register of Historic Places (NHRP), sites determined as eligible to the (NRHP), and sites identified as having traditional cultural or spiritual values to tribes or other ethnic groups. Cultural resource sites that are designated as unevaluated are not automatically considered under ETART, unless their value is exceptional and would likely be easily determined eligible or listed on the NRHP.

Once the above critical values determination is made, a GIS analysis is used to identify their proximity to Moderate or High soil burn severity areas. The BAER risk matrix (Figure 6) is used to determine if stabilization treatments or other protection actions are warranted. Treatments range from point protection to prevent damage from erosion and/or debris flows, mulching or slash dispersal to cover exposed sites having a high likelihood of looting, directional felling of danger trees to prevent damage to archeological deposits or historic structures and treatment effectiveness monitoring. In addition, S.106 compliance is required for other recommended and federally funded ETART treatments that may affect cultural resources.

3. Monitoring and Management Recommendations

Inform stakeholders of risks and advise on threat mitigation recommendations (e.g. engineering teams to inspect culverts and other road infrastructure) and storm alert systems. For hillslope stabilization there are multiple proven treatments effective against low degrees of hillslope erosion: mulching, slash spreading, erosion barriers, wattles, silt fences, debris deflectors, and protective fences.

3.1. Watershed Response and Hydrologic Analysis - Monitoring Recommendations

Modeling suggests that some watersheds affected by the Holiday Farm Fire will experience increased peak flows due to the extent and intensity of the fire. The team recommends installation of one or more near real-time (NRT) precipitation gages in or near the burn area. An NRT precipitation gage provides invaluable information about the localized intensity and amount of precipitation as it happens. Based on these data, the National Weather Service (NWS) can issue alerts to emergency managers, road crews and other partners to warn of increased potential for flooding and debris flows that could threaten lives or damage homes, roads other infrastructure. In addition to improving emergency response, expansion of the precipitation monitoring network would lead to a better understanding of how the amount and timing of runoff change due to fire in mountainous parts of the Pacific Northwest. At present, little information is available in this regard because large, intense fires have been relatively rare in this region.

Another recommendation is for additional stream gages be installed on watersheds within and adjacent to the burned areas. Gages currently exist on the Blue River, the McKenzie River and the South Fork of the McKenzie River, but the catchments measured by these gages were not

extensively burned. It would be beneficial to install new NRT stream gages on smaller, more extensively burned watersheds such as Gate Creek, Bear Creek and Simmonds Creek to provide the NWS and emergency managers with information about potential flooding and debris flows. Also, if gages on these watersheds can be paired with gages on nearby, less impacted watersheds, there's an opportunity to perform paired-watershed analyses to understand impacts of wildfires on hydrologic response. The paired-watershed method can be used to develop a runoff relationship between an experimental (burned) and a control (unburned) watershed. A better understanding of burned-watershed hydrology can assist with future evaluations of post-fire flood magnitude and hydrologic response in ungaged watersheds (Moody and Martin, 2001).

3.2. Geologic Hazards - Management Recommendations

The finding in this report are from a rapid assessment of areas prone to geologic hazards. Most properties identified in this report were not fully assessed. A more complete assessment requires examining the on-the-ground characteristics of each property at risk. In some cases, this report points to high hazard areas that could benefit from "further evaluation", therefore, additional site-specific assessments are recommended. The results of a site-specific evaluation should address protecting homes from the impacts of large debris flows, which may necessitate additional design resources and consultation with engineers that is outside the scope of this evaluation. Engineered debris flow diverting structures were not evaluated by this report. These structures need to be surveyed and designed for specific areas based on site evaluation and criteria.

3.3. Roads and Travel Routes - Management Recommendations

For locations where rock fall may occur, the recommendation is for signs to be posted and for thoroughfares to be cleared and maintained regularly. During storm inspection and response, channel clearing of debris that may be mobilized by flooding recommended at and immediately upstream of road crossings. If failure of a road crossing could result in residents being stranded, it's recommended that county emergency managers be made aware and that signs be posted to educate residents.

Storm Inspection and Response - Continue storm inspection and response until vegetation has reestablished in affected watersheds or for at least a total of two years.

3.4. Fish/Aquatic Habitat - Management Recommendations and Monitoring

With respect to hazard tree mitigations, the primary objective is to ensure exclusion of employees and the public from these sites and to remove the hazard trees. Treatment of large wood is somewhat more complex because it is a beneficial, natural feature in streams. Add to this that many river reaches are difficult for heavy equipment (capable of removing the wood) to access. Thus, the treatment for wood in streams is a combination of good signage and education to warn boaters of the risks posed by large wood. Large wood in impoundments can more easily be treated by removing it, but signage is also important to warn boaters of the risks.

Near-term success in engaging partners can be monitored by number of projects on which engagement occurs. Over the mid- to longer-terms, success can be measured by habitat variables and populations metrics, such as LWD recruitment into stream channels and escapement of salmonids or population counts of terrestrial wildlife.

Resource Reports

1. Weeds Specialist Report

Michelle Delepine, West Multnomah Soil & Water Conservation District, Portland OR

Glenn Miller, Oregon Dept of Agriculture, Noxious Weed Program, Eugene OR

1.1. Summary

1.1.1. OBJECTIVES

- Identify and summarize Critical Resource Values that could be threatened by invasive plant species following fire, based on soil burn severity and vegetation mortality and suppression activities.
- Focus post-fire recovery efforts aimed at preventing, surveying, documenting and controlling invasive plant species.
- Provide framework for strategically deploying resources aimed at protecting Critical Resource Values from the spread of invasive plant species.

1.1.2. CRITICAL VALUES

Native or naturalized plant communities where invasive species or noxious weeds are absent or present in only minor amounts. Critical habitat or suitable habitat for threatened, endangered species. Extensive riparian restoration investment and protection, severely burned forestlands, and rare habitats including oak, meadows, prairies, wetlands and old growth stands, and are at “Very Likely” risk of significant weed threats following fire.

1.1.3. THREATS/RISKS

- Small, scattered infestations of false brome and herb Robert along forest roads and waterways are well poised to rapidly infest forests, timberlands and riparian areas.
- Invasive plant invasion and rare habitat displacement in areas with 50-100% basal area loss.
- Fire prone invasive plants such as false brome and scotch broom pose threat to life and property.
- New introductions and/or spread of established local weed populations through fire suppression activities.
- Electrical power utility corridors crisscross the burn and will allow already established knapweed populations to flourish into adjacent burned forestlands and open areas.
- Debris flow, flooding and erosion may lead to knotweed spread in riparian areas, as well as transport and introduce additional weeds to new areas.

1.1.4. RECOMMENDATIONS

- Prevention is key to limiting spread of weeds. Require vehicle wash station and developing policies that enforce clean equipment and gear. Always use weed-free straw and certified seed with suitable weed content analysis.
- Control already known populations of priority perennial or biennial noxious weeds such as false brome and herb Robert within the burn during the post-fire winter/early spring months when many natives are either dormant or have yet to re-sprout from viable roots. Focus on high traffic corridors such as boat ramps, trailheads, and arterial forest roads.
- Conduct early detection, rapid response (EDRR) survey and control beginning with locations flagged by GIS modelling and analysis.
- Develop public awareness around weed species of concern, identification, signage and public reporting.
- Restore and revegetate valued areas where soil and water quality impacts from weeds are particularly concerning.
- Continue survey and monitoring 3-5 years and control target weeds.

1.2. Critical Values

Critical resource values evaluated include 1) rare habitats, 2) native plant communities, and 3) riparian restoration, parks and protection areas. Additional values are also considered that fall outside these categories. Results are summarized in the *Critical Values Table* (see Appendix B).

Rare habitats: A geospatial review of statewide habitat types (Oregon Biodiversity Information Center 2018) within the burned area found the following rare vegetation types: Oregon white oak habitat, marshes and wetlands, prairies, meadows and certain rare types of old-growth forest. Many of these occur in moderate to severely burned areas.

Native plant communities: Various mixed coniferous and hardwood forest and timberlands are found throughout the Holiday Farm Fire and are vulnerable to invasion of existing and new noxious weed species, particularly stands that experienced severe burn or are located near fire suppression activities. Extensive forest road networks and electrical utility corridors will further exacerbate and accelerate the spread of weeds into forested areas, streamside corridors and other native plant communities.

Riparian restoration, parks and protection: The extensive riparian restoration efforts along the McKenzie and Blue Rivers, managed by local entities such as the McKenzie River Trust, Lane County Parks, and the Pure Water Partnership, are also at risk. Unfortunately, a significant proportion of these project areas lie within zones of high vegetation mortality. Special management considerations need to be made to secure these restoration investments.

1.3. Resource Setting

Pre-fire: The McKenzie River Corridor is characterized by diverse uses including private timber production, recreation (fishing, boating, hiking), hydropower generation and residential uses (year-

round and second homes). The McKenzie River flows west from the Cascade Range toward the Willamette River and is fed by numerous smaller rivers and creeks. The Blue River and Cougar Reservoirs are located in the mid-upper watershed and the Leaburg Reservoir is in the lower-mid watershed. Floodplains, riffles and other important hydrologic and salmonoid habitat features can be found throughout the watershed.

Post-fire: Historic low fuel moisture, low humidity and high winds contributed to rapid spread from the Holiday Farm Fire's ignition point near Rainbow, Oregon westward through the settlements of Blue River, Nimrod and Vida towards Leaburg. Fueled by 50mph winds, flames were quickly fanned across the landscape on either side of the mainstem of the McKenzie River, engulfing numerous residential settlements along the river in the process, as well as riparian restoration sites. All three of the McKenzie River Trust restoration sites within the fire were burned severely, as well as numerous Pure Water Partnership riparian projects. In all, over 173,175 acres burned through a mix of federally and privately managed forests, small private ownerships, county parks and community settlements.



Figure 5 Clockwise from top: McKenzie River (South Fork) near Vida with vernal pools (top center), Extensive vegetation mortality in timberlands (bottom right) near Quartz Creek, Blue River Reservoir with mosaic burn severity (bottom left)

1.4. Methodology

This post-fire invasive plant assessment follows similar protocols to the Burned Area Emergency Relief (BAER) review process used by the Forest Service. The following is an outline of steps:

1. Identify critical values
2. Assess threats (field & geospatial analysis)
3. Evaluate risk
4. Develop recommendations
5. Implement locally

This assessment builds on a collaboration of local knowledge, field reconnaissance and GIS analysis carried out by federal partners. First, critical resource values (e.g. native plant communities, timber production, recreation etc.) that could be threatened by invasive plants were identified. Next, threats to these values were assessed by both field and geospatial analyses. A qualitative field assessment was conducted on November 7th, 2020 focused on riparian areas along the McKenzie River corridor, forest roads south of Quartz Creek bridge, the McKenzie River Trust Finn Rock Reach restoration site, and Blue River. For the geospatial analysis, a broad source of existing datasets (see *References section for data sources*) were reviewed with respect to fire severity maps to determine appropriate model inputs. The final model provided recommended EDRR weeds survey and treatment areas based on intersecting 50-meter buffer proximities to the following parameters: known weed presence, natural vegetation protection areas, and fire severity with greater than 50% basal area losses (i.e. vegetation mortality). Fire suppression lines were also identified and mapped.

For the third step, risks to the critical values being assessed were evaluated using the BAER Risk Matrix that considers “probability of consequence” with “magnitude of loss.” (See Appendix B/Holiday Farm Fire VAR Table attachment). Finally, recommendations were developed to mitigate any of the threats to the critical values that were “Very Likely” to occur.

1.5. Results

1.5.1. SUMMARY

There is an imminent threat of widespread expansive growth of false brome, herb Robert and spotted knapweed, in addition to other more regionally widespread noxious weeds. False brome, herb Robert and knapweed are present within the heart of the burn, but currently can only be found sporadically within the fire reaches. False brome and herb Robert can be found in small numbers along forest roads adjacent to medium and high severity burn classes where no understory vegetation currently exists. Spotted knapweed is present in the primary utility corridor within the burn area and is well suited for opportunistically invading areas disturbed or left unvegetated following the fire. There is an urgent and immediate need for addressing these seed source populations before they can drastically, and permanently, alter post-fire vegetation recovery.

Additionally, riparian areas are also at widespread risk of knotweed invasion and other aquatic-related invasive plants. Current populations in the mid-reach McKenzie River appear minimal but are already resprouting vigorously following fire despite typically entering fall dormancy. Debris flow, winter high water, and erosion from denuded burned areas will likely carry knotweed propagules to new streamside areas.

1.5.2. FIELD ASSESSMENT RESULTS

Post-fire field assessment found many persistent weeds in all burn classes, including those with severe vegetation mortality. While these include many species common at the landscape scale, some are only found with limited regional distribution including false brome, herb Robert, shinyleaf geranium, spotted knapweed, and knotweed. These warrant special priority and focus during post-fire survey, recovery and mitigation.

False brome (*Brachypodium sylvaticum*): Most concerning of these priority weeds are scattered small patches of false brome lining forest roads (such as those along the McKenzie River accessible from the Quartz Creek Bridge, as well as Blue River Reservoir near the HJA Andrews Research Forest – a threatened Critical Resource Value). False brome infestations build up flash fuels of dead leaf



Figure 6 False Brome in Vida

thatch than can drive & perpetuate high severity fire regimes (Pausas & Keeley 2009). While overall there did not appear to be high quantity of false brome coverage, it is very well poised to spread rapidly into adjacent burned areas. Previous studies have found false brome to increase over 1200% in weed cover density following fire, especially under conditions similar to those of the Holiday Fire where quickly moving fire greatly reduces competition from other plants (Poulos & Roy 2015). This is especially alarming given that current limited distribution of false brome is well-poised to explode across the burn areas if left unmanaged. False brome cover seems to be even more problematic in riparian corridors. In addition to preventing seedling establishment, false brome tolerates a wide range of conditions and can flourish in open and closed-canopy habitats to the point of "near complete exclusion of other herbaceous vegetation (Kaye 2011)." This trait allows false brome to invade recently

burned areas and persist under forest cover. False brome is not palatable to livestock, offers little wildlife value and directly displaces threatened species such as Kincaid's lupine (a critical host for the endangered Fender's blue butterfly species).

False brome Identification & Management Options: <https://appliedeco.org/wp-content/uploads/brsybrochure.pdf>



Figure 7 Spotted knapweed, pre-fire McKenzie River Valley Courtesy of Glenn Miller (ODA)

Spotted knapweed (*Centaurea stoebe*): Local ODA Noxious Weed Program Specialist Glenn Miller (pers. comm 2020) reports extensive knapweed populations along the high voltage electrical corridor from Cougar Reservoir to at least Quartz Creek. Much of this area is heavily disturbed due to pre-fire conditions and fire suppression activities, and cuts through timbered areas with very heavy vegetation mortality and soil burn severity. Knapweed seed is especially long-lived in the soil and is tolerant of fire. Dried knapweed seed can also easily be transported on equipment and thrives in disturbed habitats. Dispersal of knapweed from utility corridors, roadways and suppression lines is expected and should be anticipated in post-fire recovery planning.

Spotted knapweed Identification:

<https://bentonswcd.org/plant/spotted-knapweed/>

Management Options: <https://your.kingcounty.gov/dnrp/library/water-and-land/weeds/BMPs/Spotted-Knapweed-control.pdf>



Figure 8 Herb Robert with mature seed on NF-805

Herb Robert (*Geranium robertianum*) and shinyleaf geranium (*Geranium lucidum*): Both of these species are capable of rapidly establishing along roadsides, trails, and other edge habitats. Once present they rapidly expand into the surrounding landscape and are very difficult to control on a large scale once established. Care needs to be taken to identify isolated populations and quickly control them. Only one occurrence of herb Robert was documented during the field assessment (NF-805) but is reported to be present in small quantities inside the burn area. Shinyleaf geranium is substantially much more difficult to control and is not currently known to be inside the fire. Nearby populations exist and can easily be introduced from established infestations elsewhere.

Herb Robert Identification & Management Options:

<https://www.kingcounty.gov/services/environment/animals-and-plants/noxious-weeds/weed-identification/herb-robert.aspx>

Shinyleaf geranium Identification & Management Options:

<https://www.kingcounty.gov/services/environment/animals-and-plants/noxious-weeds/weed-identification/shiny-geranium.aspx>



Figure 9 Knotweed in mid-McKenzie River (South

Knotweed (*Fallopia japonica*): Knotweed is primarily a threat to riparian resources, including the riparian restoration sites identified in the Critical Values table. Infestations can also thrive in disturbed upland areas, such as suppression lines. The field portion of the assessment found knotweed within a moderate severity burn class resprouting vigorously along the mainstem of the McKenzie River (South Fork), immediately downstream of several destroyed residential properties and within an otherwise intact seasonal floodplain dotted with vernal pools and native riparian vegetation.

Knotweed Identification & Management Options: <https://columbiagorgecwma.org/weed-listing/best-management-practices/knotweeds/>

Clematis/Traveler's Joy: *Clematis vitalba* (also known as traveler's joy) is identified as a local priority management target within the fire due to its current limited distribution (Weybright, pers. Comm. 2020). This light-seeking vine forms dense vegetative mats that can quickly overtop and kill vulnerable seedlings and even small to medium-size trees. It thrives in disturbance, edge habitats and in part to full sun. The post-fire landscape is ideal for supporting its spread, which should be a concern for restoration and post-fire planting recovery efforts.

Clematis Identification & Management Options:
<https://your.kingcounty.gov/dnrp/library/water-and-land/weeds/BMPs/Old-mans-beard-Clematis-vitalba-control.pdf>

Additional Weeds: Many other more common and regionally abundant species were also found during the field assessment including Scotch broom, Himalayan and Cutleaf blackberry, English/Irish ivy, reed canarygrass, Canada thistle, English holly, foxglove and others. Some of these may also be local priorities for control such as English/Irish ivy which is expanding along the McKenzie Corridor (Alverson, pers. Comm) but not found often elsewhere in the watershed. Scotch broom may also warrant increased priority status given its fire hazard risk and expected expansion in burned areas. While not currently documented in the fire area, garlic mustard is a species of significant ecological and management concern in the Pacific Northwest (<https://www.portlandoregon.gov/bes/article/472724>; https://4ccwma.files.wordpress.com/2018/02/ipm_18_garlicmustard-web.pdf). A list of priority weeds identified for the greater Upper Willamette Cooperative Weed Management Area can be found in [Appendix B](#).

The BLM Holiday Biological Resources Assessment documented a total of 291 acres of weeds within the fire area. A list of species analyzed in this report can be found below. These species thrive in disturbance at varying light intensities and should be considered important threats during the post-fire vegetation survey and analysis.



Scotch broom
(Cytisus scoparius)



Himalayan
blackberry (Rubus
armeniacus)



Reed canarygrass
(Phalaris
arundinacea)



English (Irish) ivy
(Hedera helix)

Weed species documented near Quartz Creek/McKenzie River along forest roads

Table 1. Invasive Species Known to Occur Within the Fire Perimeter (BLM)*

Scientific Name	Common Name	State Classification
<i>Brachypodium sylvaticum</i>	false brome	B
<i>Brachypodium distachyon</i>	purple false brome	N/A
<i>Polygonum cuspidatum</i>	Japanese knotweed	B
<i>Onopordum acanthium</i>	Scotch thistle	B
<i>Cirsium arvense</i>	Canada thistle	B
<i>Centaurea diffusa</i>	diffuse knapweed	B
<i>Centaurea stoebe</i>	spotted knapweed	B, T
<i>Cirsium vulgare</i>	bull thistle	B
<i>Cytisus scoparius</i>	Scotch broom	B
<i>Rubus armeniacus</i>	Himalayan blackberry	B
<i>Hypericum perforatum</i>	St. Johnswort	B

*Source: Bureau of Land Management Biological Assessment

Table 2. Invasive Species Known to Occur Within the Fire Perimeter (USFS)*

Invasive Species on Forest Service lands	acres	Risk of spread
False brome (<i>Brachypodium sylvaticum</i>)	96.6	Very High
Armenian blackberry (<i>Rubus armeniacus</i>)	278	Very High
Spotted knapweed (<i>Centaurea biebersteinii</i>)	77.4	Very High
Canada thistle (<i>Cirsium arvense</i>)	42.8	Very High
Scotch broom (<i>Cystisus scoparius</i>)	200.6	Very High

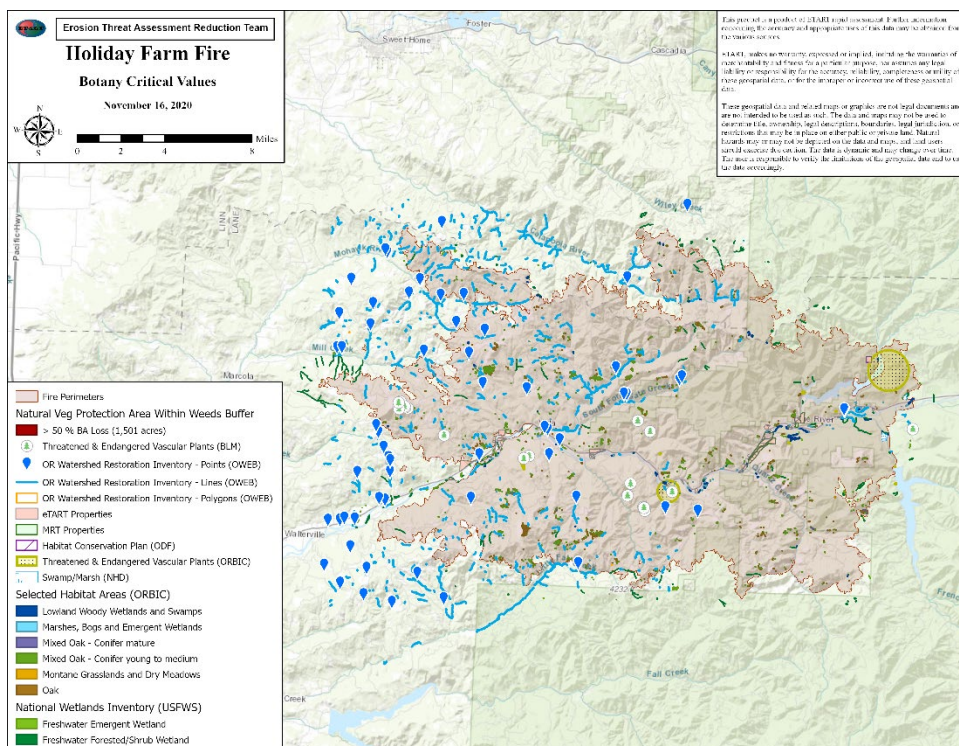
*Source: USFS - Willamette National Forest BAER Report for Holiday Farm Fire

1.5.3. GEOSPATIAL ASSESSMENT RESULTS

Natural vegetation protection areas: Sensitive, threatened, rare or other critical habitat types present within the fire were analyzed using habitat data published by the Oregon Biodiversity Information Center (2018). Selected habitats within the Holiday Farm Fire for consideration in the geospatial analysis include the following:

- Threatened & Endangered Vascular Plants
- Lowland Woody Wetlands and Swamps
- Marshes, Bogs and Emergent Wetlands
- Oak Habitat, Mixed Oak – Conifer
- Montane Grasslands and Dry Meadows

Additional wetland layers from the National Wetlands Inventory published by the US Fish & Wildlife Service were also included in the analysis.



Map showing locations of critical values threatened by invasive plants within the McKenzie River Valley and Holiday Farm Fire.

Burn severity and vegetation mortality

In all, a total of 15,206 acres of private ownership and 37,369 acres of industrial timberland was moderately to severe burned.

Basal area loss	Private ownership	Industrial timberland
91-100%	8,328 acres	23,007 acres
76-90%	2,774 acres	6,193 acres
51-75%	4,103 acres	8,169 acres
Total area >50% loss	15,206 acres	37,369 acres

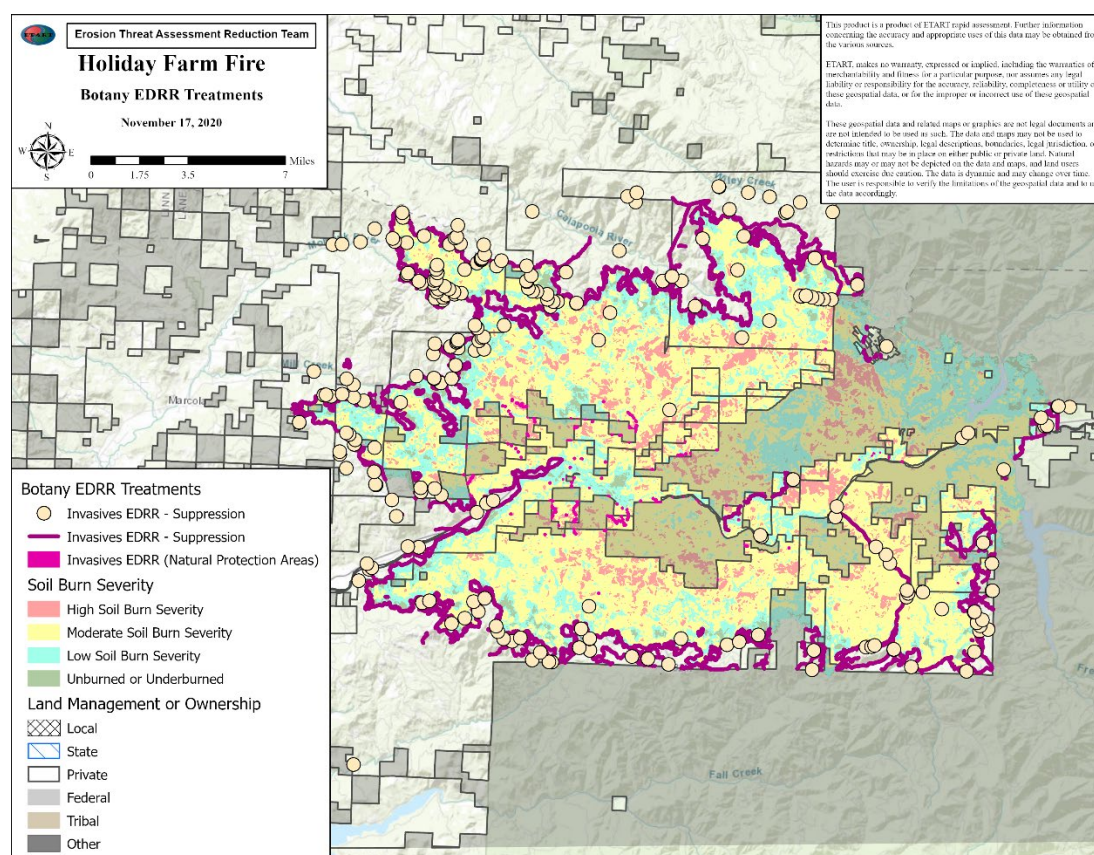
Acres of known weeds

Known weed infestations that have been documented in iMap Invasives and Oregon Dept of Agriculture Weedmapper total 262 acres of private or commercial property within the fire. There are almost certainly more acres affected that are not documented formally.

Areas identified for Early Detection, Rapid Response survey and treatments

Priority sites for initial survey and detection work are those within at least 50% basal area loss in proximity to the identified sensitive habitat types of concern and/or documented weed infestations. A total of 433 acres were flagged that met those parameters. These areas should be prioritized for survey efforts, ideally in both the spring and fall (at least the first year) and revisited annually during the mitigation period (3-5 years) as resources allow. This analysis should serve as a starting place for survey work. If more resources become available, additional areas should also be surveyed for weed presence in the context of spatial relationship to critical resource values.

Additionally, fire suppression lines and activity points such as staging areas, command stations, equipment storage, helipads and safety areas should also be surveyed for the presence of new weed introductions to the watershed.



Map showing recommended EDRR survey and treatment areas based on the geospatial analysis of vegetation mortality, sensitive natural habitat protection areas, and existing weed populations. Areas of fire suppression activities such as dozer lines should also be surveyed.

Fire suppression activities: All fire suppression lines should be assumed to be potential sources of new weed introductions and spread. Weeds thrive in disturbed areas with increased light availability such as fire lines. Equipment and personnel to fight the fire were mobilized from across a broad geography and due to the quick progression of the historic fire it should be inferred that many new

weed seeds will be brought into these areas. Highest priority lines to survey are dozer lines along the fire perimeter, followed by affected roads. In total, there were 56.6 miles of dozer line, 32 miles of hand line, 87 miles of road and 2 miles of road repair located on non-federal lands calculated in the analysis.

Fire Suppression Lines	Lands Managed by Private Industry	Private Individual or Company	Grand Total
Completed Dozer Line	23.07	33.62	56.69
Completed Hand Line	10.32	21.77	32.08
Road as Completed Line	48.36	39.15	87.51
Road Repair	0.18	1.88	2.06
Grand Total	81.93	96.41	178.35

1.6. Recommendations

Recommended early detection, rapid response (EDRR) survey and treatment areas take into account known weed infestations, sensitive natural habitat types, rare plants, fire suppression lines and existing riparian restoration investments. The result of this assessment are recommended actions to take to protect the identified critical resource values to reduce the threat of weeds during post-fire recovery efforts. Costs estimated for implementing recommendations are included in Appendix B, Section III.

Prevent Spread of Existing Weed Infestations

Threats: Numerous vectors capable of spreading existing weed infestations exist within the burned area of the Holiday Farm Fire. Both the McKenzie Highway (OR-126) and the McKenzie River run the length of the burned area from east to west. Several other well-known pathways also exist within the fire area, including public and private forest roads, trails and drainages. Furthermore, the widespread use of straw and seed in post-fire recovery efforts can easily lead to the unintended introduction of *new* weeds.

Risk: Very High

Solution: Mandate vehicle wash station for vehicles travelling into burned areas along forest roads. Implement and enforce clean equipment, footwear and gear policies. Ensure straw and seed mixes used in post-fire recovery come from reputable sources (use certified weed-free straw to the maximum extent possible). Only use seed that has documented weed analysis with values less than 0.5%.

Recommended Timeframe: Beginning immediately and throughout course of mitigation efforts until at risk areas can be revegetated with suitable native vegetation.

Control Known Noxious Weeds

Threat: Both established and new introductions of weeds are at risk of rapid expansion into moderate and severe burned areas. Species such as false brome, herb Robert, spotted knapweed and knotweed are known within the burned area in limited distribution but are well-poised to rapidly spread with increased soil nutrient and light availability, fire disturbance and increased vehicle traffic/vector potential. Additional not yet detected species may be of even greater concern. Common species such as scotch broom, blackberry, ivy, herb Robert, foxglove, reed canarygrass, and several others also threaten the numerous Critical Values identified in this assessment.

Risk: Very High

Solution: Control known populations of priority perennial or biennial noxious weeds such as false brome and herb Robert within the burn area as soon as temperatures start to warm to 50F in the early spring while many natives are either dormant or have yet to resprout from viable roots. Focus first on high traffic corridors such as boat ramps, trailheads, and arterial forest roads. Timely attention should also be given to any new or threatening infestations near sensitive natural habitat protection areas such as oak, meadow, wetlands and T&E habitat as soon as possible once they have been observed.

Recommended Timeframe: Immediately or beginning very early in the spring. Certain target species such as false brome and herb Robert can effectively be managed over winter if temperatures are at least 50F during treatment. Winter or very early spring treatments will also reduce off-target impacts to beneficial native plants that are dormant or have yet to resprout from roots following fire. Control other priority species as they are detected during survey efforts.

Survey High Risk Areas

Threat: The newly burned soil is vulnerable to rapid establishment of noxious weeds and invasive, non-native plants. Add to this the presence of 56 miles of new dozer lines, (areas of soil disturbance), and 32 miles of hand lines, and it is clear that without prompt action, the potential for an explosion of invasive weeds on high and moderately burned soils, along with the dozer and hand lines is extremely high. This is especially a concern in locations near rare natural habitats and known weed presence.

Risk: High

Solution: Conduct early detection, rapid response (EDRR) survey and control beginning with locations flagged by GIS modelling and analysis. These areas have been prioritized due to their proximity to known weed locations (50 m buffer), potential to impact adjacent sensitive habitat types (i.e. “Natural Vegetation Protection Areas”) and presence within severe burn areas. An additional 56 miles of dozer lines and 87 miles of road are also flagged for survey and control.

Recommended Timeframe: New weed introductions from fire activities are best detected during growing season months beginning Spring 2021. Dozer lines surveys should commence the first growing season (May – August 2021), and potentially through years 3-5, if resources are available. Road surveys should begin immediately where source populations and/or vector movement are a concern (i.e. arterial forest road networks). All roads used as fire lines should be surveyed at least once by August 2021 and surveyed annual if possible, through years 3-5.

Develop public awareness

Threat: Not enough resources to effectively monitor all potential areas for priority weed establishment. Fire and invasive plants do not adhere to property boundaries. Overlooked new infestations are likely to occur outside even the most comprehensive monitoring strategy, especially when so many properties are held in different ownership. As these infestations grow, they threaten critical resource values elsewhere in the fire.

Risk: High

Solution: Install signage at popular informational community gathering hubs alerting private individuals to priority invasive species. Consider posting to local forums such as social media and newsletters (e.g. River Reflections). If funds are available, consider posting roadside sign at west and east entrances to burn area. Install boot brushes and invasive species signage at boat ramps and trailheads. Encourage reports be made to OregonInvasivesHotline.org and assign local weed management contacts to receive alerts when a community report is made.

Recommended Timeframe: Information should be shared early. Ideal months for awareness campaigns are in the spring and summer. Monitor boot brush stations and signage and maintain if necessary.

Revegetate to Promote Resiliency

Threat: Restore and revegetate valued areas where soil and water quality impacts from weeds are particularly concerning. The post-fire landscape will continue to be favor the establishment of weeds for years following fire.

Risk: High

Solution: Emergency mitigation efforts to suppress weed establishment and expansion will be more effective in the long-term if susceptible areas with high vegetation mortality are revegetated quickly with suitable competitive native plant material. Restoration will also improve soil and water quality. *Note*, given the quick movement of fire it is likely that many understory plants will resprout from the roots. Be sure to account for the possibility of *passive revegetation* where appropriate but balance this approach with ensuring that weeds are not permitted to gain the upper hand before native plants are allowed a chance to resprout. Monitor, evaluate and perform maintenance as needed for desirable native vegetation to become established.

Recommended Timeframe: Years 1-5, and beyond if maintenance needs are still required. Monitor annual until native plants are established.

Continue survey and monitoring efforts

Conduct the above listed monitoring and follow up for 3-5 years and control target weeds. Evaluate efficiency, identify any gaps in the approach, modify and adapt management methods appropriately for desired outcomes and protection of critical resource values.

Consultations

Glenn Miller, Oregon Department of Agriculture, Noxious Weed Program

Ed Alverson, Lane County Parks

Jared Weybright, McKenzie Watershed Council

Kathy Pendergrass, Natural Resources Conservation Service, Oregon Plant Material Specialist

Sarah Callaghan, United States Forest Service, Columbia River National Scenic Area, Hood River, OR

Geospatial Modelling and Map Publications by Sean Carroll, US Corps of Engineers, Portland NWP

References

Alverson, Ed, Lane County Parks, Personal Communication, Email, 11/19/2020

Bureau of Land Management, Biological Assessment, Holiday Farm Fire 2020

Kaye, Tom, “Invasive Plant Alert False-brome (*Brachypodium sylvaticum*) - False Brome Working Group” <https://appliedeco.org/wp-content/uploads/brsybrochure.pdf>, 2003, updated 2011.

Miesel, Jenny and Rebecca McCoun, 2020 ETART Beachie Creek Weed Specialist Report

Oregon Biodiversity Information Center (ORBIC): <https://inr.oregonstate.edu/orbic>

Oregon Conservation Strategy Habitats <https://www.oregonconservationstrategy.org/strategy-habitats>

Oregon Explorer: <https://oregonexplorer.info/content/molalla-pudding-watershed?topic=56&ptopic=98>

Oregon Dept of Agriculture Noxious Weed Policy 2019,
<https://www.oregon.gov/oda/shared/Documents/Publications/Weeds/NoxiousWeedPolicyClassification.pdf>,
accessed 11/19/2020

Oregon Department of Fish and Wildlife Conservation opportunity Areas (Online reference).
<https://www.oregonconservationstrategy.org/conservation-opportunity-areas/>

Pausas, J.G. & J.E. Keeley. 2009. A burning story: the role of fire in the history of life. *Bioscience*. 59: 593-601.

Poulos, Lauren P. & Bitty A. Roy. 2015. Fire and False Brome: How do prescribed fire and invasive *Brachypodium sylvaticum* affect each other? *Invasive Plant Science and Management*. 8(2): 122-130.

USFS - Willamette National Forest BAER Report for Holiday Farm Fire 2020

2. Engineering Report

2.1. Objectives

The Holiday Farm Fire started on September 7th, 2020 and burned over 173,390 acres of eastern Lane County, as of October 12th, 2020). Over 20 miles of Lane County roads were either impacted by the fire or fire activities. The purpose of the engineering investigation was to assess potential negative effects on roads, culverts and bridges attributable to the post-fire condition of the watersheds.

Due to the scale of the fire, field investigations involved a rapid visual inspection of public infrastructure within the right of way and from burn severity maps of private land that drains across the public right of way. Field investigations of existing Lane County roads within the boundaries of the Holiday Farm Fire located in Lane County occurred from October 28th – 29th, 2020 and generally followed the USDA Forest Service Burn Area Emergency Response (BAER) process.

In general, the fire has reduced the stability of the slopes due to the loss of vegetation and their associated root structure. Additionally, the ash or organic debris generated by the fire event has added depth to the pre-existing over-burden. Ash and organic debris tend to reduce the cohesion of soils, further increasing the potential for sliding, sloughing or flowing, especially during wet-weather conditions. These conditions are expected to result in increased sedimentation, woody debris, and runoff volume at road and stream crossings. This report will provide a general summary of the values at risk, observations and findings, and recommendations resulting from the investigation to mitigate the adverse effects of the Holiday Farm Fire to Lane County infrastructure.

This report solely examines the expected risks associated with erosion potential. It does not address effects to the roadway directly from the fire such as road damage due to burning.

2.2. Observations

The Holiday Farm Fire burned mostly in private timber land but also sadly within small communities. Several Lane County roads that serve these communities were impacted which is the focus of this report. Two Lane County staff along with an employee of the USDA Forest Service assessed culverts and bridges within the burn area and came up with recommendations to mitigate further post fire damage to Lane County infrastructure. The following roads were assessed:

Road Number	Road	Miles	Maintenance Level	Classification
108800	Leaburg Dam Road	0.71	AC Pavement	Rural Local
109000	Angels Flight Road	1.79	AC Pavement	Rural Local
109500	Leashore Drive	0.44	AC Pavement	Rural Local

Road Number	Road	Miles	Maintenance Level	Classification
109400	Goodpasture Road	5.03	AC Pavement	Rural Minor Collector
109600	S Gate Creek	0.17	AC Pavement	Rural Local
109700	N Gate Creek	2.42	AC Pavement	Rural Minor Collector
109900	Thomson Lane	0.25	AC Pavement	Rural Local
196200	Conley Road	0.21	Gravel	Rural Local
110700	Eagle Rock Drive	0.11	AC Pavement	Rural Local
110100	Eagle Rock Place	0.25	AC Pavement	Rural Local
110500	Blue River Drive	1.36	AC Pavement	Rural Minor Collector
110600	Elk Creek Road	0.38	AC Pavement	Rural Local
110200	Blue River Road	1.64	AC Pavement	Rural Local

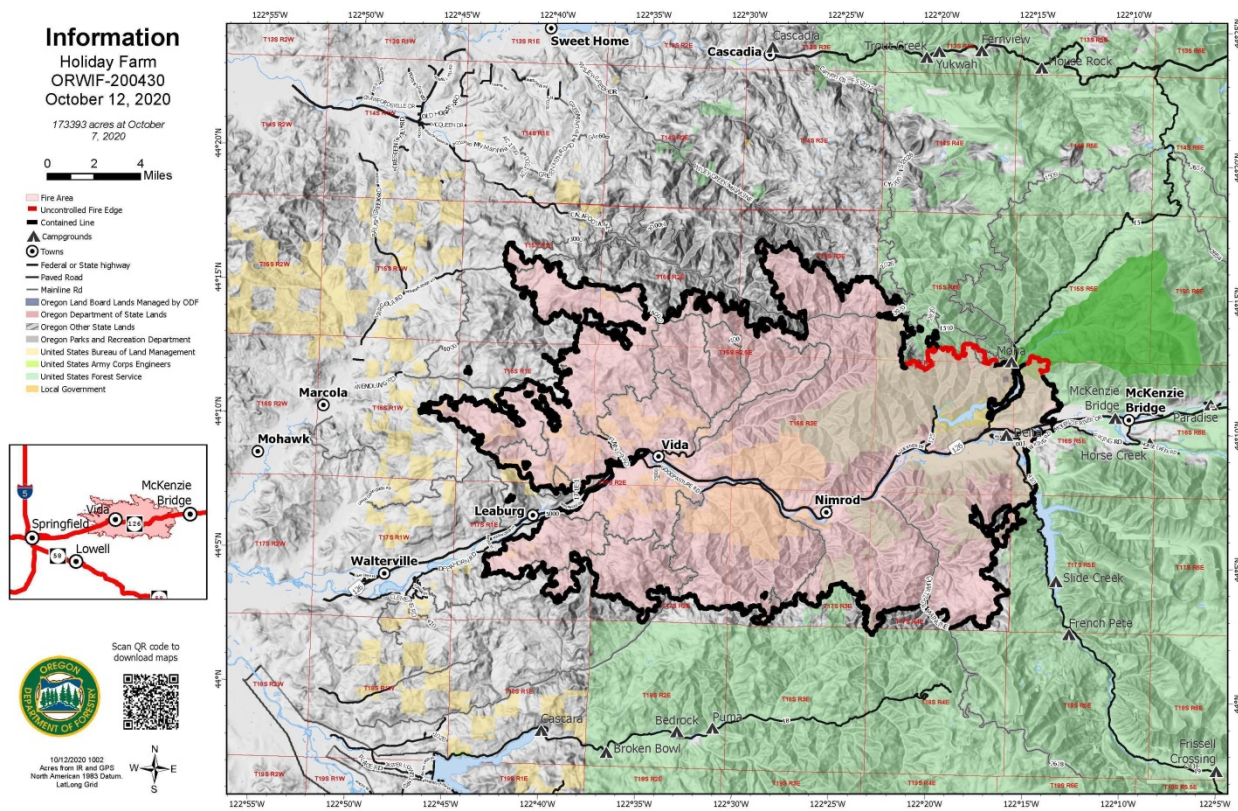


Figure 1. Map of Burned Area in the Holiday Farm Fire

County road maintenance crews were already on-site doing hazard tree removal within the right-of-way (ROW) and cleaning up stormwater ditches, as needed throughout the impacted road system. County crews intend to have all the hazard trees and woody debris from roadside ditches within the ROW removed prior to the first big storm event. However, many hazard trees outside of the ROW will still exist and will likely cause continued maintenance. County crews intend to follow up with any needed cleanup after storm events.

2.3. Critical Values

The watersheds burned within the Holiday Farm Fire will experience increased runoff, sediment/ash laden flows, and debris flows. Increased flows may cause the capacity of drainage features to be exceeded and transported sediment and debris may cause culverts and other drainage features to fail. These impacts may cause uncontrolled flow across the road prism causing damage and potential failure. The road prism may become impassible to vehicles and in extreme cases may be completely washed out due to fill slope failure. This report:

- Identifies roads and structures that will likely be impacted by post-fire debris flows and flooding,
- Evaluates their current condition and vulnerability, and
- Considers treatments to minimize the risks to safety and infrastructure.

The following table describes the threats to various resources identified during field investigations and the assigned risk value determined during this assessment.

Table 1: Lane County Roads Critical Values

Critical Value	Risk	Value Category	Threat
Blue River Road			
Simmonds Creek Bridge (MP 0.45)	Very High	Human Life & Safety Property	Damage to existing infrastructure from increased runoff, erosion, and debris flows
Blue River Rd (MP 0.0-1.64)	Intermediate	Human Life & Safety Property	Damage to existing stormwater management system (ditches, 12 culverts & all driveway culverts) from erosion and debris flows
Blue River Drive			
Blue River Dr (MP 0.0-1.55)	High	Human Life & Safety Property	Damage to existing stormwater management system (ditches, 7 culverts & all driveway culverts) from erosion and debris flows

Elk Creek Road			
12 in Concrete Pipe (44°9'15.77" N, 122°21'48.43" W)	Intermediate	Human Life & Safety Property	Damage to existing infrastructure from increased runoff, erosion, and debris flows
Elk Creek Rd (MP 0.0- 0.378)	Low	Property	Damage to existing stormwater management system (ditches, 1 culvert & all driveway culverts) from erosion and debris flows
Eagle Rock Place			
Eagle Rock PI (MP 0.0- 0.25)	Low	Property	Damage to existing stormwater management system (ditches & all driveway culverts) from erosion and debris flows
N. Gate Creek Road			
30 in Concrete Culvert (44°8'56.95" N, 122°33'25.58" W)	Intermediate	Human Life & Safety Property	Damage to existing infrastructure from increased runoff, erosion, and debris flows
18 in CMP (44°8'56.18" N, 122°32'51.96" W)	Very High	Human Life & Safety Property	Damage to existing infrastructure from increased runoff, erosion, and debris flows. If culvert becomes plugged, likely to lose road.
N. Gate Cr Rd (MP 0.0- 2.42)	High	Human Life & Safety Property	Damage to existing stormwater management system (ditches, 20 culverts & all driveway culverts) from erosion and debris flows
Goodpasture Road			
36 in Concrete Culvert (44°8'23.65" N, 122°34'45.52" W)	High	Human Life & Safety Property	Damage to existing infrastructure from increased runoff, erosion, and debris flows
156 in CMP (44°8'2.66" N, 122°33'23.54" W)	Intermediate	Human Life & Safety Property	Damage to existing infrastructure from increased runoff, erosion, and debris flows

Marten Creek Bridge #39C119 (MP 3.63)	Intermediate	Human Life & Safety Property	Damage to existing infrastructure from increased runoff, erosion, and debris flows
42in Corrugated Steel Pipe (44° 7' 45.15" N, 122° 30' 17.25" W)	Very High	Human Life & Safety Property	Damage to existing infrastructure from increased runoff, erosion, and debris flows
Goodpasture Road (MP 0.0-5.03)	High	Human Life & Safety Property	Damage to existing stormwater management system (ditches, 40+ culverts & all driveway culverts) from erosion and debris flows
Leashore Drive			
18 in HDPE Culvert (44° 8' 29.97" N, 122° 35' 27.85" W)	High	Human Life & Safety Property	Damage to existing infrastructure from increased runoff, erosion, and debris flows
Leashore Drive (MP 0.0-0.44)	Low	Property	Damage to existing stormwater management system (ditches, 2 culverts & all driveway culverts) from erosion and debris flows
Angels Flight Road			
NEW 18 in PVC (44° 8' 46.75" N, 122° 36' 17.33 W)	Very High	Human Life & Safety Property	Damage to existing infrastructure from increased runoff, erosion, and debris flows, and pond holding back water upstream of culvert
Angels Flight Road (MP 0.0-1.79)	Intermediate	Human Life & Safety Property	Damage to existing stormwater management system (ditches, 5 culverts & all driveway culverts) from erosion and debris flows
Leaburg Dam Road			
Leaburg Dam Road (MP 0.0-0.82)	Low	Property	Damage to existing stormwater management system (ditches & all driveway culverts) from erosion and debris flows

2.4. Findings and Recommendations

Please see [Appendix A](#) for road treatment cost estimates.

Blue River Road

Findings: Blue River Road is functionally classified as a Rural Local road that was assessed to have an intermediate risk. This road provides access to Blue River Lake and provides the USACE access to the top of the Blue River Dam. It is anticipated that cross drain culverts along the entire length of the road (MP 0.0-1.64) will see increased sediment delivery and woody debris to the culverts potentially plugging them and causing them to fail. There are approximately 12 culverts along 1.64 miles of road surveyed for potential treatment. Ditch lines along the length of the road are full of woody debris. Hazard trees are prevalent along the entire stretch of road.

Lane County bridge #20457 is located over Simmonds Creek at MP 0.45. It is a pre-stressed concrete bridge constructed in 2005. This bridge is assessed as a very high risk as it is of high value and is in jeopardy of damage due to the fire damage up-gradient of the bridge. The bridge is located below a drainage that has moderate and high burn severity. Debris from the large watershed catchment above is highly likely to impact the footings of the bridge.



Up-gradient side of Simmonds Creek Bridge

Proposed Remediation: It is recommended to have 1-2 people complete storm response for the road following significant rainfall events to ensure that the ditch and culverts are correctly functioning. Remove any hazard trees or woody debris that are in the roadside ditches or at inlets to all culverts along the entire stretch of road.

For the Simmonds Creek Bridge, we recommend a similar treatment, but a larger excavator will be required to remove any large woody debris. Treatment for the bridge should take high priority because it is a high value structure.

Blue River Drive

Findings: Blue River Drive is functionally classified as a Rural Minor Collector and was assessed as being at an intermediate risk level. This road provides access to the town of Blue River and to McKenzie High School. Because Blue River Drive is frequently used by the general public, the road should be a top priority for hazard mitigation. It is anticipated that cross drain culverts along the entire length of the road (MP 0.0-1.55) will see increased sediment delivery and woody debris to the culverts potentially plugging them and causing them to fail. There are approximately 40 culverts along 5.03 miles of road surveyed for potential treatment. Ditch lines along the length of the road are full of woody debris. Hazard trees are prevalent along the entire stretch of road.



Debris in ditch-line along Blue River Drive

Proposed Remediation: It is recommended to have 1-2 people complete storm response for the road following seasonal rainfall events to ensure that the ditch and culverts are correctly functioning. Remove any hazard trees or woody debris that are in the roadside ditches or at inlets to all culverts along the entire stretch of road.

Elk Creek Road

Findings: Elk Creek Road is functionally classified as a Rural Local road and assessed to be at low risk. This minor road provides access to several residences. There was only 1 culvert along 0.378 miles of road surveyed for potential treatment. It is anticipated that it will see increased sediment delivery and woody debris to the culvert potentially plugging it and causing it to fail. Ditch lines along the length of the road are full of woody debris. Hazard trees are prevalent along the entire stretch of road.

Proposed Remediation: It is recommended to have 1-2 people complete storm response for the road following seasonal rainfall events to ensure that the ditch and culverts are correctly functioning.

Remove any hazard trees or woody debris that are in the roadside ditches or at inlets to all culverts along the entire stretch of road.

Eagle Rock Rd & Eagle Rock Place

Findings: Eagle Rock Place is functionally classified as a Rural Local road and is assessed to be at low risk. This minor road is a cul-de-sac and provides access to several residences. It is anticipated that ditch lines and driveway culverts along the entire length of the road (MP 0.0-0.36) will see increased sediment delivery and woody debris, potentially plugging the driveway culverts and causing them to fail. Hazard trees are prevalent along the entire stretch of road.

Proposed Remediation: It is recommended to have 1-2 people complete storm response for the road following significant rainfall events to ensure that the ditch and culverts are correctly functioning. Remove any hazard trees or woody debris that are in the roadside ditches or at inlets to all culverts along the entire stretch of road.

N. Gate Creek Road

Findings: N. Gate Creek Road is functionally classified as a Rural Minor Collector and is assessed to be at high risk. This road provides access to many residences. Because N. Gate Creek Road is frequently used by the general public, the road should be a top priority for hazard mitigation. It is anticipated that cross drain culverts along the entire length of the road (MP 0.0-2.42) will see increased sediment delivery and woody debris, potentially plugging them and causing them to fail. There are approximately 20 culverts along 2.42 miles of road surveyed for potential treatment. Ditch lines along the length of the road are full of woody debris. Hazard trees are prevalent along the entire stretch of road.

An 18 inch CMP cross drain culvert located at MP 1.61 is in jeopardy of failure due to the fire damage. The risk at this culvert was assessed to be very high due to the culvert being located at the bottom of a steep slope that has seen moderate and high burn severity. If the pipe were to become plugged and fail, the result would most likely wash out the road prism.



Cross Drain culvert along N. Gate Cr. Rd.

Proposed Remediation: It is recommended to have 1-2 people complete storm response for the road following significant rainfall events to ensure that the ditch and culverts are correctly functioning. Remove any hazard trees or woody debris that are in the roadside ditches or at inlets to all culverts along the entire stretch of road.

The 18-inch CMP cross drain culvert on N. Gate Cr Rd should take priority due to its high risk and high consequence of failure. A potential treatment option is to upsize the 18-inch culvert to a 24 or even 36-inch culvert to handle the increase in sediment and debris. Another treatment option is to clean the inlet of the pipe frequently.

Goodpasture Road

Findings: Goodpasture Road is a Lane County road functionally classified as a Rural Minor Collector and is assessed to be at high risk. Because Goodpasture Road is frequently used by the general public, the road should be a top priority for hazard mitigation. It is anticipated that cross drain culverts along the entire length of the road (MP 0.0-5.03) will see increased sediment delivery and woody debris to the culverts potentially plugging them and causing them to fail. There are approximately 40 culverts along 5.03 miles of road surveyed for potential treatment. Ditch lines along the length of the road are full of woody debris. Hazard trees are prevalent along the entire stretch of road.

A 36-inch concrete cross drain culvert is located at MP 0.75 and is in jeopardy of failure due to erosion from the fire damage. This culvert under 15 feet of fill could result in a high consequence of failure if the plugged culvert washes out the road prism.



36-inch cross drain culvert



42-inch cross drain culvert

A 42-inch corrugated steel cross drain culvert at MP 5.01 is in jeopardy of failure due to erosion from the fire. A large amount of debris is located uphill from the culvert and with 5 feet of fill above the top of the culvert, plugging would result in a washout of the entire road prism. The culvert has a very high risk of failing.

Proposed Remediation: It is recommended to have 1-2 people complete storm response for the road following significant rainfall events to ensure that the ditch and culverts are correctly functioning. Remove any hazard trees or woody debris that are in the roadside ditches or at inlets to all culverts along the entire stretch of road. Both the 36-inch Concrete culvert and the 42-inch corrugated steel culvert should take priority in the storm response. Both culverts have high risk of failing with high consequences. An optional treatment for these culverts is to construct a debris rack on the up-gradient side of both culverts.

Leashore Drive

Findings: Leashore Drive is a Lane County road functionally classified as a Rural Local road and is assessed to be at a low risk. This minor road provides access to several residences. It is anticipated that cross drain culverts along the entire length of the road (MP 0.0-0.44) will see increased sediment delivery and woody debris to the culverts potentially plugging them and causing them to fail. There are approximately 2 culverts along 0.44 miles of road surveyed for potential treatment. Ditch lines along the length of the road are full of woody debris. Hazard trees are prevalent along the entire stretch of road.

The culvert on Leashore Drive at MP 0.42 is in high risk of failure due to the large amount of woody debris located on the up-gradient side of the culvert.

Proposed Remediation: It is recommended to have 1-2 people complete storm response for the road following significant rainfall events to ensure that the ditch and culverts are correctly functioning. Remove any hazard trees or woody debris that are in the roadside ditches or at inlets to all culverts along the entire stretch of road.



Cross drain culvert along Leashore Dr.

Angels Flight Road

Findings: Angels Flight Road is a Lane County road functionally classified as a Rural Local road and is assessed to be intermediate risk. This minor road provides access to several residences and provides access to private forest land. It is anticipated that cross drain culverts along the entire length of the road (MP 0.0-1.79) will see increased sediment delivery and woody debris to the culverts potentially plugging them and causing them to fail. There are approximately 5 culverts along 1.79 miles of road surveyed for potential treatment. Ditch lines along the length of the road are full of woody debris. Hazard trees are prevalent along the entire stretch of road. A logging salvage operation has recently filled the ditches with woody debris.

A new 18-inch HDPE pipe at MP 0.49 was recently installed due to the previous structure being significantly fire-damaged. Approximately 10 feet upstream of this culvert (on private property) is a fire damaged small dam that creates a pond that is still holding water. The pond was created with an impermeable liner supported by a wooden retaining wall that has lost most of its section in the fire. It is highly likely to fail. The remaining dam debris may plug the pipe and wash out the road.

Proposed Remediation: It is recommended to have 1-2 people complete storm response for the road following significant rainfall events to ensure that the ditch and culverts are correctly functioning. Remove any hazard trees or woody debris that are in the roadside ditches or at inlets to all culverts along the entire stretch of road.

The 18 in HDPE cross drain culvert should take high priority for treatment. It is recommended to remove the dam up-gradient of the culvert or to replace the wooden dam retaining wall structure. Investigation of ownership of the dam may be necessary prior to treatment.



New 18" culvert with pond holding water up-gradient of culvert

Leaburg Dam Road

Findings: Leaburg Dam Road is a Lane County road classified as a Rural Local road and is assessed to be low risk. This minor road provides access to several residences. Ditch lines along the length of the road have some woody debris. Hazard trees are prevalent along the entire stretch of road.

Proposed Remediation: It is recommended to have 1-2 people complete storm response for the road following significant rainfall events to ensure that the ditch and culverts are correctly functioning. Remove any hazard trees or woody debris that are in the roadside ditches or at inlets to all culverts along the entire stretch of road.

Significant Rain Events

Determination of a significant rain event needing post fire specific maintenance is in development. Please see Hydrology Report in section 5 for guidance on rain events that are significant enough to increase debris flow movement in the post-fire environment. This event will likely adjust as we continue to monitor the watershed and respond to maintenance issues caused by fire damage.

3. Heritage and Cultural Resources

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ETART (Erosion Threat Assessment and Reduction Team) is a process used by FEMA in partnership with other federal lands management agencies to assist state, local governments and private land owners in preventing post-fire threats to human life and safety as well as protecting critical natural and cultural resources on state and private lands. The Forest Service and the BLM have similar procedures to address post-fire effects for national forest and public lands which are known as BAER (Burned Area Emergency Response) and ES (Emergency Stabilization) respectively. ETART is deployed following devastating wildfires once the Governor has declared a state of emergency and FEMA is deployed to assist by the Department of Homeland Security.

The goal of the ETART process for the four large fires in Oregon during the devastating 2020 wildfire season was to form a team of BAER/ES and other resources specialists who would train and supervise state and local specialists to conduct the critical value analysis. The ETART assessment for cultural resources is a high-level look at the potential for post-fire erosion, debris flows and exposure of critical cultural resources in the non-federal portions of the Holiday Farm fire. It is not meant to be an assessment of each cultural resource site, but an overall look at the vegetation burn severity on or adjacent to cultural resources and sites of tribal significance.

Unfortunately for the Holiday Farm Fire, no state or local cultural resource specialists volunteered or were otherwise made available for this effort. In addition, the acquisition of sensitive cultural resource GIS (feature data classes) from the Oregon SHPO for state and private lands in the fire area was not possible. This was due to the team's inability to secure a data sharing agreement in the timeframe allotted. Thus, a fine-grained analysis of site locations as compared to moderate to high burn severity in the fire area could not be performed.

Given the lack of cultural resource personnel and completion of a critical values analysis, we recommend that FEMA, State and local agencies seek to acquire GIS data on archaeological and historic sites directly with Oregon SHPO and then apply the ETART process to determine the cultural resource critical values, perceived risks and propose treatments where the likelihood of success is greatest. What follows are some general guidelines for addressing values, risks and treatments.

3.1. Setting

The Holiday Farm fire located in Lane and Linn Counties, Oregon originated on September 7, 2020 and burned approximately 173,175 acres. The soil burn severity on state and private lands was Moderate on 75,818 acres, and High on 11,519 acres.

Soil Burn Severity classifications are as follows:

Unburned – Little to no burn expected within these areas. Canopy and ground litter completely intact. Little to no vegetative mortality expected

Low - The ground surface, including any exposed mineral soil, may appear lightly charred, and the canopy and understory vegetation will likely appear green

Moderate - Up to 80 percent of the pre-fire ground cover may be consumed but generally not all of it. There may be potential for recruitment of effective ground cover from scorched needles or leaves remaining in the canopy that will soon fall to the ground. Soil structure is generally unchanged

High – All or nearly all of the pre-fire ground cover and surface organic matter is generally consumed, and charring may be visible on larger roots. Soil is often gray, orange, or reddish at the ground surface where large fuels were concentrated and consumed.

Table 1: Soil Burn Severity by Ownership

Ownership	Soil Burn Severity	Acres	Percent
Army Corps of Engineers	High	12.17	0.0%
	Moderate	290.14	0.2%
	Low	730.36	0.4%
	Unburned	39.38	0.0%
Army Corps of Engineers Total		1,072.05	0.6%
Bureau of Land Management	High	1,964.19	1.1%
	Moderate	13,996.59	8.1%
	Low	2,389.79	1.4%
	Unburned	163.32	0.1%
Bureau of Land Management Total		18,513.89	10.7%
Private	High	11,519.31	6.7%
	Moderate	75,574.02	43.7%
	Low	28,208.79	16.3%

Ownership	Soil Burn Severity	Acres	Percent
	Unburned	6,235.37	3.6%
Private Total		121,537.49	70.2%
U.S. Forest Service	High	2,608.67	1.5%
	Moderate	17,128.71	9.9%
	Low	10,802.74	6.2%
	Unburned	1,038.25	0.6%
U.S. Forest Service Total		31,578.37	18.2%
State/Undefined	Moderate	244.09	0.1%
	Low	101.31	0.1%
	Unburned	2.68	0.0%
Undefined Total		348.08	0.2%
Grand Total		173,049.88	100.0%

3.2. Background

Wildfires have the potential to damage or destroy non-renewable cultural resource sites through a variety of processes, including effects from burning and smoke damage, fire suppression actions, soil movement caused by subsequent storm precipitation, such as gully and rilling, and the implementation of suppression rehabilitation and ETART treatments. Cultural resources with fire sensitive or combustible components are most susceptible to direct fire effects. Additional direct fire effects include suppression activities such as the construction of dozer and hand lines, safety zones, helispots, contingency lines and drop points on or immediately adjacent to surface or subsurface cultural resource deposits. Indirect fire effects have the potential to impact a greater number of cultural resources over a longer period of time. Indirect effects may include erosional threats, visibility and accessibility threats that could invite unauthorized removal (looting), and hazardous fuel loading/fire-killed tree falling threats.

The objectives of the assessment are to: (1) identify critical cultural resource values, and (2) propose treatments and measures to prohibit any predicted immediate post-fire effects from fire-related erosion, debris flows, and rehabilitation treatments. Critical cultural resource values typically include historic properties, archaeological sites and sites or areas of Traditional Cultural Values or Sacred Sites as identified by resident traditional communities or groups, such as Federally recognized and non-recognized Indian Tribes.

Not all cultural resource sites should be considered under the ETART process, rather a triage process is deployed to fine-tune which sites are critical, have risks and warrant treatment. Ideally a small group of specialists, including representatives of interested tribes should prioritize the site inventory to reflect (in order of value) sites listed on the National Register of Historic Places (NRHP), sites determined as eligible to the (NRHP), and sites identified as having traditional cultural or spiritual values to tribes or other ethnic groups. Cultural resource sites that are designated as unevaluated are generally not considered under ETART, unless their value is exceptional and would likely be easily determined eligible or listed on the NRHP. Cultural resource sites are categorized into 4 broad types: precontact (“prehistoric”) sites, historic sites, traditional cultural properties and Indian Sacred Sites. These are further distinguished by whether they are “above ground” structures (historic properties) or surface and buried archeological sites. A precontact site is one that was established, used and occupied prior the advent of a continuous written record. A historic site postdates this time.

A traditional cultural property is a defined locality that is associated with the cultural practices or beliefs of a living traditional community, is rooted in that community’s history, and is important in maintaining the continuing cultural identity of the community. Indian Sacred Sites represent areas which hold special and sacred attachments by a Native American religion or religious practitioners.

Prehistoric and historic sites and traditional cultural areas that are eligible for listing to the National Register of Historic Places (NRHP) are considered historic properties under the National Historic Preservation Act (NHPA) and are managed and protected under that law. Cultural resource sites for which NRHP eligibility has not yet been determined are managed as historic properties until that determination is completed. The most significant and/or endangered historic properties are identified as priority heritage assets (PHAs) and are proactively monitored and managed.

The goal in performing a post-fire ETART assessment allows for the site-specific identification of threatened critical value cultural resources and provides an opportunity to recommend stabilizing treatments that may mitigate short term post-fire effects to critical value cultural resources. GIS data on soil burn severity, debris flows, other potential hazards are necessary from which to assess risks. Objectives of this assessment are as follows:

1. Identify previously documented cultural resources located on state and private lands within the fire that may be at risk.
2. Determine which cultural resource sites contain critical values that may be subjected to immediate threats from post-fire effects
3. Assess effects of soil burn severity to critical value cultural resources, as well as the potential for indirect, post-fire effects on cultural resources.
4. Apply the BAER Risk Matrix to Critical Value cultural resources to determine which sites should be considered for treatment options
5. Propose specific BAER treatments for critical value cultural resource sites in jeopardy, in order to prevent and mitigate future damage to cultural resources determined “eligible” or “potentially

eligible” for listing on the National Register of Historic Places (NRHP), per criteria in 36 Code of Federal Regulations (CFR) 60.4.

3.3. Critical Values and Proposed Treatments

The Forest Service lands within the Holiday Farm Fire were also subjected to a post-fire assessment process. USDA FS BAER team archaeologists identified a total of seven sites with a potential for critical values at risk. They proposed treatments consisting of monitoring sites to track changed condition and potential damage from looting and vandalism. A total of eight sites in the Gold Hill Mining District were not addressed at this time due to hazardous field conditions.

3.4. Assessment Methodology

It is recommended that the following process be used to identify critical values, assess risks and recommend treatments. Ideally, this effort is performed by a small group of cultural resource specialists and tribal representatives knowledgeable about the fire area. The analysis process should begin with a review of the Oregon State Historic Preservation Office (SHPO) geodatabase of archaeological sites and historic structures (feature data classes). Once the “triage” process as described above for determining which cultural resources should be considered as critical values then the focus can shift to geospatial analysis. Using geo-spatial software (ArcGIS), archaeological and historic sites are overlaid with the fire’s Soil Burn Severity map. Site locations that fall within high and moderate burn severity should be prioritized for field assessment if possible, as well as sites at risk from falling snags, flooding, or other post-fire conditions likely to adversely affect cultural resources. Since field assessments may not be feasible the initial findings of this analysis should be reviewed by a select group of cultural resource and tribal specialists for review. Based on their input a decision can be made to concentrate on sites of greater significance (critical values), such as those listed or eligible for the NRHP, sites with tribal values and those that are likely candidates for future eligibility or listing.

Once a select set of cultural resource sites of critical value are determined then the group shifts their focus to determining the level of risk and the magnitude of consequences using the table below for guidance.

Probability of Damage or Loss	Magnitude of Consequences		
	Major	Moderate	Minor
Very Likely	Very High Risk	Very High Risk	Low Risk
Likely	Very High Risk	High Risk	Low Risk
Possible	High Risk	Intermediate Risk	Low Risk
Unlikely	Intermediate Risk	Low Risk	Very Low Risk

Figure 6. Risk Matrix

*Probability of Damage or Loss: The following descriptions provide a framework to estimate the relative probability that damage or loss would occur within one to three years (depending on the resource):

- Very likely - nearly certain occurrence (>90%)
- Likely - likely occurrence (>50% to < 90%)
- Possible - possible occurrence (>10% to <50%)
- Unlikely - unlikely occurrence (<10%)

Magnitude of Consequences:

- Major - Loss of life or injury to humans; substantial property damage; irreversible damage to critical natural or cultural resources.
- Moderate - Injury or illness to humans; moderate property damage; damage to critical natural or cultural resources resulting in considerable or long-term effects.
- Minor - Property damage is limited in economic value and/or to few investments; damage to natural or cultural resources resulting in minimal, recoverable or localized effects.

In determining the magnitude of consequences, it is important to consult with other natural resource specialists and engineers to help determine if the probability of damage or loss of significant cultural resource properties or their cultural and data/informational values.

Once the magnitude of consequences is determined to fall under the pink shaded cells in the matrix above then treatment options should be considered, developed, costed out in consultation with land managers, engineers and other resource specialists with knowledge and skills in point protection from flooding and debris flows, windfall or exposure. For critical value cultural resource sites newly exposed and vulnerable to unauthorized artifact removal consider temporary access closures, and mulching or slash dispersal to deter theft.

To summarize, the ETART assessment process should:

- Determine if any critical values exist; e.g. Sites listed on the National Register or that have been determined to be eligible for the NRHP, sites important to local Tribes (based on consultation with the Tribes) within the fire perimeter
- Determine if critical value sites are located within areas of high/moderate burn intensity
- Apply the Risk Matrix to determine if any sites area at risk to post-fire effects
- Propose treatments to reduce risks, treatments should have a high likelihood of success
- Monitor the effectiveness of treatment for this and future fires on state or private lands

4. Soil Resources

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4.1. Objectives

This resource condition assessment covers the Holiday Farm Fire on private land within and adjacent to the Willamette National Forest. Soils assessments are included as part of the Emergency Threat Assessment Response Team (ETART) effort to determine emergency watershed conditions from fire altered soils within burned areas. This report includes a verification of the Burned Area Reflectance Classification (BARC) map and assesses potential emergency conditions to the soils resource and critical values on private ownership. It also includes a determination whether conditions result in risks to long-term soil productivity, and whether soil erosion or sedimentation result in risks to other critical values.

This is a rapid, landscape-scale emergency assessment to determine potential risk across private lands affected by the Holiday Farm Fire. This is not a comprehensive list of all damage that occurred on private land. Site specific determinations are being completed by the Natural Resources Conservation Service (NRCS) and Pure Water Partners (PWP) including the Upper Willamette Soil and Water Conservation District, the McKenzie Watershed Council and the Eugene Water and Electric Board. Site specific restoration recommendations will not be part of this report. For questions about site specific restoration methods contact NRCS or any of the listed partners.

4.1.1. CRITICAL VALUES

Critical values are divided into four categories. Human Life and Safety, Property, Natural Resources and Cultural and Heritage Resources. The largest observed critical values at risk are Property and Natural Resources. Communities and homes are situated at the mouths of rivers and creeks draining into the McKenzie River. Highway 126 (McKenzie Highway) is located at the toe of slopes that have been burned. Despite heavy tree mortality, the soils are fairly intact. The threat of erosion and slope movement will be a concern until the plant community recovers. There are many viable fine roots immediately below the soil surface. Vegetation recovery is already visible throughout the burned areas.

4.1.2. INITIAL CONCERNS FOR SOIL RESOURCES

Reduced ground cover, reduced infiltration, and altered soil structure following wildfire increase the risk of soil erosion and mass wasting. Human life and safety, infrastructure function and stability, stream function, fish viability, and soil productivity can all be threatened from debris flows, mass wasting, road slumping, and sediment delivery to streams. In some cases, these risks may persist several years after the fire. While low burn severity may increase the likelihood of soil moving events, these events are most likely and most severe in areas of moderate to high soil burn severity.

4.1.3. SOIL RESOURCE SETTING

Lands within the fire perimeter are largely in the Cirque Basin Mountain Landform Association. Soils are derived from Glacial Materials composed of tuffs, breccias and basalts. Slopes range from 0 to 70%, with an average of 35%. Soils are generally Inceptisols (Dystric Cryandepts) with loamy surface textures. Soil climate regimes are typically cryic. Soil depths range from 24 to 70 cm on mountain slopes to very deep in fluvial valleys. Pre-fire litter depth was typically 4 cm, and soils were largely covered with mosses and bryophytes.

4.1.4. SOIL EROSION HAZARD RATINGS

To assess the potential risk of accelerated soil erosion, erosion hazard ratings (EHR) have been applied to soils within the fire affected following the guidance for Computation of Erosion Hazard Rating to calculate EHRs. EHRs predict the overall hazard of soil loss by map unit. The EHR's calculation is based on soil texture, 2 years 6 hours climate, slope percent, infiltration, etc. See [Appendix C](#) at the end of this report for the Holiday Farm Fire's soil erosion hazard ratings. Table 1 below summarizes the burn severity across state and private lands, as well as the Holiday Farm fire overall.

Table 5. Summary of soil burn severity for the Holiday Farm Fire, presented in acres and percent of total burned area (summary of burned acres for all land ownerships)

Severity	Acres on State and Private Lands	Acres across All Land Ownerships	Percent of Total Burned Area
High	11,495	16,116	9%
Moderate	75,305	107,315	62%
Low	28,315	42,265	24%
Unburned	6,241	7,485	4%
Total	12,1356	173,181	

4.2. Methodology

4.2.1. BURNED AREA FIELD RECONNAISSANCE

Burned Area Reflectance Classification (BARC) and was used to develop a preliminary “High”, “Moderate”, and “Low” fire intensity map for the Holiday Farm fire. BARC imagery depicts the fire intensity or above ground fire effects for making interpretations of fire impacts on pre-fire vegetation-soil-hydrologic conditions (Hudak et al., 2004). Data from on-the-ground surveys were collected to: 1) validate the BARC fire intensity product and produce a final soil burn severity map; and 2) focus the assessment on identifying the emergency nature and locations of potential threats to human life and safety, property, and natural and cultural resources. Field assessment soil properties are described

in [Appendix C](#), Table 1, and include measures of root condition, soil structure, ash color and depth, and organic matter consumption.

It is important to note that fire intensity and soil burn severity are often incorrectly interchanged. Fire intensity relates to the above ground fire effects generally identified through visual observations of the over-story vegetation and ground fuels. Soil burn severity is the effect of fire at and below the ground surface; specifically, how the fire changes the physical and chemical composition of the soils. While fire intensity can help identify heat concentrations, areas of reduced ground cover, and predict hydrologic response, a high burn intensity may not result in high soil burn severity. Fire severity that detrimentally impacts soil conditions leads to further degradation of soil productivity and soil-hydrologic function. Impacts to the natural erosion processes can lead to increased flooding, sedimentation, and loss of soil productivity – which can cause chronic and perpetual hillslope instability because of decadal or longer time periods needed for soil development and recovery if severely impaired.

The potential for soil movement was modeled using the Water Erosion Prediction Project Cloud - Disturbed (WEPPCloud - Disturbed) Model (Robichaud and others, 2019). This model uses NRCS Soil Survey data, land cover, land use, and climate data to predict the potential for soil movement. The model is run using pre-burn conditions, then using the burn severity map to estimate soil loss following the fire. The results of the modeling are listed in Table 3.

Table 3. Summary of modeled hillslope erosion for target drainages within the Holiday Farm Fire

Drainage Name	Total Unburned Hillslope Soil Loss from Outlet (ton/yr)	Total Unburned Hillslope Soil Loss per unit area of watershed (lb/acr/yr)	Total Burned Hillslope Soil Loss from Outlet (ton/yr)	Total Burned Hillslope Soil Loss per unit area of watershed (lb/acr/yr)	Magnitude of Increase
Cone Creek	190	120	1,600	980	8.4
Deer Creek	2,100	680	11,000	2,700	5.2
Finn Rock Unnamed	29	170	140	820	4.8
Gate Creek	7,200	480	38,000	2,500	5.3
Goodpasture Unnamed	44	370	69	580	1.6
Hatchery Creek	58	90	370	570	6.4
Indian Creek	100	56	890	480	8.9
Johnson Creek	250	120	960	470	3.8

Drainage Name	Total Unburned Hillslope Soil Loss from Outlet (ton/yr)	Total Unburned Hillslope Soil Loss per unit area of watershed (lb/acr/yr)	Total Burned Hillslope Soil Loss from Outlet (ton/yr)	Total Burned Hillslope Soil Loss per unit area of watershed (lb/acr/yr)	Magnitude of Increase
Marten Creek	4.5	350	21	1,600	4.7
Quartz Creek	33,000	2,500	120,000	9,100	3.4
Ritchie Creek	670	250	3,200	1,200	4.8
Simmonds Creek	95	82	850	730	8.9
Toms Creek	53	53	650	650	12.3
Trout Creek	80	71	970	860	12.1

4.3. Critical Values at Sampling Points – Findings and Recommendations

This report will evaluate critical values moving from West to East.

Johnson Creek

Johnson Creek is on the West end of the burned area. The burn occurred in the headwaters. The burn intensity was light to moderate with a couple small patches of high intensity burn. Johnson Creek drains through the town of Leaburg. Since the burn is upstream of the town, it is anticipated that the unburned creek channel and hill sides will act as a buffer for sediment heading downslope through the Johnson Creek drainage. The likelihood of catastrophic soil movement into the Town of Leaburg is low.

Ritchie Creek

Ritchie Creek is on the South side of the McKenzie River across from Johnson Creek and slightly East. The burn intensity was moderate to high. The hazard map identifies a slope that could cause mass soil movement. The fire burned private industrial timber. There are no houses or infrastructure on the south side of the river. According to the model, soil erosion will increase, but is not likely to affect any critical values.

Trout Creek

Trout Creek is on the South side of the McKenzie River. This creek runs through the Whitewater Ranch which is a large private property (approx. 1,600 ac) that is managed for timber, blueberry production and grazing. The timber land above the agricultural land experienced moderate to high

burn intensity. There was nearly 100% tree mortality in the forested land. Despite the impacts to the vegetation, the soil burn severity was light to moderate. A thick layer of needles acted as an adequate mulch. Salvage logging is currently happening. Several fields were recently replanted. The 2 to 3-year old trees did not survive. These fields need to be planted as soon as plant materials are available. This property is currently consulting with NRCS and the Pure Water Partners. In the riparian zones where there is no merchantable timber, the trees should be cut, chipped and reapplied to the soil as mulch. These areas are a high priority for planting because this could cause significant sediment to enter the McKenzie River.

Hatchery Creek

Hatchery Creek is on the North side of the McKenzie River and drains through the old fish hatchery that is currently being used as a disaster relief site. The forest was extensively burned in this watershed. Burn intensity was moderate throughout most of the watershed and was high severity in the headwaters. The old fish hatchery is located on the lower terrace adjacent to the McKenzie Highway. Above the hatchery there is another terrace below the steep slopes of the watershed. The burn intensity at the hatchery site was low to none. The deciduous trees around the hatchery still have green leaves with minor char on some of the trunks. It is unlikely that there is a significant threat to the old hatchery because the upper terrace will likely collect sediment prior to it arriving at the hatchery site. Additionally, modeling showed no significant soil movement anticipated.

Indian Creek

Indian Creek is a small creek just west of Vida. There are multiple home sites at the bottom of the watershed that burned in the fire. Erosion and sediment delivery will increase after the fire, but the projected amount is still not an excessive amount. There does not appear to be significant threat to critical values at this location because there are currently only homesites, not inhabited homes.

Gate Creek

Gate Creek is one of the largest watersheds within the burn area. The upper watershed is Federal land and private industrial land. NRCS is working with several landowners in this watershed. The burn severity map shows moderate severity on private non-industrial land. There is quite a bit of high burn severity on private industrial land. There is active salvage logging occurring in this watershed. Tree mortality in this watershed is patchy. Most of the trees are dead, but there are pockets that have survived. The photo on the cover of this report is in the Gate Creek watershed. Despite heavy tree mortality, the soil burn severity on private land is low. There is significant vegetation recovery, grasses, ferns and some invasive species such as thistles are all coming back after the fire. Fine roots immediately below the soil surface appear to be undamaged. There is a large amount of needles on the soil surface acting as mulch. NRCS has recommended cutting trees that are not merchantable, chipping them and applying the chips to the ground as mulch. Most of the private acres visited will need to be replanted. The greatest concern in this watershed is private industrial lands that have recently been clear cut. These stands are on steep slopes and have little to no needles on the ground to act as mulch. There are many dwellings along the lower reach of Gate

Creek. According to the modelling the soil movement in Gate Creek will increase to 2.5 tons per acre. Debris flows coming down Gate Creek would threaten many homes and the community of Vida. While NRCS and the Pure Water Partners are working with the private non-industrial landowners, private industrial property owners are responsible for addressing erosion concerns on lands their own property.

Goodpasture Unnamed, Toms Creek and Marten Creek

All these creeks are on the South Side of the McKenzie River along Goodpasture Road. There are many homes along Goodpasture Road. These homes are located on the fans where creeks enter the McKenzie River. There are also several hazelnut orchards and pasture lands along this road. This whole area suffered from a moderate to high intensity burn. Tree mortality is nearly 100%. There are currently many efforts to stabilize slopes along Goodpasture Road. Hydro seeding has been done in several places. Grass seed was visible on the ground in many burned areas. There is a good layer of needles and leaves on the ground acting as a mulch on the soil surface. There are also many properties chipping dead trees and spreading the chips on the ground as a mulch. According to the modelling the erosion potential increases in all of these watersheds. There are many critical values in this area, including many inhabited homes. Following the immediate soil stabilization efforts, significant restoration efforts are needed to protect these watersheds long term. Long term restoration includes establishing appropriate native woody vegetation and controlling/managing invasive species.

Deer Creek

Deer Creek is on private industrial timber land. No burn severity validation points were done in this watershed. There was no access due to locked gates. The model was run for this watershed because the hazard map showed a large area of potential landslide. The burn severity in this watershed is moderate to severe. The anticipated soil loss in this watershed is significant. Despite being much smaller than the Gate Creek watershed, the erosion and soil movement potential is greater. There are no critical values within this watershed beyond natural resource critical values of soil productivity and water quality.

Quartz Creek

Quartz Creek drains into the McKenzie River near Finn Rock. There is private property owned by the McKenzie River Trust that includes the Finn Rock boat ramp. The tree mortality on the private land is 100%. There is a powerline that goes along the toe of the slope adjacent to the Finn Rock property. The private property is located on the flat terrace adjacent to the river. The slope next to the flat terrace is very steep. This slope was clear cut prior to the burn. There is no vegetation on this slope. Since the trees have been cut, there are no roots stabilizing this soil. There is no regeneration of herbaceous vegetation within this clear cut. There is significant salvage logging occurring in this watershed. Quartz Creek is the second largest watershed in the burn area. Despite this not being the largest watershed, the soil loss and erosion potential in this watershed is the greatest. The soil movement potential in the Quartz Creek Watershed is three times greater than Gate Creek, and 3.4

times greater than the natural unburned condition. The critical value at this site is the Finn Rock boat ramp that attracts many people from the public accessing the McKenzie River. Appropriate erosion measures to control upslope soil erosion risks would be to plant fast growing herbaceous vegetation on the steep slopes.

Finn Rock Unnamed

This unnamed creek is on the North side of the McKenzie River across from Finn Rock. This model was run because of the high burn severity on this side of the river. The slopes are steep with the McKenzie Hwy right at the toe of the slope. The critical value here is the highway itself. According to the modelling, the erosion potential is not significant, but this area should be monitored for slide potential that could impact the highway.

Cone Creek

Cone Creek includes the tributary or Elk Creek. Cone Creek is above Blue River and flows past the McKenzie Elementary School. The watershed is primarily federal land. The watershed suffered from a moderate to severe burn. Watershed immediately above Blue River has old growth characteristics. Despite the large size of trees, they seem to have all died. The soils exhibit light SBS with fine roots right below the soil surface. There is a thick layer of needles on the forest floor. This watershed needs to be monitored for stability to prevent damage to the McKenzie Elementary School.

Simmonds Creek

Simmonds Creek flows into Blue River at the Northeast end of the town of Blue River. There are many Inhabited homes along this drainage. The water tower for Blue River is above town surrounded by private industrial forest land. The burn intensity was moderate with pockets of severely burned lands. The soils exhibit low SBS with many fine roots at the soil surface. The steep slope immediately behind several homes in this drainage need to be treated. The standing hazard trees need to be removed. Many of these trees can be salvaged. The remaining smaller trees should be cut, chipped then reapplied to the ground as mulch. The clear cut above the Blue River water tower has little or no cover on the soil surface. Evidence of past erosion was visible in this clear cut. It appears that the rills existed prior to the fire. There is concern that this soil will move during heavy rainstorms.

Table 4. Summary of critical values within the Holiday Farm Fire, along with hazard and treatment recommendations

Value	Probability of Damage from Hillslope Erosion	Magnitude of Consequence	Risk	Treatment Recommendation	Treatment Justification
Trout Creek Soil Productivity	Likely	Moderate	High	Re-establish trees in recent clear cuts prior to invasive species infestation.	Treatment will protect soil resources and minimize invasive species colonization.
Old McKenzie Fish Hatchery	Unlikely	Moderate	Low	No treatment is recommended.	It is unlikely that mass soil movement would move beyond the upper terrace above the fish hatchery.
Homes along Gate Creek	Possible	Major	High	Remove hazard trees, remove downed wood, create defensible space.	Treatment will help protect inhabited homes.
Gate Creek Soil Productivity	Likely	Moderate	High	Remove standing dead trees. Chip trees and apply to soil as mulch. Re-establish native trees.	Treatment will protect soil resources and minimize invasive species colonization.
Homes along Goodpasture Road	Possible	Major	High	Remove hazard trees, remove downed wood, create defensible space.	Treatment will help protect inhabited homes.

Value	Probability of Damage from Hillslope Erosion	Magnitude of Consequence	Risk	Treatment Recommendation	Treatment Justification
Deer Creek Soil Productivity	Likely	Moderate	High	Remove standing dead trees. Chip trees and apply to soil as mulch. Re-establish native trees.	Treatment will protect soil resources and minimize invasive species colonization.
Quartz Creek Soil Productivity	Likely	Moderate	High	Remove standing dead trees. Chip trees and apply to soil as mulch. Re-establish native trees.	Treatment will protect soil resources and minimize invasive species colonization.
McKenzie Hwy near Finn Rock	Likely	Major	Very High	Establish vegetation, erosion control matting to stabilize slope.	Without treatment, the McKenzie Hwy would be impacted, possibly causing human safety hazard.
McKenzie Elementary School	Unlikely	Major	Intermediate	Remove standing dead trees. Chip trees and apply to soil as mulch. Re-establish native trees.	Re-establishing watershed vegetation will minimize soil movement.
Homes along Simmonds Creek	Possible	Major	High	Remove hazard trees, remove downed wood, create defensible space.	Treatment will help protect inhabited homes.

4.4. Summary

- Despite high tree mortality the soils appear to have a low burn severity on non-industrial private lands.
- Herbaceous vegetation is already regenerating from their existing root systems.
- Gate Creek is a concern because of the density of dwellings and the town of Vida. Trees that aren't marketable should be chipped then reapplied to the soils as a mulch.
- The area along Goodpasture road should be monitored due to the high number of dwellings. Restoration activities should begin as soon as possible to re-establish woody vegetation.
- Quartz Creek is a concern because of the high amount of predicted erosion in this highly disturbed watershed.
- Industrial private timber is a concern because of the steep slopes, clear cuts, lack of vegetation and lack of needles and duff on the soil surface.
- Many of the soils in this area is relatively thin. Losing topsoil will limit restoration potential and long-term health of these watersheds.
- Despite how things look right now, it is expected that the low soil burn severity across much of the affected drainages will lead to speedy natural regeneration.

5. Hydrology Resources

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5.1. Objectives

The objectives of this report are focused on Holiday Farm Fire:

- Identify locations where changes to hydrology and watershed function caused by the fire may lead to flooding, debris flows, and/or deposition of sediment and debris that potentially threaten life, property, and/or infrastructure on private and public lands, excluding those managed by the National Forest Service (NFS) and the Bureau of Land Management (BLM).
- Develop treatment recommendations.
- Identify the need for future monitoring.

5.2. Critical Values

Critical values include property, structures, physical improvements, natural and cultural resources, community infrastructure, and economic, environmental, and social values. The following discussion

is specifically concerned with values on private, municipal, county, state, and federal (excluding NFS and BLM) lands that are at elevated risk of damage from post-fire erosion, flooding, and debris flows within and downstream of the Holiday Farm fire. Values on NFS lands are discussed in the Hydrology Resource Assessment prepared as part of the Holiday Farm Burned Area Emergency Response (BAER) Report (Zigmund and Hopster, 2020). Values on BLM lands were likewise assessed by a separate process and report.

Note that critical values on lands owned by private timber companies e.g. Weyerhaeuser, were excluded from this assessment at the request of the companies. Critical values associated with state and county highways also were generally excluded from the assessment unless specifically requested or if the team noticed that the roadway had a stream crossing that could be impacted by flooding or debris. Although not a hydrologic concern, the risk posed by hazard trees was also assessed at many sites visited by the team.

Due to the large geographic extent of the fire, only a general description of values at risk (VAR) are provided below. Details about particular VARs identified by the hydrology team are provided in Appendix G/Holiday Farm Fire VAR Table attachment.

5.2.1. HUMAN LIFE AND SAFETY

The life and safety of all residents, visitors, and workers are critical values within and below the burned area. Watershed-related threats caused by the fire are primarily flooding and debris flows that can endanger people by impacting roads and bridges, homes, worksites, recreation sites, and other infrastructure such as dams and canals. Debris transported into streams and lakes can also pose a safety threat to boaters, swimmers, and other recreational users of the waterways.

5.2.2. PROPERTY

Critical infrastructure threatened by post-fire flooding and debris flows include homes, roads and bridges, parks and other developed recreation areas, dams, canals, and hatcheries. Non-federal critical values of note within or downstream of the Holiday Farm fire are the Leaburg and Walterville Canals (EWEB), and the Hayden Bridge Filtration Plant (EWEB). Non-NFS federal properties include Blue River Dam and Reservoir (USACE) and Leaburg Dam (USACE).

5.2.3. WATER QUALITY

Water quality is a major concern post-fire because increased erosion and flood flows may transport sediment and organic and inorganic contaminants into streams. Private and public critical values that may experience water-quality concerns include the municipal water supplies for Eugene (McKenzie River) and Brownsville (Calapooia River) and flows to the Leaburg and McKenzie Hatcheries (ODFW).

Potential threats to critical habitat and suitable occupied habitat for federally-listed threatened or endangered aquatic species also exist within multiple streams throughout the burned area.

5.3. Resource Setting and Condition

The Holiday Farm Fire began on September 7, 2020 and grew to a total of 173,393 acres. The fire grew from 37,000 acres on September 8th, to over 100,000 acres on the 9th when strong eastern winds drove through several communities along State Highway 126 including Blue River and Vida, OR. The fire was fast moving and left high vegetation mortality and moderate soil burn severity across the burned area. The soils have a high erosion risk in areas where the surface litter and duff were removed and canopy cover has been reduced. The fire burned across multiple entities, including the Willamette National Forest, Bureau of Land Management, and commercial and private lands protected by the State of Oregon Department of Forestry. Fuel types consist of mixed conifer, shrub, and some sparse grass. The forests in the area consist of old growth timber, second-growth stands, and reproduction. The fire perimeter occurs in nineteen 6th field subwatersheds, eight 5th field watersheds and includes 39,954 acres of the Willamette National Forest (Figure 1 and Table 1). The final soil burn severity is 9% high, 62% moderate, 24% low, and 5% unburned.

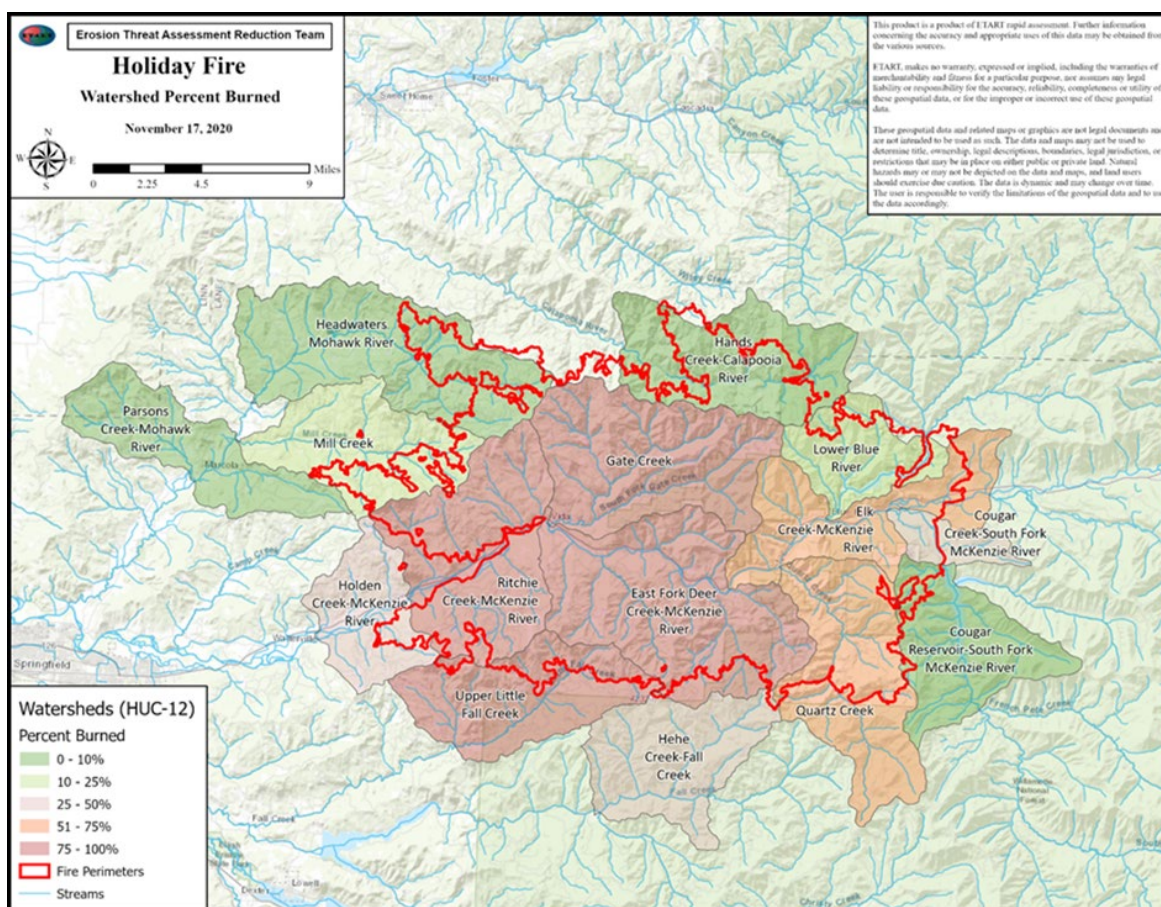


Figure 1. Map of HUC12 Watersheds affected by the Holiday Farm Fire

Table 1. Watersheds and Subwatersheds affected by the Holiday Farm Fire

Watershed Name	Subwatershed Name	Soil Burn Severity				Outside Fire Perimeter
		High	Moderate	Low	Unburned	
Blue River	Lookout Creek	0	7	164	159	15,394
	Lower Blue River	1,076	3,884	5,056	436	2,336
	Upper Blue River	0	9	195	119	30,075
Fall Creek	Hehe Creek-Fall Creek	0	23	138	9	20,755
Little Fall Creek	Upper Little Fall Creek	91	2,949	1,676	335	17,267
McKenzie River	East Fork Deer Creek-McKenzie River	4,134	25,472	5,654	665	2,972
	Gate Creek	5,010	20,029	5,387	374	0
	Holden Creek-McKenzie River	7	349	648	327	12,801
	Ritchie Creek-McKenzie River	1,773	16,790	6,013	960	5,134
	Headwaters Mohawk River	197	4,732	3,018	827	24,538
	Mill Creek	54	1,635	2,837	1,082	15,205
Quartz Creek-McKenzie River	Elk Creek-McKenzie River	2,240	11,453	2,734	107	4,294
	Quartz Creek	1,058	11,298	1,796	325	12,446
South Fork McKenzie River	Cougar Creek-South Fork McKenzie River	21	1,487	743	5	2,839
	Cougar Reservoir-South Fork McKenzie River	78	841	691	178	17,711

Watershed Name	Subwatershed Name	Soil Burn Severity				Outside Fire Perimeter
Upper Calapooia River	Bigs Creek-Calapooia River	0	483	691	493	13,927
	Hands Creek-Calapooia River	366	5,544	4,685	1,028	12,825
Wiley Creek	Jackson Creek-Wiley Creek	0	247	106	50	29,364

5.3.1. CLIMATE

The Holiday Farm Fire took place in a region that experiences wet winters and dry summers and ranges in elevation from less than 1,000 ft along the McKenzie River corridor to 4,500 ft. Precipitation throughout the burn area ranges from about 60 along valley bottoms to more than 90 inches at the higher elevations, with most of the precipitation occurring from October through May (Figure 2). In the lower elevations (<2,000 feet), precipitation is dominated by rainfall. Precipitation for the higher elevations of the burned area, between 2,000 and 4,500 ft, is a mix of rain and snow. This rain-on-snow zone can produce very high peak flows during long-duration rainstorms falling on a shallow snowpack. The first wetting fall storms begin to occur in late October into November and are generally characterized by lower intensity, longer duration events. Steady rains fell over the fire from October 10-12, with some areas receiving nearly 3.5 inches (measured at several temporary RAWS set up for the fire) and field reconnaissance reported no observations of overland flow or apparent water quality concerns.

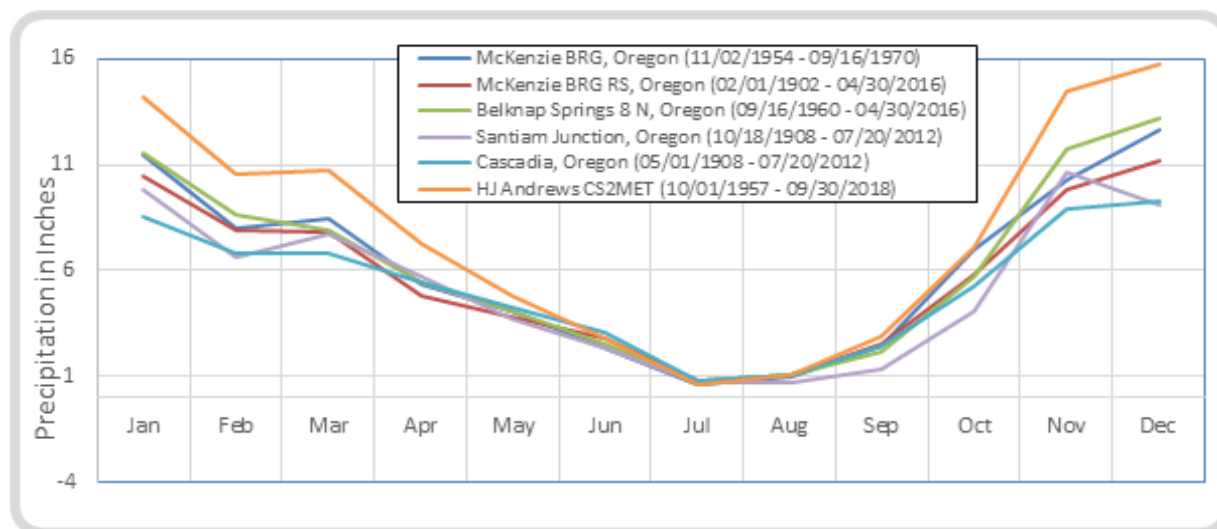
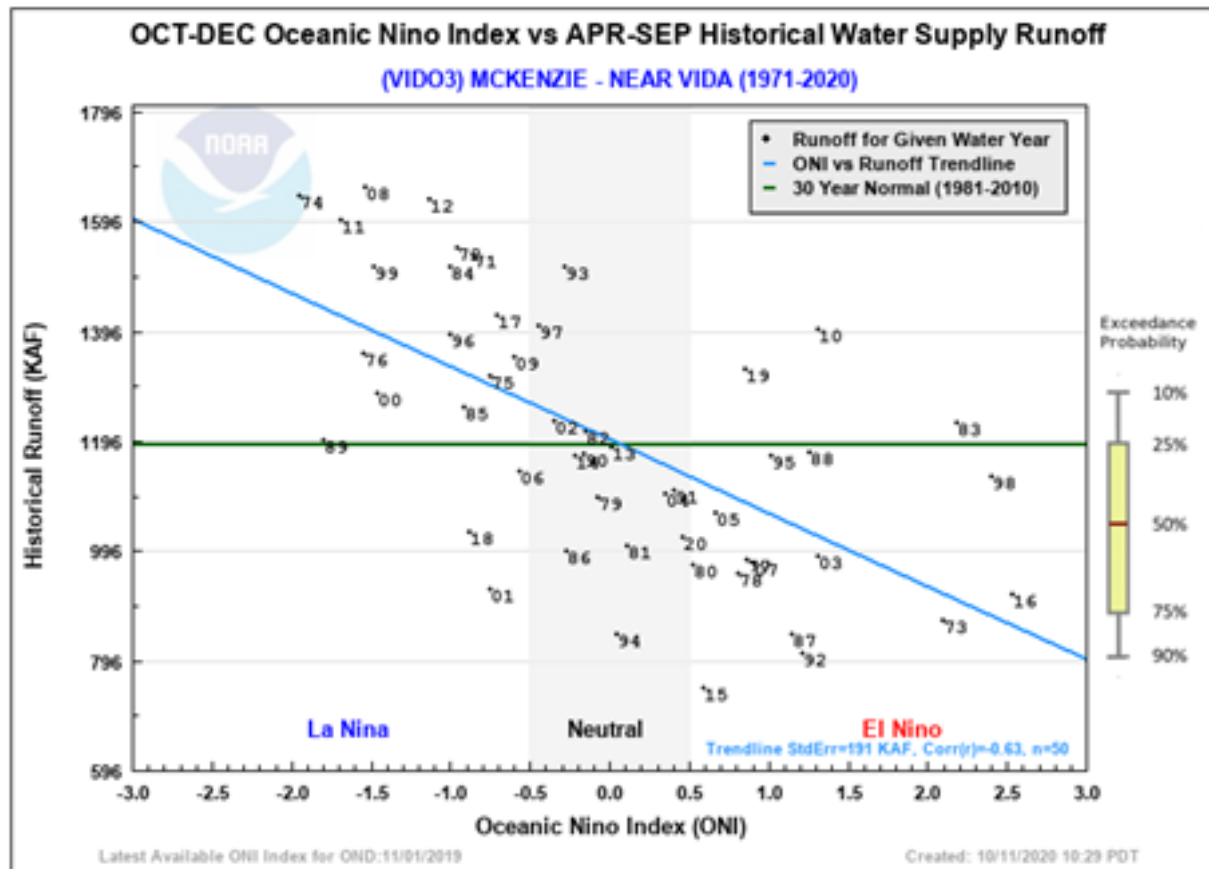


Figure 2. Representative precipitation stations for the Holiday Farm Fire (average monthly precipitation)

La Niña conditions are present in the tropical Pacific, with an approximately 85% chance of lasting through the winter. Forecasters currently think this La Niña will be on the stronger side and peak in November–January, which is expected to result in higher precipitation and snowpack. NOAA modelling illustrates that increased runoff is more likely during La Niña years (Figure 3).



For Data Used in Plot (1971 - 2020)

Figure 3. NOAA model illustrating increased runoff during La Niña years
(<https://www.climate.gov/news-features/blogs/enso/october-2020-la-ni%C3%B1a-update>)

Atmospheric rivers (ARs) are fast-moving bands of moisture that transport much of the moisture from the tropics to northern latitudes and influence local precipitation. According to NOAA, most ARs are “weak systems that often provide beneficial rain or snow...and are closely tied to water supply and flood risks.” Strong atmospheric rivers produce heavy rainfall upon landfall, especially over mountainous terrain, and most flooding events that occur along the west coast in winter are associated with the landfall of AR conditions. Events with 4- inches of precipitation are typical for these fall into early winter AR events (Andy Bryant, NWS hydrologist, personal communication on October 2).

5.3.2. HYDROLOGY

Areas affected by the Holiday Farm Fire drain portions of the Willamette River basin. The primary drainages of the Holiday Farm Fire are the McKenzie River, Calapooia River, and Mohawk River, with

approximately 1,500 miles of intermittent and perennial streams (Table 2). Flow in the McKenzie River is controlled to varying degrees by several dams, reservoirs, and diversions (Carmen Diversion Dam, Smith River Reservoir, Trail Bridge Regulating Reservoir, Cougar Dam, Blue River Dam and Reservoir, Leaburg Dam and Diversion, Walterville Diversion). These facilities occur along a 60-mile stretch of river from Walterville upstream to near the headwaters at Clear Lake. Peak flows (2-, 10-, 50- and 100-year return intervals) on the McKenzie River near Vida (USGS gage 14162500) have been reduced by 30-40% compared to the pre-dam peaks (Risley et al 2010). These regulated flows will therefore help to buffer the effects of post-fire runoff events.

Table 2. Miles of stream within fire perimeter by flow regime

Flow Regime	Soil Burn Severity (w/in Fire Perimeter)				Grand Total
	High	Moderate	Low	Unburned	
Intermittent Stream	62	497	206	108	873
Perennial Stream	13	316	145	91	565
Perennial River	0.03	15	26	21	61
Grand Total	75	827	377	220	1499

5.3.3. WATER USE

Beneficial uses for these waters are public domestic water supply, private domestic water supply, industrial water supply, irrigation, livestock watering, fish and aquatic life, wildlife and hunting, fishing, boating, water contact recreation, aesthetic quality, and hydro power (ODEQ 2020). Total Maximum Daily Loads (TMDL) currently exist for the Upper McKenzie River Subbasin and Upper Willamette Subbasin, which includes the Calapooia River (ODEQ 2006).

5.3.4. GEOLOGY

The upstream reaches of the McKenzie River (24% of the basin) are fed by springs and snow melt in the High Cascades, a high elevation area underlain by young, relatively permeable material consisting of High Cascade volcanic rocks and glacial deposits. The middle reaches flow through older volcanic material of the Western Cascades, a region of older less permeable weathered volcanic material representing 58% of the basin. Streams deeply dissect the Western Cascade area. In the lower reaches, the remaining 18% of the basin is Quaternary alluvium primarily along the valley bottoms. The middle and lower McKenzie River basin, downstream of the South Fork McKenzie River confluence (RM 60), is situated in the rugged and highly dissected Western Cascades, where the hydrology is controlled by geology, snowmelt, and rain-on-snow events. As a consequence of less-permeable geologic formations, streamflow in the region of the Holiday Farm Fire is more responsive to storm runoff than the upper basin, which results in high sediment yields (Risley et al 2010). As a result of streamflow regulation from the upstream effects of the High

Cascades in the McKenzie River, streamflow response of the main stem McKenzie River, in addition to the numerous dams in the basin, is not expected to be as flashy as unregulated tributaries.

Debris flow morphology is evident in this area, which is located largely on private timberlands that have been heavily logged, and experienced moderate to high soil burn severity. Similar steep and unstable hillslopes, with linear drainages, many of which experienced moderate to high burn severity, are present across much of the burned area. Instability is most pronounced where pyroclastic and volcaniclastic lithologies are dominant, and these rock types make up approximately 50% of the bedrock, including the steepest, most incised and unstable portions of the landscape in the central and eastern portions of the Holiday Farm burned area.

Abundant evidence of historic and recent pre-fire landslide processes and deposits is present across much of the landscape. Mass wasting processes appear to be dominantly of a shallow, rapid nature, particularly in the steep, high-relief portions of the landscape that make up the National Forest portion of the burned area. Deep-seated, chronic mass-wasting features commonly characterized as earthflows or slump-earthflow complexes are present on lower-gradient hillslopes and are evident on LiDAR imagery in the western portions of the burned area on BLM and private timberlands.

5.4. Assessment Methodology - Field and Modeling

Team members investigated a list of private and public properties provided by Lane and Linn Counties, the towns of Blue River and Vida, EWEB, USACE, NFS, emergency management agencies, and assessment teams. Additional sites were added by the team if potential hazards or impacts were observed when traveling between previously identified sites. The team used a combination of onsite observations, information available from publications and maps, and professional judgment to assess the risks at hand. Common indicators were:

- Channel form (e.g., incision, gradient, roughness) and extent of watershed that burned and burn severity to assess potential for flooding and debris flows
- Level of moss on rocks and vegetation type and elevation to indicate flood return intervals of e.g., less than 5 years
- Portion of upslope area with different percentages of burn severity
- Existence of hazard trees onsite and along upstream channels

These assessments were conducted by motor vehicle and on foot between October 28 and November 3, 2020.

Post-fire watershed response for the Holiday Farm Fire was conducted in order to determine the impact of soil burn severity on the response of modeled peak flows in drainages with values identified as at elevated risk. The findings contribute towards understanding post-fire impacts on flooding and subsequent increases in sediment yield and debris flows to evaluate risk to values on private and public properties, excluding those managed by NFS and BLM. Pourpoint watersheds were created to estimate watershed characteristics, analyze drainages, and assess the need for treatment actions.

5.5. Results of Field Work and Modeling

The team found numerous values that had varying degrees and types of threats, which are detailed in the Values at Risk Table in Appendix G/Holiday Farm Fire VAR Table attachment. In particular, imminent threats due to hazard trees and/or rock fall were noted at Blue River Park, Blue River Dam, the county access road to Blue River Dam, and Forest Glen Boat Landing. Areas where potential flooding and debris flows could threaten homes were observed along the banks of Gate Creek and Cone Creek. At numerous locations, the team observed road crossings that could be impacted by flooding and debris.

Regional regression equations were used to estimate pre- and post-fire peak flows for a number of watersheds (see appendix G, Section II for further details). The relative increase in 5-year peak flows is expected to be largest in watersheds such as Simmonds Creek, Cone Creek, and Rough Creek, where 85 to 100% of the watershed was moderately to severely burned (tables 3 and 4, figures 4 and 5). Higher peak flows on these watersheds could lead to damage of road crossing that are unable to pass the additional water and debris. Also, homes along the watersheds such as Gate Creek and Cone Creek maybe at increased risk of flooding.

The analysis of post-fire peak flows should only be used as a tool to better understand relative stream response levels for various drainages throughout the fire area. Post-fire stream response in smaller watersheds tends to be much greater than those in large watersheds because of the relative volume of water it takes to show an amplified increase from pre-fire flow and the spatial scale of continuous high-severity fire patches in relation to the extent of a storm event in the Cascades.

Table 3. Acres of Soil Burn Severity for modeled drainages in the Holiday Farm Fire

PourShed	Soil Burn Severity				Outside Fire	Total Acres
	High	Moderate	Low	Unburned		
Bear Cr at Hwy 126	362	2,077	364	16	-	2,819
Calapooia River, at road crossing below Cedar Cr	369	5,393	6,049	1,525	36,822	50,158
Cone Cr at confluence with Elk Cr	350	1,588	252	-	-	2,190
Gate Creek at Hwy 126	5,018	19,979	5,307	371	-	30,675
Marten Creek at Goodpasture Rd.	1,676	7,231	755	39	14	9,715
McKenzie River at Leaburg Dam	14,646	79,308	23,303	2,434	495,430	615,122
McKenzie River at Hayden Bridge	15,391	91,628	29,081	3,658	554,721	694,479

PourShed	Soil Burn Severity				Outside Fire	Total Acres
	High	Moderate	Low	Unburned		
Quartz Creek at H.J. Morton Memorial State Park	1,054	11,225	1,793	328	12,480	26,881
Quartz Cr at NF-126, Blue River Lake	84	630	967	105	795	2,580
Rough Cr at Hwy126	230	329	-	-	-	559
Simmonds Cr at River Street, Blue River	831	1,325	255	8	6	2,425
Unnamed Trib to McKenzie R, at Goodpasture Rd.	-	156	22	3	-	181

Table 4. Pre- and post-fire peak discharge at select poursheds.

Peak Flow (cfs)								
PourShed	Drainage Area (acres)	% Mod + High Burn Severity	Pre-fire 2-year	Pre-fire 5-year	Pre-fire 10-year	Post-fire 2-year	Post-fire 5-year	Magnitude Increase for 5-year peak
Bear Creek at Hwy 126	2,819	86.5	323	473	575	523	688	1.5
Calapooia River, at road crossing below Cedar Cr	50,158	12.8	5500	7920	9550	6180	8490	1.1
Cone Creek at confluence with Elk Cr	2,190	88.5	162	236	284	261	342	1.5
Gate Creek at Hwy 126	30,675	81.5	2830	4160	5050	4580	6020	1.4
Marten Creek at Goodpasture Rd.	9,715	91.7	1063	1545	1872	1720	2280	1.5

Peak Flow (cfs)								
McKenzie River at Leaburg Dam	615,122	15.3	31700	43800	52500	34800	47200	1.1
McKenzie River at Hayden Bridge	694,479	15.4	42800	59600	71300	47100	64300	1.1
Quartz Creek at H.J. Morton Memorial State Park	26,881	45.7	2832	4112	4979	3720	5060	1.2
Quartz Creek at NF-126, Blue River Reservoir	2,580	27.7	386	554	666	513	648	1.2
Rough Creek at Hwy126	559	100.0	76	111	135	128	172	1.5
Simmonds Creek at River Street, Blue River	2,425	88.9	333	483	582	543	717	1.5
Unnamed Trib to McKenzie R, at Goodpasture Rd.	181	86.2	18	27	32	29	38	1.4

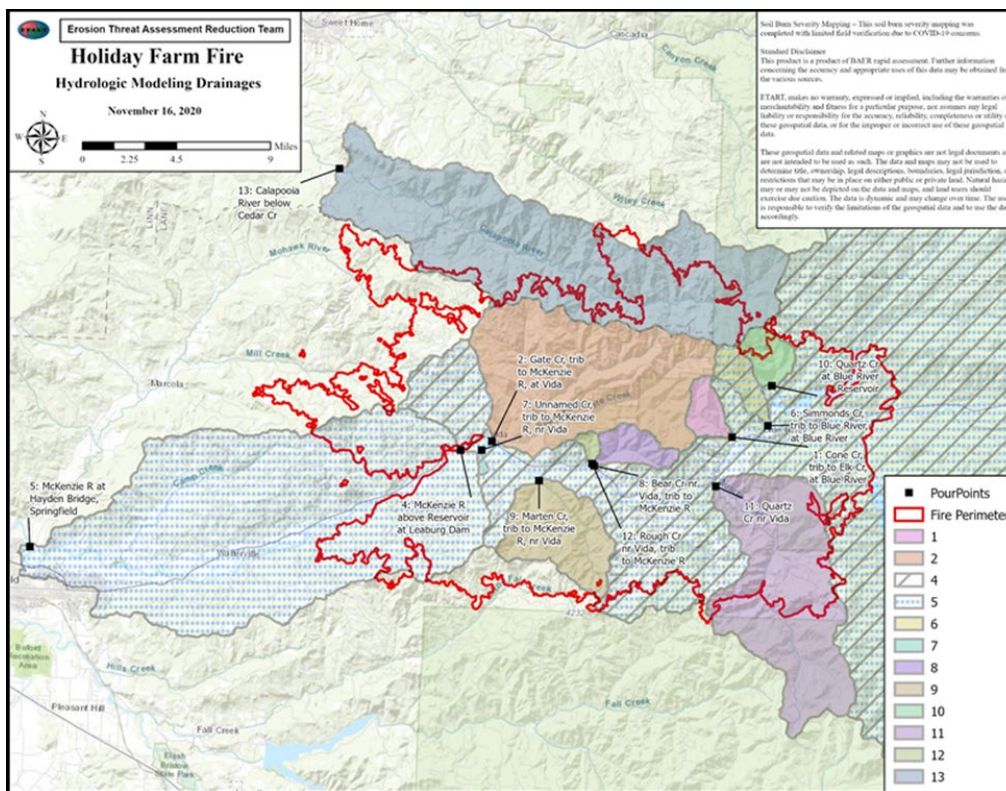


Figure 4. Map of hydrologic modeling drainages for the Holiday Farm Fire.

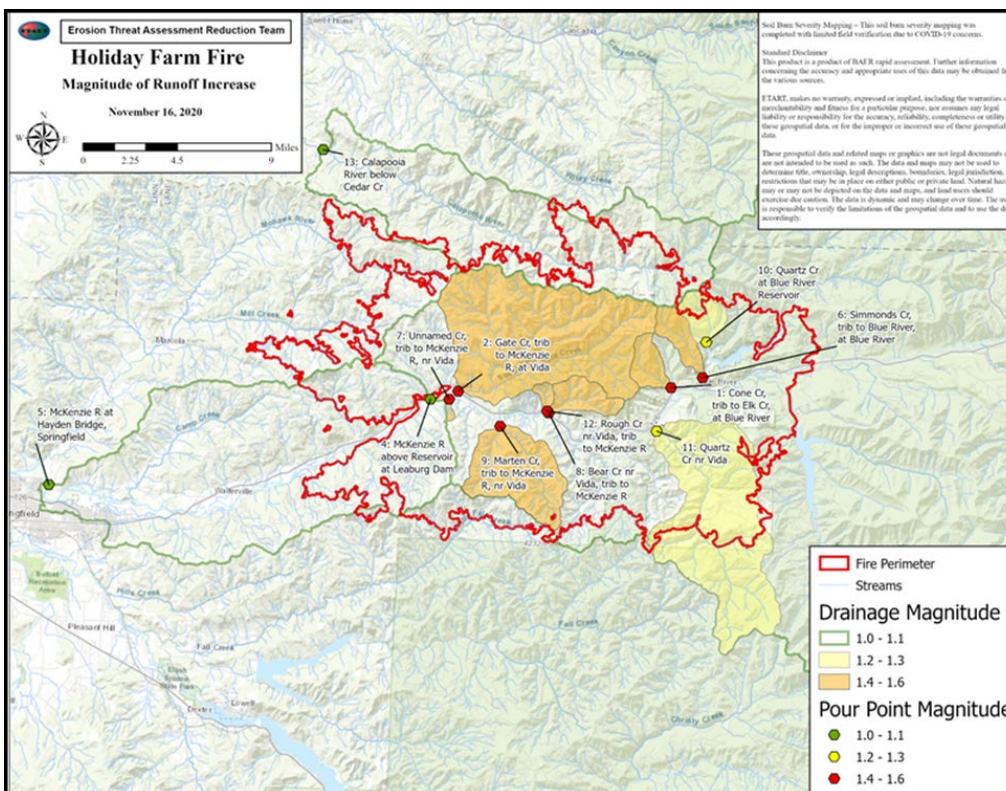


Figure 5. Map of modeled magnitude increase of post-fire, 5-year peak flow for poursheds.

5.6. Risk Assessment

Upon completion of the ETART hydrology survey and analysis, the ETART hydrology team completed a review of threats to the Values at Risk. Through this process, a probability of loss or damage was assigned along with a magnitude of the consequence to determine the level of risk. The level of risk was then used to determine proposed treatments and response actions.

Values with very high risk include: Blue River Park and Forest Glen Boat Landing (hazard trees) and recreational boaters on streams and lakes (large woody debris). Values at high risk included the residents and a couple homes adjacent to Gate Creek near Vida as well as several bridges or culverts on county roads. The risk for each of the values considered by the hydrology team is provided in the VAR table (appendix G/ Holiday Farm Fire VAR Table attachment).

5.7. Recommended Response Actions

Regarding hazard trees, the main recommendations are to ensure exclusion of the public from these sites and to remove the hazard trees. Treatment of large wood is somewhat more complex because it is a beneficial, natural feature in streams. Add to this that many river reaches are difficult for heavy equipment (capable of removing the wood) to access. Thus the treatment for wood in streams is a combination of good signage and education to warn boaters of the risks posed by large wood. Large wood in an impoundment like Leaburg Lake can more easily be treated by removing it, but signage is also important to warn boaters of the risks. For locations where rock fall may occur, the recommendation is for signs to be posted and for thoroughfares to be cleared and maintained regularly. The use of channel clearing and storm inspection/patrol is recommended at road crossings that may be impacted by increased flooding and debris. If failure of a road crossing could result in residents being stranded, it's recommended that county emergency managers be made aware and that signs be posted to educate residents.

5.7.1. RECOMMENDED MONITORING

Modeling suggests that some watersheds affected by the Holiday Farm Fire will experience increased peak flows due to the extent and intensity of the fire. With this in mind, the team recommends installation of one or more near real-time (NRT) precipitation gages in or near the burn area. A NRT precipitation gage provides invaluable information about the localized intensity and amount of precipitation as it happens. Based on these data, the National Weather Service (NWS) can issue alerts to emergency managers, road crews, and other partners to warn of increased potential for flooding and debris flows that could threaten lives or damage homes, roads, and other infrastructure.

In addition to improving emergency response, expansion of the precipitation monitoring network would lead to a better understanding of how the amount and timing of runoff change due to fire in mountainous parts of the Pacific Northwest. At present, little information is available in this regard because large, intense fires have been relatively rare in this region.

As of November 19, 2020, plans are moving ahead for placement of a rain gage on the summit of Mt. Hagan that will be maintained and operated by the USGS. NWS is proposing installation of a site on Weyerhaeuser property in the upper Gate Creek drainage; no other details are available at the moment.

Another hydrology team recommendation is that additional stream gages be installed on watersheds within and adjacent to the burned areas. Gages currently exist on the Blue River, the McKenzie River, and the South Fork of the McKenzie River, but the catchments measured by these gages were not extensively burned. It would be beneficial to install new NRT gages on smaller, more extensively burned watersheds such as Gate Creek, Bear Creek, and Simmonds Creek to provide the NWS and emergency managers with information about potential flooding and debris flows. Also, if gages on these watersheds can be paired with gages on nearby, less impacted watersheds, there's an opportunity to perform paired-watershed analyses to understand impacts of wildfires on hydrologic response. The paired-watershed method can be used to develop a runoff relationship between an experimental (burned) and a control (unburned) watershed. A better understanding of burned-watershed hydrology can assist with future evaluations of post-fire flood magnitude and hydrologic response in ungaged watersheds (Moody and Martin, 2001).

References

- Cooper, R.M. 2005. Estimation of Peak Discharges for Rural, Unregulated Streams in Western Oregon. U.S. Geological Survey Scientific Investigations Report 2005-5116, 134 p.
- Moody, J.A., and Martin, D.A. 2001. Post-Fire, Rainfall Intensity – Peak Discharge Relations for Three Mountainous Watersheds in the Western USA. *Hydrological Processes*, 15, 2981-2993.
- Oregon Department of Environmental Quality. 2006. Willamette Basin Total Maximum Daily Load. <https://www.oregon.gov/deq/wq/tmdls/Pages/TMDLs-Willamette-Basin.aspx>
- Oregon Department of Environmental Quality. 2020. Water Quality Standards. <https://www.oregon.gov/deq/wq/Pages/WQ-Standards.aspx>.
- Risley, John, Wallick, J.R., Waite, Ian, and Stonewall, Adam, 2010, Development of an environmental flow framework for the McKenzie River basin, Oregon: U.S. Geological Survey Scientific Investigations Report 2010-5016, 94 p. <https://pubs.usgs.gov/sir/2010/5016/section2.html>
- Zigmund, N. and Hopster, D. 2020. Holiday Farm Fire Hydrology Resource Assessment, Burned Area Emergency Response. U.S. Department of Agriculture, Forest Service, Willamette National Forest.

6. Geologic Hazards

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6.1. Introduction

This report is a rapid post-wildfire geologic hazards assessment of the non-federal land portions of the Holiday Farm Fire area. Hazards assessed include debris flows, rockfall, shallow and deep landslides and related flash flooding/hyper-concentrated flow that may adversely impact public safety and (or) infrastructure.

Wildfire can significantly change the hydrologic response of a watershed to the extent that even modest rainstorms can produce dangerous flash flooding and (or) debris flows. Areas downstream of slopes burned by wildfire were assessed for historical evidence of debris flow impacts through limited field reconnaissance and GIS interpretation. This is a qualitative assessment based on our professional judgement and experience and was performed in cooperation with U.S. Forest Service (USFS), U.S. Geological Survey (USGS), and the State of Oregon Department of Geology and Mineral Industries (DOGAMI). Summarized in the report are geologic observations, interpretations, and recommendations.

The Holiday Farm Fire began on September 7, 2020, during a strong east wind event that passed through the area. The fire started approximately 3 miles west of McKenzie Bridge, OR. Pushed westward by strong winds, the fire moved through the communities of Blue River, Finn Rock, Nimrod, Vida and Leaburg, damaging and destroying homes, businesses and facilities in its path. The fire (as of 10/12/2020) encompassed 173,439 acres primarily in a mixed conifer forest. The fire burned a mosaic pattern through most of the area, and the majority burned with low and moderate severity. The cause of the fire is under investigation. The fire burned a total of 31,578 acres of NFS lands, 1072 acres of Army Corps of Engineers lands, 18,513 acres of BLM lands, and 121,537 acres of private lands including communities along the Highway 126 corridor and private timber lands at the upper elevations. The fire destroyed 768 structures, caused six injuries, and one fatality. The wind driven fire caused high vegetation mortality across ownerships and there are distinct differences from west to east of forest management intensity and fuel loading, and forest canopy cover.

The USFS assembled a Burned Area Emergency Response (BAER) team on September 30, 2020. The BAER team of experts in soils, geology, hydrology, engineering, botany, recreation, archaeology, wildlife, fisheries, and GIS began assessing the post-fire effects to assets/critical values on USFS managed lands. The team developed a Soil Burn Severity (SBS) map to document the degree to which soil properties had changed within the burned area. Fire damaged soils have low strength, high root mortality, and increased rates of water runoff and erosion. Using the SBS map, BAER team members ran models to estimate changes in stream flows (hydrology) and the USGS ran models for debris flow (soils and geology) potential. Even though the reports produced by this team cover the

USFS land only, the reports are likely generally applicable for communities just outside the forest boundary and we recommend these reports are acquired and consulted.

On October 26, 2020, the Oregon Erosion Threat Assessment and Reduction Team (ETART) was formed to make assessments of state, county, and private lands and property using information collected by the BAER team. The ETART team of experts from a variety of national, state, and local agencies in soils, geology, hydrology, engineering, botany, recreation, archaeology, wildlife, fisheries, and GIS began assessing the post-fire effects to assets/critical values on non-federal lands managed lands.

6.1.1. RAPID ASSESSMENT OBJECTIVES

When evaluating Geologic Hazards, the objectives of the “Geology” specialty group on an ETART Team are to identify the geologic conditions and geomorphic processes that have helped shape and alter the watersheds and landscapes, and assess the impacts from the fire on those conditions and processes that potentially could affect downstream assets/critical values. The fire removed vegetation which keeps slopes and drainages intact, changed the structure and erosiveness of the soil, and altered the stability of the landscape. Using the understanding of rock types and characteristics, geomorphic processes, and distribution of geologic hazards helps predict how the watersheds will respond to and be affected by upcoming storms. Analysis focused on areas where geologic hazards coincide with assets/critical values. In addition to the immediate threats, considerations also include geologic hazards that are more likely to occur during the coming years and up to 15 years post-fire. The following tasks were performed:

- Review mapping products to generate a risk map within the fire areas.
- Limited on the ground survey of burned area reconnaissance
- Creation of this report that describes the risks of geologic hazards across the fire and identifies assets/critical values at high risk.
- Emergency response recommendations
- Additional analysis and advice, as requested, for the fire assessment teams for specific assets/critical values that are of high concern for post-fire effects.

6.1.2. GEOLOGIC HAZARDS DESCRIBED

The fire is located in the Cascade Mountains geologic province. The Cascade Range is almost entirely comprised of igneous extrusive volcanic rocks and are the magmatic expression of the Cascadia subduction zone where the Juan de Fuca tectonic plate is being subducted beneath the North American plate. The Cascade Range is divided into two physiographic sub provinces: Western Cascades and the High Cascades.

Landslides are one of the most widespread and damaging natural hazards in Oregon. The general term “landslide” refers to a range of mass movements including rockfall, debris flows, and earth slides. Different types of landslides have varying frequencies of movements, triggering conditions, and very diverse resulting hazards. In the Cascades, debris flows and related flash flood/hyper-

concentrated flow events, rockfall, shallow and deep landslides are the most common types of landslides.

Debris flows are a complicated landslide process. They commonly start or initiate on steep slopes or colluvium-filled hollows or in a drainage in the upper portions of a basin. As the landslide moves down the channel, they commonly grow in volume through erosion of the sediments and debris on the channel bed, erosion of the channel banks, rilling and surface erosion of slopes adjacent to a channel, or by coalescing with adjacent channel debris flows, and the addition of water. As they continue to transport down the channel, depending on volume and channel gradient debris flow can reach speeds of 100 miles per hour. The downslope transport distance can be relatively long depending on the morphology of the channel. For example, some have traveled over a mile down a channel before they stop. When the debris flows reach the canyon mouth, the debris spreads out over the flatter unconfined ground (generally referred to as run out), many times forming a fan shaped deposit frequently made up of many events. Life safety is the biggest concern because debris flows can start a long distance away from depositional zones and thus residents can be unaware of the pending danger. Vegetation and soil changes after a fire increase the runoff and erosion in a watershed and can significantly increase the likelihood of debris flows and flash flooding. Flash flooding and debris flows can initiate during even moderate rainstorms over burn areas and often occur with very little warning. Post-fire flow can alternate between flood and debris flow depending on the concentration of sediment and debris in transport.

In addition to debris flows, rockfall and post-fire activation/reactivation of shallow and deep landslides can occur. Rockfall is very common throughout the Cascades where steep/near vertical cliffs form. Shallow landslides are also very common throughout the Cascades especially on relatively steep soil/colluvium mantled slopes. The influence of root reinforcement on shallow landslides has been widely established. Beginning in less than five years after a fire, when roots of burned trees lose strength, heavy rains could saturate and destabilize steep slopes and cause them to slide.

6.2. Methods

Assessment of potential post-fire impacts from geologic hazards at locations intersecting infrastructure and public safety were reliant upon limited observations in the field, LIDAR derived topography (where available), soil burn severity maps (SBS), GIS data with buildings/structures and infrastructure, USGS emergency assessments of post-fire debris-flow hazards, Statewide Landslide Information Database of Oregon (SLIDO), and orthoimagery. A detailed list of assessments is included in the Appendix D of this report.

The USGS emergency assessments of post-fire debris-flow hazards is considered ongoing research and uses geospatial data related to basin morphometry, burn severity, soil properties, and rainfall characteristics to estimate the probability and volume of debris flows that may occur in response to a design storm (Staley, 2013). They recommend using the hazard data with a 15-minute rainfall intensity of 24 millimeters (~1 inch) per hour (mm/h) and is included in the Appendix D - Figure 1 of this report.

The USGS Landslide Hazards Program, in cooperation with DOGAMI and university researchers, are actively conducting research to better calibrate the model to western Oregon. At this time the model may overestimate or underestimate the risk in some areas. Model thresholds can provide approximate information for warning systems but should be considered alongside hydrologic modeling and local knowledge.

SLIDO is a compilation of existing landslide deposits and landslides susceptibility in Oregon that have been compiled from published maps. Many landslides have not yet been located or are not on these maps and therefore are not in this database. The original studies vary widely in scale, scope, and focus, which is reflected in a wide range in the accuracy, detail, and completeness with which the landslides are mapped

In addition to the immediate threats, considerations also include shallow-landslide-initiated debris flows that are more likely to occur roughly 3-15 years post-fire and are unlikely to be an immediate post-fire concern.

Reconnaissance of the burn area was a rapid assessment at high level. The assessment concentrated on local communities at risk, state and county property, transmission lines, dams and reservoirs, schools, non-profit education and sport camps, and fish hatcheries.

6.3. Observations and Interpretations

The following is a summary of the observations and interpretations. A detailed list is included in Appendix D to this report. Below is a short list of the primary high-risk assets/critical values:

Communities of Blue River – Portions of Blue River are located below channels identified by the USGS as moderate and high potential for debris flows (Appendix D, Figure 2 and Photo 1). Furthermore, portions of these communities are built on debris flow fan deposits, which is the runout/deposition zone for any potential debris flow from channels above. Lane County has already placed debris flow warning signs on roads in community. However, further hazards evaluation is recommended for the K-12 school and structures located in or near channels with moderate to high debris flow hazards.

Communities of Nimrod, Vida, and along Oregon State Route 126 – Communities along OR126 including Vida and Nimrod areas are in the runout/deposition zone below channels identified by the USGS as moderate and high potential for debris flows (Appendix D, Figure 3 & 4). Recommend alerting the communities and placing warning signs along the roads.

Oregon State Route 126 – The state highway was not specifically analyzed by this report. Dependent on the specific location along the highway, a variety of post-fire geologic hazards are likely including, flooding, erosion, sluffing, dry ravel, rockfall and debris flows (Appendix D, Figure 1, 2, 3 & 4). Communications with ODOT geologist and geotechnical engineers indicate that they are currently planning and addressing rockfall and are planning for potential debris flow hazards on the highway corridor.

During the ground survey, evidence of widespread mass wasting, rockfall, landslides, and debris flow deposits were observed throughout the burned area. People living, working, traveling or recreating through and below burned areas could be subject to loss of life or injury as a result of debris flows, rockfall, or flash flooding in and downstream of the burn area. For further site-specific areas such as State and county roads, private access roads, and water systems refer to the ETART hydrologic and engineering reports for recommendations of operation and maintenance of those facilities. For critical infrastructure, such as transmission lines and pipelines, examine the provided maps, data, and models to determine if further site-specific evaluation is needed.

Depending on the specific location of these assets/critical values, some of these might be impacted by various types of slope failures such as landslides and/or rockfall, while others might be impacted by hyper-concentrated flows and/or debris flows. In addition to the immediate threats, longer term landslide hazards are more likely to occur during the next several years to 15 years.

Based on this rapid assessment, we find there is a range of landslide risk highly dependent on location from very low to high within the fire affect area. Therefore, we make the following recommendations to reduce landslide risk. These recommendations are focused on life safety.

6.4. Recommendations

This rapid assessment was performed to alert communities in portions of Holiday Farm Fire of the need to be prepared for post-fire landslides. We note that the portion of Oregon included in this assessment has high average annual precipitation as well as potentially high 24-hour-duration precipitation related to storm events. Both factors are extremely important in triggering landslides, especially when combined with the local geology and geomorphology. Human activities may also contribute and/or trigger landslides.

The results of this rapid assessment indicate that some assets/critical values in the Holiday Farm Fire area are at high risk from post-fire landslide hazards. Post-fire debris flows are generally the primary concern because of their speed, debris flows threaten both lives and property. Rockfall is also a primary concern. Shallow and deep landslides cover a much broader area and can threaten property and possibly lives in the long term.

We provide the following recommendations to communities in the fire area for continued work on landslide risk reduction. These recommendations are not comprehensive, but they should provide an adequate foundation. The primary actions are awareness, warnings, and emergency mitigation/further evaluation. Additional details are provided below.

6.4.1. AWARENESS

Awareness of local hazards is crucial to understanding associated dangers and how to prepare for them. One of the main purposes of this assessment and data compilation is to help residents and landowners in the fire area become aware of the risk reduction actions they can take for preparation for hazardous events.

At many sites, we recommend signs are placed in locations to help awareness and remind everyone of the potential risk. These signs should include a clear message and a link to additional information (Appendix D, Photo 5).

To increase awareness, the following flyers and fact sheets can be linked and and/or distributed to help educate landowners of activities that individuals can take in order to reduce landslide risk.

Educational Flyers

Homeowners Guide to Landslides

- https://www.oregongeology.org/Landslide/ger_homeowners_guide_landslides.pdf

Landslide Hazards in Oregon

- <https://www.oregongeology.org/pubs/fs/landslide-factsheet.pdf>

Debris flow hazards. Includes recommendations for before and during events

- <https://pubs.usgs.gov/fs/fs-176-97/fs-176-97.pdf>

Post Wildfire Flash Flood and Debris Flow Guide

- <https://www.wrh.noaa.gov/lox/hydrology/files/DebrisFlowSurvivalGuide.pdf>

General landslide preparedness

- https://www.usgs.gov/natural-hazards/landslide-hazards/science/landslide-preparedness?qt-science_center_objects=0#qt-science_center_objects

6.4.2. LANDSLIDE WARNINGS

Preparing for emergency situations such as storm events can be done in several ways. Oregon has a statewide landslide alert system triggered by the National Weather Service (NWS). When the NWS issues a flood watch or flash flood watch, they include language about the potential for landslides and debris flows. At the same time several Oregon state agencies (Oregon Emergency Management [OEM], Oregon Department of Transportation [ODOT], and DOGAMI) disseminate the alert. The current alert system could be used by the communities in the fire area. In addition, the USGS Landslide Program has conducted emergency assessments of post-fire debris-flow hazards in the fires that occurred in Oregon during the 2020 season (https://landslides.usgs.gov/hazards/postfire_debrisflow/). The following are the 15, 30, and 60-minute rainfall amounts for post-fire debris flow potential for the five largest fires in the Cascades.

- Archie Creek
 - 15-minute: 19 mm/h, or 0.2 inches in 15 minutes
 - 30-minute: 15 mm/h, or 0.3 inches in 30 minutes

- 60-minute: 13 mm/h, or 0.5 inches in 60 minutes
- Beachie Creek
 - 15-minute: 24 mm/h, or 0.25 inches in 15 minutes
 - 30-minute: 19 mm/h, or 0.4 inches in 30 minutes
 - 60-minute: 17 mm/h, or 0.65 inches in 60 minutes
- Holiday Farm
 - 15-minute: 22 mm/h, or 0.2 inches in 15 minutes
 - 30-minute: 17 mm/h, or 0.3 inches in 30 minutes
 - 60-minute: 15 mm/h, or 0.6 inches in 60 minutes
- Lionshead
 - 15-minute: 36 mm/h, or 0.35 inches in 15 minutes
 - 30-minute: 28 mm/h, or 0.55 inches in 30 minutes
 - 60-minute: 26 mm/h, or 1.0 inches in 60 minutes
- Riverside
 - 15-minute: 28 mm/h, or 0.3 inches in 15 minutes
 - 30-minute: 22 mm/h, or 0.45 inches in 30 minutes
 - 60-minute: 20 mm/h, or 0.8 inches in 60 minutes

Additionally, after the 1996-97 landslide events, DOGAMI created a map of 24-hour rainfall intensity that is likely to trigger debris flows for western Oregon. Although post-fire effects are not included in the DOGAMI thresholds, it is another resource that should be reviewed before future storms. Below are the lowest rainfall intensities for each fire.

- Archie Creek - 3-4 inches in 24 hours
- Beachie Creek - 4-5 inches in 24 hours
- Holiday Farm - 3-4 inches in 24 hours
- Lionshead - 2-3 inches in 24 hours
- Riverside - 3-4 inches in 24 hours

Knowing when there will be periods of increased landslide potential will help communities prepare and respond should landslides occur. Evacuation should be considered, recommended, or required under certain conditions in high risk areas.

A life-safety action plan also can be enacted. When the National Weather Service issues a flood watch or flash flood watch with landslide and debris flow language, local emergency managers can relay that information to residents located in high debris flow hazard areas. This could entail a local emergency notification system directed by the county or city or a reverse 911 call being put out to residents when a debris flow warning is issued, alerting them to the potential danger.

6.4.3. MITIGATION & FURTHER EVALUATION

This is a high-level report, done through a rapid assessment of areas prone to geologic hazards. Most properties identified in this report were not fully assessed. A more complete assessment requires examining the on the ground characteristics of each property at risk. Therefore, we

recommend additional site-specific evaluation. The results of a site-specific evaluation should include recommendations for site-specific mitigation. Protecting homes from the impacts of large debris flows should be explored but may need additional design resources and consultation with engineers that is outside the scope of this evaluation. In some cases, from this review, the report points to high hazard areas that would need “further evaluation.” Further evaluation could lead to constructing mitigative control structures. Engineered debris flow diverting structures were not evaluated by this report. These structures need to be surveyed and designed for specific areas they would be needed. Examples of debris flow and rockfall structures may include:

Debris flow

- Debris basin
- Deflection wall or berm
- Terminal wall or berm
- Small log crib check dams located near distal end of fan
- Debris racks (straining structure)
- Debris check dams

Rockfall

- Hand/mechanical scaling
- Trim blasting
- Rock bolts
- Anchored wire mesh/draped mesh
- Shotcrete
- Barrier and fences

Other forms of mitigation to consider should include emergency management buyouts of property with very high risk. Consulting an expert to conduct a site-specific evaluation if considering reconstruction or new construction in these high-risk areas. Residents on the fans should consider purchasing flood insurance coverage. Consult the Post Wildfire Flash Flood and Debris Flow guide <https://www.wrh.noaa.gov/lox/hydrology/files/DebrisFlowSurvivalGuide.pdf>.

6.5. References

Burns, W.J., Mickelson, K.A., and Madin, I.P., 2016, Landslide Susceptibility Overview Map of Oregon, Oregon Department of Geology and Mineral Industries, Open File Report O-16-02

Cannon, S.H. and DeGraff, J (2009) The Increasing Wildfire and Post-Fire Debris-Flow Threat in Western USA, and Implications for Consequences of Climate Change: Landslides – Disaster Risk Reduction.

De Graff, J. V. and Gallegos, A. J. (2012) The Challenge of Improving Identification of Rockfall Hazard after Wildfires: Environmental and Engineering Geoscience 18(4): 389-397.

DeGraff J.V., Shelmerdine B., Gallegos, A., and Annis D. (2015) Uncertainty Associated with Evaluating Rockfall Hazard to Roads in Burned Areas. *Environmental & Engineering Geoscience*, Vol. XXI, No. 1: 21-33

DOGAMI, 2020, Statewide Landslide Information Database for Oregon (SLIDO), Oregon Department of Geology and Mineral Industries, updated October 2020, <https://www.oregongeology.org/slido/index.htm>

Highland, L.M., and Bobrowsky, Peter, 2008, *The landslide handbook—A guide to understanding landslides*: Reston, Virginia, U.S. Geological Survey Circular 1325: 129

Kean, J.W., McCoy, S.W., Tucker, G.E., Staley, D.M., Coe, J.A., 2013, Runoff-generated debris flows: Observations and modeling of surge initiation, magnitude, and frequency, *Journal of Geophysical Research Earth Surface*, 118(4), p. 2190-2207

Oregon Department of Transportation (2014) *Hydraulics Design Manual – Rainfall Intensity-Duration-Recurrence Interval Curves*, Chapter 7, Appendix A.

Peck, D.L., Griggs, A.B., Schlicker, H.G., Wells, F.G., and Dole, H.M, 1964, *Geology of the central and northern parts of the western Cascade Range in Oregon*: U.S. Geological Survey PP-449, scale 1:250,000.

Roering, JJ, et al, 2003, Shallow landsliding, root reinforcement, and the special distribution of trees in the Oregon Coast Range, *Canadian Geotechnical Journal*

Staley, D.M, and Kean, J.W., 2020, Emergency assessment of post fire debris flow hazards, Holiday Farm Fire (Willamette National Forest, OR): U.S. Geological Survey https://landslides.usgs.gov/hazards/postfire_debrisflow/detail.php?objectid=339.

Staley DM, Kean JW, Cannon SH, Schmidt KM, Laber JL, 2013, Objective definition of Rain-fall intensity–duration thresholds for the initiation of post-fire debris flows in Southern California. *Landslides* 10:547–562

Staley, D.M., Negri, J.A., Kean, J.W., Tillery, A.C., Youberg, A.M., 2016, Updated logistic regression equations for the calculation of post-fire debris-flow likelihood in the western

Staley, D.M., Negri, J.A., Kean, J.W., Tillery, A.C., Youberg, A.M., 2016, Updated logistic regression equations for the calculation of post-fire debris-flow likelihood in the western United States: U.S. Geological Survey Open-File Report 2016-1106, 20 p., available at <https://pubs.er.usgs.gov/publication/ofr20161106>

Staley, D.M., Negri, J.A., Kean, J.W., Tillery, A.C., Youberg, A.M., 2016, Updated logistic regression equations for the calculation of post-fire debris-flow likelihood in the western United States: U.S. Geological Survey Open-File Report 2016-XXXX, 20 p., available at <http://pubs.usgs.gov/of/2016/XXXX/>

Staley DM, Negri JA, Kean JW, Laber JL, Tillery AC, Youberg AM (2017) Prediction of spatially explicit rainfall intensity–duration thresholds for post-fire debris-flow generation in the Western United States. *Geomorphology* 278:149–162

Wiley, T.J., 2000, Relationship between rainfall and debris flows in western Oregon, *Oregon Geology*, Volume 62, Number 20, Department of Geology and Mineral Industries

7. Hazard Trees

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This report is a rapid post-wildfire danger/hazard tree assessment of the non-federal land portions of the Holiday Farm Fire.

7.1. Objectives

This assessment provides a high-level look at the potential for danger/hazard trees along roads and around structures in the non-federal portions of the Holiday Farm Fire. It is not meant to be an assessment of each mile of road, nor of each structure, but an overall look at the vegetation burn severity along the roads and around structures that lead to a risk of danger trees. Overall objectives of this assessment are:

- Assess the miles of roads traveling across non-federal lands that are most likely to have danger trees
- Assess the number of structures, and the acres surrounding these structures, that will need detail assessments for danger/hazard trees
- Provide general details on criteria used to assess danger/hazard trees
- Provide information on training available for assessing danger/hazard trees

7.2. Danger/Hazard Trees Described

A danger/hazard tree is defined as a tree that is located near a structure, roadway, or infrastructure that has an imminent or immediate risk of failing. Danger/hazard trees pose safety hazards to the public and must be identified for prompt mitigation of the risk.

Trees along open roads and surrounding structures in areas of low to high vegetation burn severity are susceptible to falling and pose an imminent hazard to people and property within striking distance if they fall. Trees that are determined to be a danger and could cause damage to life and property along roads and around private structures should be mitigated by closing roads, preventing access to structures, or felling the trees.

For the purpose of this document the terms danger and hazard trees are synonymous. The USDA-FS PNW region has guiding documents that reference both danger and hazard trees. The Field Guide for Danger Tree Identification and Response along forest Roads and Work Sites in Oregon and Washington (Filip et al. 2016) uses the term danger trees for identifying trees surrounding roads or work sites. The Field Guide for Hazard Tree Identification and Mitigation on Developed Sites in Oregon and Washington Forests (Filip et al. 2014) is a similar guide for developed recreation sites and uses the term hazard trees for identifying trees surrounding sites with permanent infrastructure.

7.2.1. ROADS ANALYSIS

- Roads within the Holiday Farm Fire were stratified by underlying ownership and percent basal area mortality. Miles per basal area burn severity class were then calculated (Table 1).
- Roads within the fire perimeter were then symbolized by basal area burn severity class and mapped on top of the soil burn severity layer (Figure 1).

Table 1. Miles of road by basal area mortality on Holiday Farm Fire. This provides a coarse estimate of miles of roads where roadside danger tree treatments will be needed. Underlying land ownership is the land under and around the road. Orange shading indicates state, county and non-industrial private land ownership, including unspecified private lands.

Miles of Road by basal area mortality (BA Mort)							
Fire Name	Underlying Land Ownership	0.0	Low 1-50% BA Mort	Mod 51-75% BA Mort	High >75% BA Mort	Total Miles	Total Miles w/BA Mort
Holiday Farm	BLM	0.8	1	5	10	16	15
	Local Government	0.1	2	3	2	8	7
	Not Known	0.0	0.1	0.3	0.2	0.5	0.5
	Private (Unspecified)	19	31	43	96	189	170
	Private Industrial	180	155	193	442	970	790
	Private Non-industrial	0.0	0.2	0.7	0.9	2	2
	State	2	6	8	4	20	18
	USACE	3	2	0.8	0.1	6	3

Miles of Road by basal area mortality (BA Mort)							
	USFS	0.0	0.0	0.2	2	2	2
Holiday Farm Total		205	198	254	557	1213	1008

There are nearly 160 miles of roads with moderate to high levels of basal area mortality on local, state and private land (including unspecified private), with another nearly 40 miles with low basal area mortality (less than 50%; Fig. 1). Cost to mitigate danger trees along these roads will vary with the mortality that occurred due to fire, post-fire mortality that will occur within the next 3 to 5 years, as well as the size of the trees which determines the failure zone. Additional details on determining if a tree is a danger or will become a danger are discussed below in “Damage indicators likely to contribute to failure of fire-injured trees.”

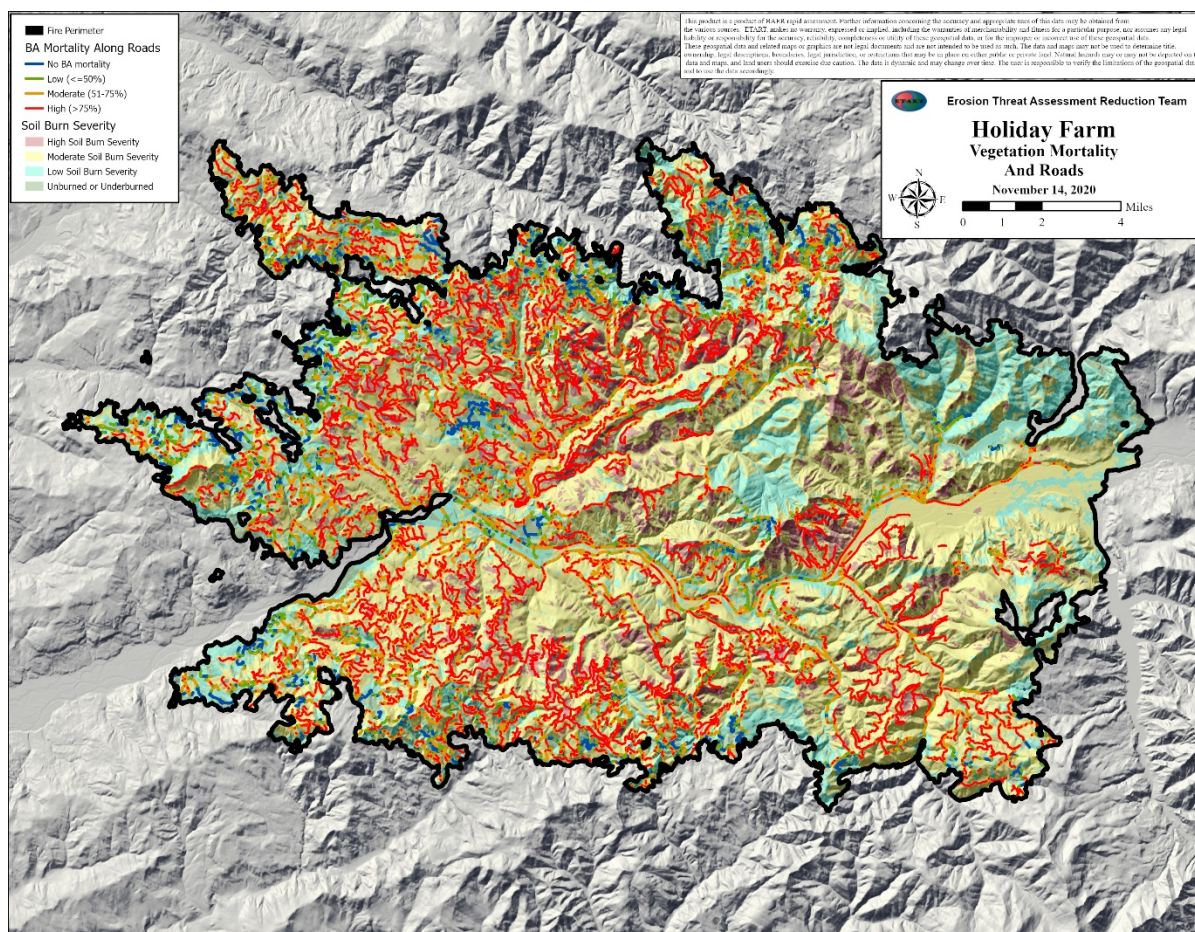


Figure 1. Roads mapped by percent basal area mortality within the Holiday Farm Fire perimeter.

7.2.2. STRUCTURES ANALYSIS

- Acres within a 100' buffer surrounding all structures within the Holiday Farm Fire perimeter were calculated and then stratified by percent basal area mortality class (none, low (1-50%), moderate (51-75%), high (>75%)). One hundred feet was used as a surrogate for the average height of trees assessed for hazard and within striking distance of structures. The numbers of structures were also counted by percent basal area mortality class (Table 2).
- Structures were then symbolized and mapped on top of the basal area burn severity map to provide a visual and to assist with general location of structures (Figure 2).

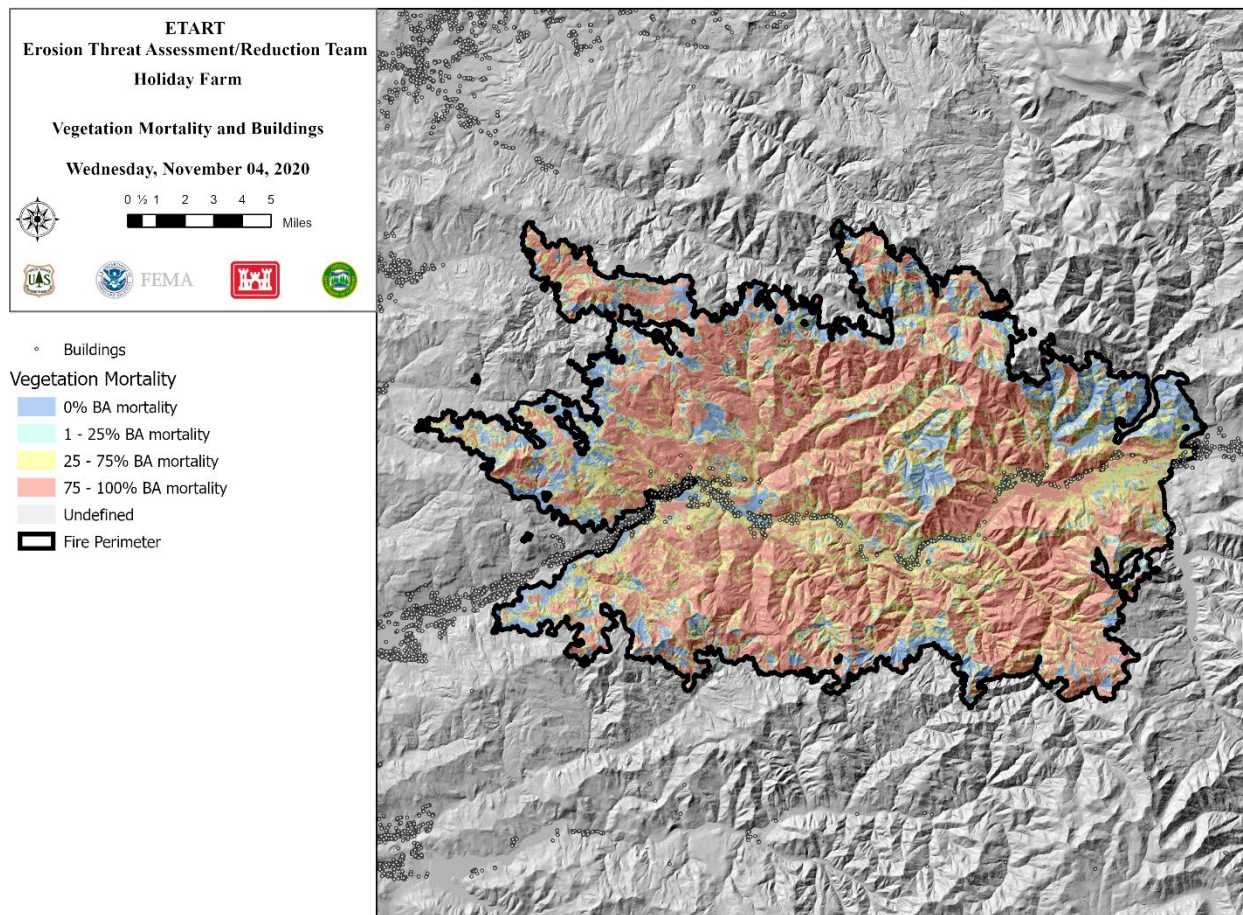


Figure 2. Location of structures within the Holiday Farm Fire perimeter and their locations relative to vegetation mortality.

Table 2. Numbers of structures and acres by percent basal area mortality within 100-foot buffer surrounding structures in each fire.

Fire Name	None (no BA Mortality)		Low BA Mort (1-50% BA Mortality)		Mod BA Mort (51-75% BA Mortality)		High BA Mort (>75% BA mortality)		Low+Mod+High BA Mort (>1% BA Mortality)	
	Acres within 100' foot buffer	Number of structures	Acres within 100' foot buffer	Number of structures	Acres within 100' foot buffer	Number of structures	Acres within 100' foot buffer	Number of structures	Acres within 100' foot buffer	Number of structures
Holiday Farm	193	261	370	404	299	352	132	126	801	882

There are 478 structures located in areas that suffered 50% or greater basal area mortality (Fig. 2). Another 404 structures are located in areas that suffered less than 50% basal area mortality. A 100-foot buffer was drawn around these structures and the acres calculated by basal area burn severity class to provide some guidance on the level of hazard trees that need to be mitigated. There are over 800 acres of hazard trees within the 100' buffer surrounding all structures. The radius of 100 feet was used as a surrogate for tree height, which determines the failure zone. The actual failure zone around structures may be less with shorter trees and greater with taller trees. Additional details on determining if a tree is a hazard or will become a hazard are discussed below in “Damage indicators likely to contribute to failure of fire-injured trees”.

Work sites around recovery efforts

- Many activities involving people and machinery will occur within the fire perimeter during the recovery efforts. Danger trees should be evaluated around these work sites for their likelihood of failure.

7.3. Recommendations

- Fell all trees assessed to be a danger and within the potential failure zone of road systems, work sites, and around structures.
- If resources are limited for accomplishing the felling of all danger trees, then:
 - Roads and structures should be prioritized for evaluation and treatment;
 - Close roads until danger trees can be assessed and felled;
 - Prevent access to structures until danger trees can be assessed and felled.

Recommendation is to use the USFS publication, *Field Guide for Danger Tree Identification and Response along Forest Roads and Work Sites in Oregon and Washington* (Filip et al. 2016) along with Post-fire Assessment of Tree Status and Marking Guidelines for Conifers in Oregon and Washington (Hood et al. 2020) to assess and mark danger trees for removal.

7.3.1. MONITORING

It would be prudent to monitor roads and areas surrounding structures for continued mortality and failure for 3-5 years after initial mitigation. Although the provided guidelines and criteria are meant to identify danger/hazard trees, not all trees will be accurately assessed, and further mortality and degradation may occur after initial assessment and mitigation.

Resources available for assessing danger/hazard trees on the ground

- OSU Fire Extension has recorded a number of post-fire webinars. Links to these webinars, as well as an extensive summary of resources available, can be found by following this link: <https://extension.oregonstate.edu/fire-program>.
- ODF post-fire resources, including information on locating stewardship foresters, can be found here: (<https://www.oregon.gov/odf/fire/Pages/afterafire.aspx>)
- *Field Guide for Danger Tree Identification and Response along Forest Roads and Work Sites in Oregon and Washington*. Link in references and here: http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd512960.pdf
- Post-fire tree mortality assessment and marking guidelines. Link in references and here: https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd814664.pdf
- If on the ground training is needed, this can be arranged by contacting ODF and/or OSU Extension. USFS State and Private Forestry also has experts on staff to help with trainings for assessing trees post-fire at the request of ODF.

Further Evaluation of Danger/Hazard Trees

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7.3.2. DAMAGE INDICATORS LIKELY TO CONTRIBUTE TO FAILURE OF FIRE-INJURED TREES

The following are damage indicators from the USDA-FS Danger Tree criteria (Filip et al. 2016) that should be considered in the post-fire period. Damage thresholds for determining structural stability of a tree are outlined later in this document.

- Trees with **bole cross-section partially consumed**, may be at base or higher on the bole (Filip et al. 2016). This is one of the most common causes of failure post fire.
- Trees with **undermined or severed roots, or roots consumed** by fire (Filip et al. 2016)
- Trees with **cracks or splits** (due to fire and wind) (Filip et al. (2016) refers to this as a bole crack)
- **Detached or broken tops, branches, or bark** (Filip et al. 2016)
- **Recent leaning and/or root sprung trees**. Filip et al. (2016) uses degree of lean greater than 15 degrees.
- Trees with **multiple indicators that are synergistic** where one condition worsens the other. This is very common post-fire where pre-existing conditions are often exacerbated by fire, leading to a tree being a danger. Examples of multiple indicators include: a bole wound with a crack; trees with undermined or severed roots and a lean; stem decay and cracks.
- Additional criteria for determining likelihood of post-fire tree mortality are below.

7.3.3. ADDITIONAL CRITERIA FOR DETERMINING DANGER / HAZARD TREES AFTER WILDFIRE

The determination of danger trees after wildfire is based on two documents:

- 1) Danger Tree Guidelines document: *Field Guide for Danger Tree Identification and Response along forest Roads and Work Sites in Oregon and Washington* (Filip et. al. 2016)
- 2) Post-fire Tree Mortality Guidelines document: *Post-fire Assessment of Tree Status and Marking Guidelines for Conifers in Oregon and Washington* (Hood et al. 2020)

The two documents work together, as shown in Figure 3, to determine if a tree qualifies as a danger tree. First, dead trees are evaluated for their failure potential using Filip et al. (2016). If the tree is damaged, but alive, then it should be evaluated for structural damage using Filip et al. (2016), and subsequently evaluated using Hood et al. (2020) to determine if the tree will likely die within five years of the wildfire. If the tree is likely to die from the fire, then the Danger Tree Guidelines document (Filip et al. 2016) for recently dead trees is used (even if the tree still has green foliage) to determine if the tree is likely to fail within 5 years.

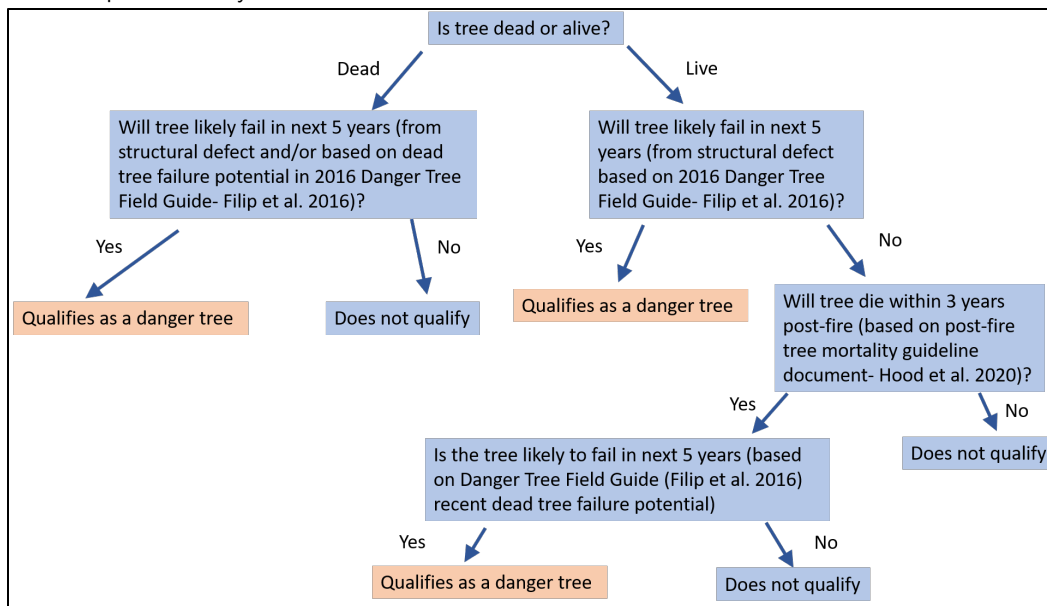


Figure 3. Decision tree for determination of danger trees after wildfire

7.3.4. DANGER TREE GUIDELINES

The Pacific Northwest Region of the USDA Forest Service uses the Field Guide for Danger Tree Identification and Response along Forest Roads and Work Sites in Oregon and Washington (Filip et al. 2016) to identify danger trees on Federal lands. Filip et al. (2016) was authored by forest pathologists, logging specialists, and the Regional road engineer. The Field Guide outlines three levels of failure potential (low, likely, and imminent) and describes structural thresholds that lead to failure based on common failure indicators, including fire damage, on tree species in Oregon and Washington. This publication was first developed in 2005 (Toupin and Barger 2005) to assist field going personnel in the workplace and along roads. It was updated in 2008 (Toupin et al. 2008) and again in 2016 (Filip et al. 2016). The first rendition was based on Harvey and Hessburg (1992), which was designed for developed campgrounds. It was then recognized that a more simplistic process was needed to identify danger trees for field going personnel in a variety of work sites.

The Field Guide for Danger trees outlines three failure potentials:

- **Low Failure Potential:** Trees or their parts are defective or decayed, but it would take considerable effort to make them fail. These trees or parts have a low probability of failure within 10 years.
- **Likely Failure Potential:** Trees or their parts are defective or decayed, but it would take moderate effort to make them fail. These trees or parts have a high probability of failure within 3 to 5 years.
- **Imminent Failure Potential:** Trees or their parts are so defective or decayed that it would take little effort to make them fail. These trees or parts have a high probability of failure within one year.

The likely and imminent failure potential timelines in Filip et al. (2016) appear to be in line with FEMA's guidance to consider imminent hazards within 5 years of the incident.

Table 1 in the Field Guide (Filip et al. 2016, pp. 27-31) lists the failure indicators and their associated failure potentials along with descriptions of low, likely, and imminent. Failure indicators that are relevant to fire damaged trees are outlined below (Table 3), which is an excerpt from Filip et al. (2016; p. 27). Other indicators that may be relevant to fire damaged trees (as listed below) can be found in Appendix E (Table 1 from Filip et al. 2016).

Table 3. Failure indicators that are relevant to living and dead or dying fire-damaged trees.

Failure indicator	Failure potential		
	Imminent	Likely	Low
Old Dead trees (>5 years) No foliage or fine branches; bark is absent or falling off	All tree species except cedar, juniper, and large (>20 in. dbh) Douglas-fir	Cedar, juniper, larch or large Douglas-fir with no other visible indicators	none
Recent Dead Trees (<5 years) All or some foliage; fine branches; bark mostly intact	All trees < 10 in dbh	All trees > 10 in. dbh except cedar, juniper, larch, or large Douglas-fir	Cedar, juniper, larch, or large Douglas-fir
Living, fire-damaged trees with recent (<5 year) fire damage	<p>True fir, hemlock, spruce or hardwood with >50% of bole cross-section burned & consumed.</p> <p>DF, pine, cedar, juniper or larch with >75% of bole cross-section burned & consumed.</p> <p>Any species with >1 quadrant burned & consumed structural roots.</p>	<p>True fir, hemlock, spruce or hardwood with 25-50% of bole cross-section burned & consumed.</p> <p>DF, pine, cedar, juniper or larch with 50-75% of bole cross-section burned & consumed,</p> <p>Any species with 1 quadrant burned & consumed structural roots.</p>	<p>True fir, hemlock, spruce or hardwood with <25% of bole cross-section burned & consumed.</p> <p>DF, pine, cedar, juniper or larch with <50% of bole cross-section burned & consumed,</p> <p>AND no burned & consumed structural roots.</p>

Potential Failure Zone

The potential failure zone is the area on the ground that could be reached by any part of a failed tree. The potential failure zone of a total tree failure is based on several factors, including tree height; ground slope angle- the steeper the slope, the larger the failure zone downhill; and direction of lean if tree is leaning 15 degrees or more. In the USFS Pacific Northwest Region, Engineering Policy FSM R6 supplement 7730-2007-2, the potential failure zone is generally defined as a circle with a radius of 1 ½ times the height of the tree or tree segment, plus additional distance for ground slope and tree lean.

Failure of dead trees

The potential for failure of recent and older dead trees from Table 3 has guidelines based on tree species and size. These recommendations were developed from an analysis of two separate long-term permanent plot data sets on federal and non-federal lands. These analyses were completed and then incorporated into DecAID. “DecAID” is an advisory system developed from a synthesis of data and research results pertaining to forests in Oregon and Washington. These analyses and documentation and data can be found in the summary information on the DecAID application (https://apps.fs.usda.gov/r6_decaid/views/snag_dynamics.html). Over time, more data has become available and the region plans to re-analyze this data in the near future.

Post-fire Tree Mortality Research

The Post-fire Tree Mortality Guidelines (Hood et al. 2020) provides injury thresholds for predicting which trees will likely die (see Table 4 below, which is Appendix E in Hood et al. 2020). Trees are considered dead if they have a > 50% likelihood of dying within 3 years post-fire to capture delayed tree mortality. Trees exceeding the listed thresholds are considered dead, even if they have green needles, because they will likely die within 3 years.

The Post-fire Tree Mortality Guidelines are a compilation of the latest research on predicting post-fire mortality and were developed from data collected from Oregon and Washington (Ryan and Reinhardt 1988, Thies et al. 2006, Grayson et al. 2017) and other research on post-fire mortality model predictions and accuracy evaluation (Fowler et al. 2010, Hood et al. 2010, Davis et al. 2012, Thies and Westlind 2012, Hood and Lutes 2017). The majority of data used to develop and assess accuracy of post-fire tree mortality models that are reported in the above-referenced peer-reviewed publications are described in Cansler et al. (2020a) and are publicly available in the Forest Service Research Data Archive (Cansler et al. 2020b). Model performance is described in (Cansler et al. 2020c); see appendices for full descriptions by species. The 3-year estimate was used because that is what the data support – trees were followed for 3 years after fire and logistic regression was used to develop predicted probability of mortality models. Therefore, any estimate FEMA makes of hazard trees following these guidelines will be conservative in that additional mortality could occur between three and five years.

The Post-fire Tree Mortality Guidelines are based, in part, on Forest Service guidelines for the US Department of Agriculture, Forest Service, Pacific Southwest Region (Smith and Cluck 2011) and Northern Region (USDA Forest Service Region One 2017). The document describes how to determine the levels of fire injury and insect damage that have been shown to be the best indicators of tree mortality. The guidelines use the crown injury indicator of crown scorch, DBH, bark char or cambium injury, and/or the presence or absence of beetle activity indicators to predict mortality.

The likelihood of a tree dying after fire can be assessed by the following indicators:

- 1) Crown Condition: the percentage of the live crown volume or length that is remaining,
- 2) Cambium Injury: the cambium mortality at the root collar,
- 3) Beetle Activity: mass attack or simple presence of bark beetles and wood boring beetles.

The probability that a tree will die after fire depends upon the magnitude of severity of all three factors. More detailed reviews of fire-caused tree mortality are described in (Filip et al. 2007) and (Hood et al. 2018).

Assessing Fire-caused Injury and Bark Beetle Attacks

Percent crown volume scorch (PCVS) is the percentage of the pre-fire crown volume that is scorched from fire. Crown scorch is generally the most important predictor of tree mortality after fire (Sieg et al. 2006, Woolley et al. 2012). It is determined by first estimating the pre-fire live crown volume, based on remaining live crown, residual scorched foliage, residual burned foliage, and residual branches that have burned but likely had live needles prior to the fire. After estimating what the pre-fire live crown looked like, the percentage of the crown by volume that is scorched is estimated (Hood et al. 2007a).

Bark char is an indicator of the condition of the cambium and determines whether a tree will be able to continue to transport nutrients to roots. Trees with high amounts of dead cambium, but with little crown injury, may take several years to die because the trees can still photosynthesize and transport water up through the xylem, but the connection between the crown and roots is severed. Over time, fine roots die without photosynthates, causing a decline in the tree's ability to transport water to the crown and photosynthesize and eventually the tree dies (Hood et al. 2018). Root injury is not included as a mortality risk factor in the guidelines in the mortality document because it is very difficult to assess. However, if a fire consumed deep duff (>5 inches) that had accumulated around the bases of trees, and root injury is a concern, we direct readers to Hood (2010). Cambium death, caused by high or sustained heating of the tree bole or root collar, is an influential factor in tree mortality following fire. Ryan (1982) states that, in the absence of significant crown injury, most trees survive up to 25% basal girdling, but few trees survive more than 75% girdling. The severity and extent of bark char at the root collar can be used as a surrogate for direct cambium sampling. Estimating bark char to determine if a tree is fire-killed is much faster; however, the accuracy varies by species and not all species have been evaluated (Hood et al. 2008). Table 4 (Hood et al. 2020) provides a crosswalk for bark char codes and probable cambium status by species.

Trees heavily infested by bark and/or wood boring beetles are predicted to die (Goheen and Willhite 2006). Beetle mass-attacks that indicate tree mortality are designated by presence of pitch tubes and/or boring dust around > 50% of the circumference of the lower bole of a tree (Hagle et al. 2003). This is either due directly to the impact of bark beetle infestation and/or indirectly due to trees being so significantly injured that they have become infested by wood boring or ambrosia beetles that only feed in dying and recently dead hosts. The amount of bark beetle and wood boring beetle infestation will determine the potential for mortality even if the tree is not predicted to die based on other injury variables. Some types of beetle attack can indicate a tree may, in fact, already be dead or dying while still appearing alive. Beetle infestation is typically indicated by the presence of pitch tubes or boring dust on the bole or around the base of a tree.

Determining Immediate and Imminent Mortality

The rubric shown in Table 4 (which is Appendix A of the Post-fire Tree Mortality Guidelines) provides criteria for determining when there is a high likelihood of tree mortality after fire based on the crown condition as estimated by crown scorch, cambium injury based on bark char severity and magnitude, and bark beetle attack severity. The species included in the rubric are ones in Washington and Oregon for which accurate post-fire mortality models exist. If a species is not listed, either no post-fire tree mortality data exist, or the existing evaluated models performed very poorly. The rubric draws on published research of post-fire tree mortality (Ryan and Reinhardt 1988, Thies et al. 2006, Hood and Bentz 2007, Hood et al. 2007b, Hood et al. 2008, Fowler et al. 2010, Smith and Cluck 2011, Grayson et al. 2017, Hood and Lutes 2017). All trees should be evaluated before the beginning of the second post-fire winter, preferably within the first post-fire year. These criteria are a simplification of statistical model predictions.

Once a tree is evaluated if it will likely live or die, the Danger Tree Guidelines (“Recent Dead Trees” in Table 3 above; Filip et al. 2016) can then be used to determine if it is likely to fail within five years of the wildfire.

Table 4. The rubric shows mortality thresholds using percent crown scorched (either as a percentage of volume or length), circumference and severity of bark char at the root collar, and the bole circumference infested by bark beetles or wood boring beetles. For the rubric, bark char severity is used instead of cambium kill. A tree is considered dead if any criterion is met. (Table from Appendix A in Hood et al. 2020).

Species	Criteria	Diameter Class		
		5 – 11.9”	12 – 20.9”	21”+
ABAM: Pacific silver fir	Crown scorch	> 30% volume		> 40% volume
	Bark char	≥ 50% any char		
ABCO: white fir or hybrids	Crown scorch	≥ 70% volume		
	Bark char	≥ 75% deep char		
ABGR: grand fir	Crown scorch	≥ 60% volume		
	Bark char	≥ 50% any char	≥ 75% moderate or deep char	
ABLA: subalpine fir	Crown scorch	> 30% volume		> 40% volume
	Bark char	> 50% any char		
ABMA: red fir	Crown scorch	≥ 70% volume		
	Bark char	> 75% deep char		
CADE: Incense cedar	Crown scorch	≥ 85% volume		
	Bark char	> 75% deep char		

LAOC: Western larch	Crown scorch	If needles on: $\geq 80\%$ crown length If needles off: average char height over entire tree length $> 70\%$		
	Bark char	$> 75\%$ deep char	Bole char not a predictive injury indicator	
PIEN: Engelmann spruce	Crown scorch	$\geq 75\%$ volume		
	Bark char	$> 75\%$ any char		
PISI: Sitka spruce	Crown scorch	$\geq 75\%$ volume		
	Bark char	$> 75\%$ any char		
PICO: Lodgepole pine	Crown scorch	$\geq 40\%$ volume		
	Bark char	$\geq 75\%$ any char		
PIAL: Whitebark pine	Crown scorch	$\geq 40\%$ volume		
	Bark char	$\geq 75\%$ any char		
PILA: Sugar pine	Crown scorch	$\geq 70\%$ volume		
	Bark char	$> 90\%$ moderate or deep char		
PIMO: Western white pine	Crown scorch	$> 30\%$ volume		
	Bark char	$\geq 90\%$ any char		
PIPO: Ponderosa pine	Crown scorch	Pre-bud break (volume): $> 85\%$ needles scorched OR $> 40\%$ needles consumed/blackened OR $> 5\%$ and $\leq 40\%$ needles consumed/blackened combined with $> 50\%$ needles scorched Post-bud break (volume): $> 70\%$ crown volume killed (no new growth)		
	Bark char	$> 90\%$ deep char		
PSME: Douglas-fir	Crown scorch	$> 65\%$ crown volume		
	Bark char	$> 50\%$ deep char	$> 75\%$ deep char	
THPL: Western red cedar	Crown scorch	$> 20\%$ crown volume	$> 40\%$ crown volume	$> 60\%$ crown volume
	Bark char	$> 50\%$ any char		
TSHE: Western hemlock	Crown scorch	$\geq 20\%$ crown volume		
	Bark char	$\geq 90\%$ any char		
	Crown scorch	$\geq 20\%$ crown volume		

TSME: Mountain hemlock	Bark char	≥ 90% any char
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Note: If a species is host to bark beetles or wood borers and there is boring dust and attack signs that are not RTB around > 50% of the bole circumference, the tree will die regardless of fire injury.

7.4. References

Cansler, C. A., S. M. Hood, J. M. Varner, P. J. van Mantgem, M. C. Agne, R. A. Andrus, M. P. Ayres, B. D. Ayres, J. D. Bakker, M. A. Battaglia, B. J. Bentz, C. R. Breece, J. K. Brown, D. R. Cluck, T. W. Coleman, R. G. Corace, W. W. Covington, D. S. Cram, J. B. Cronan, J. E. Crouse, A. J. Das, R. S. Davis, D. M. Dickinson, S. A. Fitzgerald, P. Z. Fulé, L. M. Ganio, L. M. Grayson, C. B. Halpern, J. L. Hanula, B. J. Harvey, J. Kevin Hiers, D. W. Huffman, M. Keifer, T. L. Keyser, L. N. Kobziar, T. E. Kolb, C. A. Kolden, K. E. Kopper, J. R. Kreidler, J. K. Kreye, A. M. Latimer, A. P. Lerch, M. J. Lombardero, V. L. McDaniel, C. W. McHugh, J. D. McMillin, J. J. Moghaddas, J. J. O'Brien, D. D. B. Perrakis, D. W. Peterson, S. J. Prichard, R. A. Progar, K. F. Raffa, E. D. Reinhardt, J. C. Restaino, J. P. Roccaforte, B. M. Rogers, K. C. Ryan, H. D. Safford, A. E. Santoro, T. M. Shearman, A. M. Shumate, C. H. Sieg, S. L. Smith, R. J. Smith, N. L. Stephenson, M. Stuever, J. T. Stevens, M. T. Stoddard, W. G. Thies, N. M. Vaillant, S. A. Weiss, D. J. Westlind, T. J. Woolley, and M. C. Wright. 2020a. The Fire and Tree Mortality Database, for empirical modeling of individual tree mortality after fire. *Scientific Data* 7:194.

Cansler, C. A., S. M. Hood, J. M. Varner, P. J. van Mantgem, M. C. Agne, R. A. Andrus, M. P. Ayres, B. D. Ayres, J. D. Bakker, M. A. Battaglia, B. J. Bentz, C. R. Breece, J. K. Brown, D. R. Cluck, T. W. Coleman, R. G. Corace, W. W. Covington, D. S. Cram, J. B. Cronan, J. E. Crouse, A. J. Das, R. S. Davis, D. M. Dickinson, S. A. Fitzgerald, P. Z. Fulé, L. M. Ganio, L. M. Grayson, C. B. Halpern, J. L. Hanula, B. J. Harvey, J. K. Hiers, D. W. Huffman, M. Keifer, T. L. Keyser, L. N. Kobziar, T. E. Kolb, C. A. Kolden, K. E. Kopper, J. R. Kreidler, J. K. Kreye, A. M. Latimer, A. P. Lerch, M. J. Lombardero, V. L. McDaniel, C. W. McHugh, J. D. McMillin, J. J. Moghaddas, J. J. O'Brien, D. D. B. Perrakis, D. W. Peterson, S. J. Prichard, R. A. Progar, K. F. Raffa, E. D. Reinhardt, J. C. Restaino, J. P. Roccaforte, B. M. Rogers, K. C. Ryan, H. D. Safford, A. E. Santoro, T. M. Shearman, A. M. Shumate, C. H. Sieg, S. L. Smith, R. J. Smith, N. L. Stephenson, M. Steuver, J. T. Stevens, M. T. Stoddard, W. G. Thies, N. M. Vaillant, S. A. Weiss, D. J. Westlind, T. J. Woolley, and M. Wright. 2020b. Fire and tree mortality database (FTM). Fort Collins, CO: Forest Service Research Data Archive. Updated 24 July 2020. <https://doi.org/10.2737/RDS-2020-000>.

Cansler, C. A., S. M. Hood, P. J. van Mantgem, and J. M. Varner. 2020c. A large database supports the use of simple models of post-fire tree mortality for thick-barked conifers, with less support for other species. *Fire Ecology* 16:25.

Davis, R. S., S. Hood, and B. J. Bentz. 2012. Fire-injured ponderosa pine provide a pulsed resource for bark beetles. *Canadian Journal of Forest Research* 42:2022-2036.

Filip, G., M. Barger, J. Bronson, K. Chadwick, R. Collins, B. Goodrich, H. Kearns, M. McWilliams, B. Oblinger, D. Omdal, A. Ramsey, and A. Saaverdra. 2016. Danger-Tree Identification and Response along Forest Roads and Work Sites in Oregon and Washington. R6-NR-TP-021-2016. http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd512960.pdf.

Filip, G., J. Biro, K. Chadwick, D. Goheen, E. Goheen, J. Hadfield, A. Kanaskie, H. Kearns, H. Maffei, K. Mallams, D. Omdal, A. Saavedra, and C. Schmitt. 2014. Field Guide for Hazard-Tree Identification and Mitigation on Developed Sites in Oregon and Washington Forests. R6-NR-TP-021-2013. https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprd3799993.pdf .

Filip, G. M., C. L. Schmitt, D. W. Scott, and S. A. Fitzgerald. 2007. Understanding and defining mortality in western conifer forests. *Western Journal of Applied Forestry* 22:105-115.

Fowler, J. F., C. H. Sieg, J. McMillin, K. K. Allen, J. F. Negron, L. L. Wadleigh, J. A. Anhold, and K. E. Gibson. 2010. Development of post-fire crown damage mortality thresholds in ponderosa pine. *International Journal of Wildland Fire* 19:583-588.

Goheen, E. M., and E. A. Willhite. 2006. Field guide to the common diseases and insect pests of Oregon and Washington Conifers. R6-NR-FID-PR-01-06. U.S. Department of Agriculture, Forest Service, Pacific Northwest Region, Portland, OR. 325p.

Grayson, L. M., R. A. Progar, and S. M. Hood. 2017. Predicting post-fire tree mortality for 14 conifers in the Pacific Northwest, USA: Model evaluation, development, and thresholds. *Forest Ecology and Management* 399:213-226.

Hagle, S. K., K. Gibson, and S. Tunnock. 2003. Field guide to diseases and insect pests of Northern and Central Rocky Mountain conifers. Report Number R1-03-08. U.S. Department of Agriculture, Forest Service, State and Private Forestry, Northern Region and Intermountain Region, Missoula, MT.

Harvey, R. D., and P. F. Hessburg. 1992. Long-Range Planning for Developed Sites in the Pacific Northwest: The context of Hazard Tree Management. FPM-TP039-92. https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fsbdev2_026108.pdf.

Hood, S., and D. Lutes. 2017. Predicting post-fire tree mortality for 12 western US conifers using the First-Order Fire Effects Model (FOFEM). *Fire Ecology* 13:66-84.

Hood, S., I. Ragenovich, and B. Schaupp. 2020. Post-fire Assessment of Tree Status and Marking Guidelines for Conifers in Oregon and Washington. Report Number R6-FHP-RO-2020-02. https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd814664.pdf

Hood, S., M. Varner, P. van Mantgem, and C. A. Cansler. 2018. Fire and Tree Death: Understanding and Improving Modeling of Fire-induced Tree Mortality *Environmental Research Letters* 13:113004.

Hood, S. M. 2010. Mitigating old tree mortality in long-unburned, fire-dependent forests: a synthesis. RMRS-GTR-238. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

Hood, S. M., and B. Bentz. 2007. Predicting post-fire Douglas-fir beetle attacks and tree mortality in the Northern Rocky Mountains. *Canadian Journal of Forest Research* 37:1058-1069.

Hood, S. M., B. Bentz, K. Gibson, K. C. Ryan, and G. DeNitto. 2007a. Assessing post-fire Douglas-fir mortality and Douglas-fir beetle attacks in the northern Rocky Mountains. RMRS-GTR-199. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

Hood, S. M., D. R. Cluck, S. L. Smith, and K. C. Ryan. 2008. Using bark char codes to predict post-fire cambium mortality. *Fire Ecology* 4:57-73.

Hood, S. M., C. McHugh, K. C. Ryan, E. Reinhardt, and S. L. Smith. 2007b. Evaluation of a post-fire tree mortality model for western US conifers. *International Journal of Wildland Fire* 16:679-689.

Hood, S. M., S. Smith, and D. Cluck. 2010. Predicting tree mortality for five California conifers following wildfire. *Forest Ecology and Management* 260:750-762.

Ryan, K. C. 1982. Techniques for assessing fire damage to trees. Pages 1-11 in J. Lotan, editor. *Proceedings of the symposium: Fire, its field effects, 19-21 October 1982, Jackson, Wyoming*. Intermountain Fire Council, Missoula, MT.

Ryan, K. C., and E. D. Reinhardt. 1988. Predicting postfire mortality of seven western conifers. *Canadian Journal of Forest Research* 18:1291-1297.

Sieg, C. H., J. D. McMillin, J. F. Fowler, K. K. Allen, J. F. Negrón, L. L. Wadleigh, J. A. Anhold, and K. E. Gibson. 2006. Best predictors for postfire mortality of ponderosa pine trees in the Intermountain West. *Forest Science* 52:718-728.

Smith, S. L., and D. R. Cluck. 2011. Marking Guidelines for Fire-Injured Trees in California. Report RO-11-01. RO-11-01, USDA Forest Service, Forest Health Protection, Region 5, Susanville, CA.

Thies, W. G., and D. J. Westlind. 2012. Validating the Malheur model for predicting ponderosa pine post-fire mortality using 24 fires in the Pacific Northwest, USA. *International Journal of Wildland Fire* 21:572-582.

Thies, W. G., D. J. Westlind, M. Loewen, and G. Brenner. 2006. Prediction of delayed mortality of fire-damaged ponderosa pine following prescribed fires in eastern Oregon, USA. *International Journal of Wildland Fire* 15:19-29.

Toupin, R., and M. Barger. 2005. Field Guide for Danger Tree Identification and Response. R6-NR-FP-PR-03-05.

Toupin, R., G. Filip, T. Erkert, and M. Barger. 2008. Field Guide for Danger Tree Identification and Response. R6-NR-FP-PR-01-08.

USDA Forest Service Region One. 2017. Post-fire assessment of Tree Status. Vegetation Classification, Mapping, Inventory and Analysis Report. Report 17-17 v2.0.

Woolley, T., D. C. Shaw, L. M. Ganio, and S. A. Fitzgerald. 2012. A review of logistic regression models used to predict post-fire tree mortality of western North American conifers. *International Journal of Wildland Fire* 21:1-35.

8. Fish and Wildlife Resources

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8.1. Objectives

Document post-fire concerns and management opportunities for fish and wildlife critical values within the Archie Creek, Beachie Creek, Holiday Farm and Riverside Fires.

8.2. Assessment Methodology - Field and Modeling

Oregon Department of Fish and Wildlife (ODFW) fish and wildlife biologists combined pre-fire knowledge of fish and wildlife distribution, habitat, and limiting factors with post-fire information such as soil burn severity, vegetation mortality, hazardous materials, and other data to develop maps depicting both threats to critical values and areas where post-fire management could benefit critical values. These maps were compared to recent field data collected by the ETARTs effort to determine any additional threats or opportunities. Additionally, ODFW identified potential negative impacts to [Oregon Conservation Strategy](#) (OCS) wildlife priorities from the fires.

8.3. Resource Setting

High value natural resources are found in and around the Holiday Farm Fire: populations of spring Chinook, winter steelhead, and bull trout (federally threatened); cutthroat trout; lamprey (state sensitive); Roosevelt elk and black-tailed deer, and multiple wildlife strategy species including coastal tailed frog (state sensitive), clouded salamander (state sensitive), Cascade torrent salamander (state sensitive), northwestern pond turtle (state sensitive-critical), Northern spotted owl (federal threatened), and Townsend's big-eared bat (state sensitive-critical); and key strategy habitats including late successional forest, riparian, oak woodland, and wetland habitats that support these species. Prior to the fire, many of the riparian and stream habitats supporting these values were depauperate of large woody debris (LWD) and/or vegetation suitable to support beavers. The Archie Creek Fire burned these habitats with a relatively high percentage of moderate to high burn severity.

8.4. Critical Values, Results, Risk Assessment, and Recommendations

Two categories of fish and wildlife Critical Values (CVs) were identified: those determined to be at risk of post-fire threats, and those deemed restoration/natural recovery opportunities. In some cases, ODFW can directly implement actions to address direct threats (e.g. to hatchery water supplies or fish ladders); in all other cases, ODFW will work with partners to address both risks and opportunities. In subsequent sections, these values are specifically evaluated for each fire.

Four Critical Values (CVs) were determined to be at risk of post-fire threats (1 at high risk), and restoration/natural recovery opportunities were identified for nine additional CVs (8 with high reward; Table 1). In all cases, ODFW will work with partners to address both risks and opportunities. A large portion of the McKenzie River Area COA is within the fire perimeter.

8.5. Recommended Monitoring

Near-term success in engaging partners can be monitored by number of projects on which engagement occurs. Over the mid- to longer-terms, success can be measured by habitat variables and populations metrics, such as LWD recruitment into stream channels and escapement of

salmonids or population counts of terrestrial wildlife. In addition, partners should prioritize monitoring to increase understanding of species response to fire and post-fire habitat treatments. Likewise, habitats should be assessed over time to determine effectiveness of and responses to treatments, changes in species composition, and presence of invasive species.

Holiday Farm ETART Members

Holiday Farm ETART

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Appendix A – Road Treatment Cost Estimates

Storm Inspection and Response. Following significant rainfall events, implement appropriate storm response to ensure the drainage infrastructure (bridges, culverts, ditches and cross-drains) are properly functioning to minimize road damage until the natural revegetation of the burned area has occurred. Deploy personnel with equipment to inspect and react as appropriate to: maintain and/or repair any damage to road surfaces; remove hazard trees or woody debris from roadside ditches and culvert inlet basins along affected length of priority roads; and monitor the movement of large woody debris, make a determination to remove material before it contacts bridge piers, abutments or culverts.

Determination of a significant rainfall event triggering storm response is in development with National Weather Service hydrologists. Storm predictions and watershed response parameters will provide guidance to cooperators on what level of event(s) are considered significant for flooding or to mobilize debris. This triggering event will likely adjust over time with post-storm event response to address road maintenance needs and monitoring of emerging concerns.

Priority roads for Storm Response. Blue River Road, Blue River Drive, Elk Creek Road, Eagle Rock Road & Eagle Rock Place, North Gate Creek Road, Goodpasture Road, Leashore Drive, Angels Flight Road and Leaburg Dam Road.

Priority bridge & culverts for Storm Response. Stream crossing treatments should be high priority because of high-value structures and potential loss of emergency access should the crossing fail.

Blue River Road, Simmonds Creek Bridge (MP 0.45)

Stage larger excavator to pull debris from channel as there is increased potential for damage to abutments and footings.

North Gate Creek Road, 18-inch CMP cross-drain culvert (MP 1.65)

It is highly advised the inlet basin for this crossing be cleaned frequently. A treatment alternative is to upsize the 18-inch culvert to a 24 or 36-inch culvert to handle the expected increases in water flow, sediment and debris.

Goodpasture Road, 36-inch concrete culvert (MP 0.75) and 42-inch corrugated steel culvert (MP 5.00)

Both culverts have high risk for failure from increased flow and mobilized debris, with high consequences. A treatment alternative to construct a debris rack on the up-gradient side of both culverts should be considered.

Leashore Drive, culvert (MP 0.42)

High risk for failure from increased flow and mobilized debris, with high consequences. It is advised the inlet basin for this crossing be monitored frequently and cleaned as needed.

Angels Flight Road, 18-inch HDPE cross drain culvert (MP 0.49)

High risk for failure from increased flow and mobilized debris, with high consequences. It is recommended to remove the dam up-gradient of the culvert or to replace the wooden dam retaining wall. Investigation of ownership of the dam may be necessary prior to treatment.

Cost Summary. Lane County maintenance activities are not assessed in this cost estimate. Only proposed remediations such as culvert replacements are listed in the cost summary. If there is a culvert failure due to the fire impacts on a Lane County road, the cost estimates in Table 7 would be a similar cost of replacing any other culverts.

Table 7. Road Treatments Cost Estimates – Holiday Farm Fire

North Gate Creek Road - Upsize Culvert (MP 1.65) Cost Summary				
Item	Unit	QTY	Unit Price	Total
Mobilization	LS	1	\$1,683	\$2,000
Traffic Control	LS	1	\$6,300	\$6,300
Erosion Control	LS	1	\$500	\$500
General Excavation	CY	75	\$20	\$1,500
Embankment-In-Place	CY	55	\$25	\$1,375
36-inch Storm Sewer Pipe, 5 feet deep	FT	25	\$100	\$2,500
Aggregate Base	TON	20	\$15	\$300
Level 3, ½ Inch Dense ACP	TON	10	\$75	\$750

6-Inch Asphalt Concrete Pavement Repair	SY	30	\$10	\$300
Sub-Total				\$15,525
50% Contingency				\$7,763
Total				\$23,290
Goodpasture Rd – Debris Rack 36-in Culvert (MP 0.75) Cost Summary				
Item	Unit	QTY	Unit Price	Total
Mobilization	LS	1	\$800	\$800
Traffic Control	LS	1	\$1,500	\$1,500
Erosion Control	LS	1	\$500	\$500
Heavy Trash Guard for 36-in Culvert	LS	1	\$1,320	\$1,320
Sub-Total				\$4,120
50% Contingency				\$2,060
Total				\$6,180
Goodpasture Rd – Debris Rack 42-in Culvert (MP 5.0) Cost Summary				
Item	Unit	QTY	Unit Price	Total
Mobilization	LS	1	\$800	\$800
Traffic Control	LS	1	\$1,500	\$1,500
Erosion Control	LS	1	\$500	\$500
Heavy Trash Guard for 42-in Culvert	LS	1	\$1,800	\$1,800
Sub-Total				\$4,600
50% Contingency				\$2,300
Total				\$6,900
Angels Flight Rd – Dam Removal (MP 0.49) Cost Summary				
Item	Unit	QTY	Unit Price	Total
Mobilization	LS	1	\$500	\$500
Traffic Control	LS	1	\$1,500	\$1,500

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Erosion Control	LS	1	\$500	\$500
Excavation + operator	Hr	8	\$150	\$1,200
Sub-Total				\$4,000
50% Contingency				\$2,000
Total				\$6,000

Appendix B – Supporting Botany Information

Section I. Botany VAR Table

Section II. ODA Noxious Weed Classifications

Section III. Treatment Design and Estimated Costs

Section IV. Upper Willamette Cooperative Weed Management Area Priority List 2014

Section V. Field Assessment Photos

I. VAR Table

See Holiday Farm Fire Complete VAR Table Attachment.

II. ODA Noxious Weed Classifications

Local Noxious Weed and Invasive Species Information:

The Oregon Department of Agriculture (ODA) Noxious Weed Program works with the Oregon State Weed Board to list and publish state noxious weed classifications. This include A, B and T-listed weeds.

A-listed weeds are of very limited distribution across the state of Oregon.

B-listed weeds may be regionally abundant but may have limited local distribution.

T-designated weeds are those targeted for state control measures. Both A and B listed species may also receive a T-designation if they are targeted for treatment through the ODA program (which may include manual, mechanical, chemical or biological control).

Additionally, local entities may develop their own noxious weed priorities based on local distributions, economic/environmental threats, and available resources for control.

ODA: <https://www.oregon.gov/oda/programs/Weeds/Pages/AboutWeeds.aspx>

OSWB: <https://www.oregon.gov/ODA/programs/Weeds/Pages/WeedBoard.aspx>

III. Treatment Design and Estimated Costs

The analysis in the 2020 ETART Holiday Farm Botany report should serve as a starting place for addressing weed threats. Weed detection surveys and treatments should begin Spring 2021 and continue over the next 3-5 years, if resources are available. Surveys along roads should begin immediately where source populations and/or vector movement are a concern (i.e. arterial forest road networks). All roads used as fire lines should be surveyed at least once by August 2021 and repeated, if possible, for 3-5 years. If more resources become available, additional areas should also

identified for weed presence surveys and prioritized in the context of spatial relationship to critical resource values.

The Early Detection Rapid Response (EDRR) treatments are designed to protect sensitive native plant communities and supplement remaining native seed banks that promote native plant community recovery. The EDRR survey and treatment actions take into account known weed infestations, sensitive natural habitat types, rare plants, fire suppression lines and existing riparian restoration investments. This assessment identifies response actions to protect native plant communities by reducing the threat of weeds from fire disturbance, fire suppression operations and during post-fire recovery efforts. Cost estimates for implementing these treatments are in Table 8. It is critical to perform EDRR actions in the spring and fall of 2021 to prevent invasive plants from establishing in weed-free burned areas. Refer to the 2020 ETART Holiday Farm Botany Specialist Report for additional details on the invasive plant species and noxious weed threat analysis and treatments.

ETART EDRR

Priority sites for initial survey and detection work are those within at least 50% basal area loss in proximity to the identified sensitive habitat types of concern and/or documented weed infestations. A total of 433 acres were flagged that met those parameters. These areas should be prioritized for survey efforts, ideally in both the spring and fall (at least the first year) and revisited annually during the mitigation period (3-5 years) as resources allow.

Table 8. Cost Estimates for Invasive Plant and Noxious Weed Treatments - Holiday Farm Fire

Treatment or Response Action	Units	Number	Estimated Unit Cost	Description of Cost
ETART EDRR (natural vegetation protection areas)	Acres	433	\$360/acre Spring Comb Spray \$280/acre Fall Spot Spray \$62/hr = Surveying and Monitoring	Spring 2021 and Fall 2021 EDRR surveys and treatment in natural vegetation protection areas that experienced moderate to high SBS and are adjacent to known weed populations.

Treatment or Response Action	Units	Number	Estimated Unit Cost	Description of Cost
ETART EDRR (roads and trails)	Miles	87	\$360/acre Spring Comb Spray \$280/acre Fall Spot Spray \$62/hr = Surveying and Monitoring	Spring 2021 and Fall 2021 Early detection rapid response surveys and treatment along roadsides and trails that experienced Mod/High severity burning and are adjacent to known weed populations.
ETART Suppression EDRR (suppression lines)	Miles (Acres)	56	\$360/acre Spring Comb Spray \$280/acre Fall Spot Spray \$62/hr = Surveying and Monitoring	Spring 2021 and Fall 2021 Early detection rapid response surveys and treatment on the dozer line, hand line and road completed line.
ETART Suppression EDRR (drop points)	Each	12	\$360/acre Spring Comb Spray \$280/acre Fall Spot Spray \$62/hr = Surveying and Monitoring	Spring 2021 and Fall 2021 Early detection rapid response surveys and treatment of drop points/staging areas. Acres unknown.
Weed Wash Stations for Equipment	Each	2	\$3,200/Station (recycled water)	Locate west and east on McKenzie River Highway prior to entering fire.
Weed Survey and Control Coordination	Month	6	\$62,477	ODA Noxious Weed Staff employee or local coordinator resource to direct and implement survey detection and evaluation.
Native Seed for suppression lines and drop points	Acre	70	\$140/acre	Blue Wildrye native seed (broadcast seeding at 14 lbs./acre).

Treatment or Response Action	Units	Number	Estimated Unit Cost	Description of Cost
Educational Signs	Each	10	\$500	Place in parks, at boat ramps and trailheads.
Boot Brushes	Each	20	\$300	Boot brush supplies and installation
Bare Root Plants	Each		\$1.00	As needed for future plantings.
Native Seed	Pound		\$10.00	As needed for future plantings.

ETART Fire Suppression EDRR

All fire suppression lines should be assumed to be potential sources of new weed introductions and spread. Weeds thrive in disturbed areas with increased light availability such as fire lines. Equipment and personnel used for suppression efforts were mobilized from across a broad geography and due to the quick progression of the historic fire it should be inferred that many new weed seeds will be brought into these areas. The highest priorities are dozer lines along the fire perimeter, followed by affected roads (Table 9). In addition to suppression lines, activity points such as incident camps, equipment and personnel staging areas, helipads and safety zones should be surveyed for the presence of new weed introductions (Figure 8).

Table 9. ETART EDRR Fire Suppression Treatments for Invasive Plant Species & Noxious Weeds – Holiday Farm Fire

Fire Suppression Feature	Holiday Farm Fire (non-Federal Lands)		
	Private Industry Lands (miles)	Private Individual or Company (miles)	Total Miles
Completed Dozer Line	23	34	57
Completed Hand Line	10	22	32
Road as Completed Line	48	39	87
Road Repair	<1	2	2
Total Miles	82	97	178

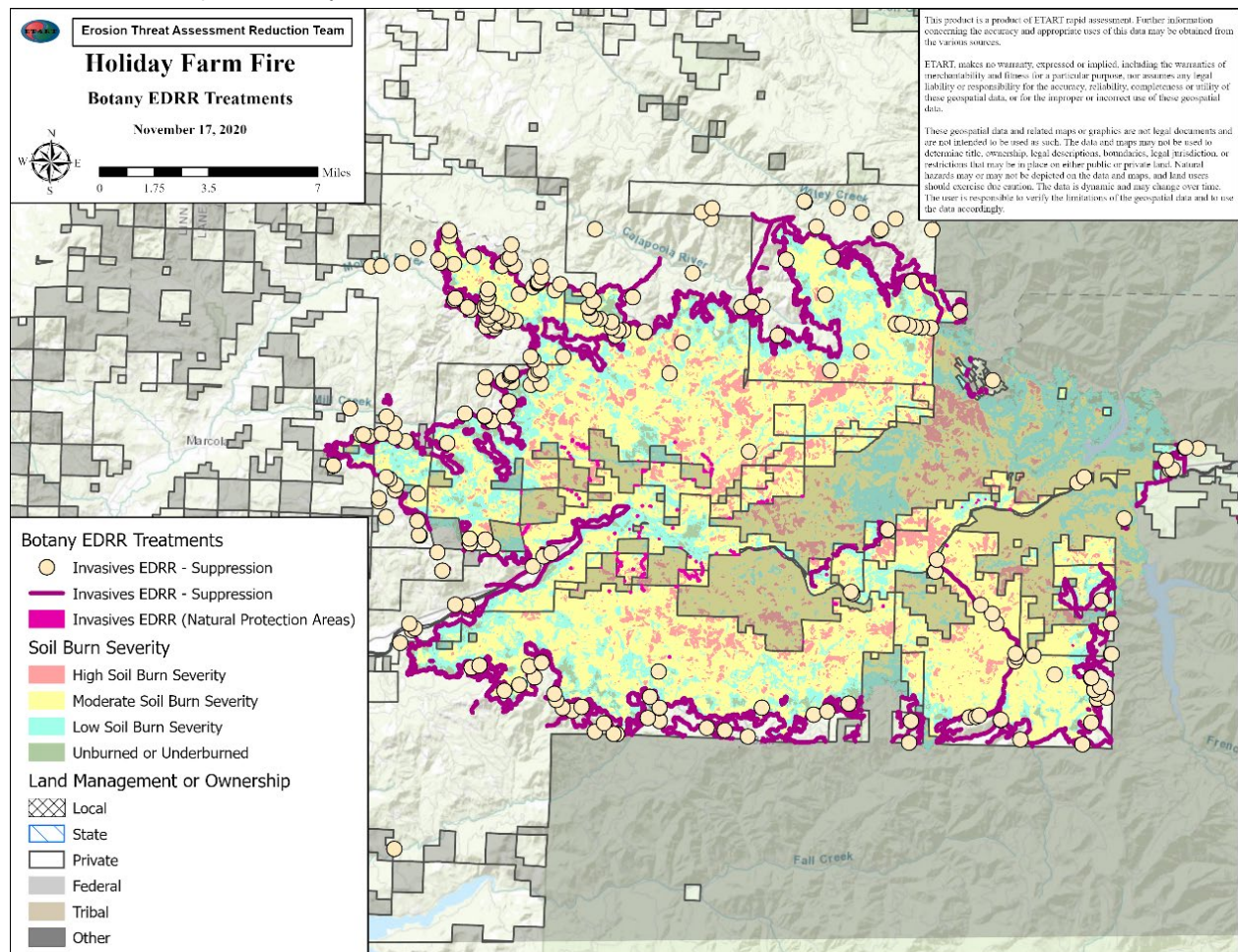


Figure 8. ETART Fire Suppression Treatments – Holiday Farm Fire

Prevent Spread of Existing Weed Infestations. Numerous vectors capable of spreading existing weed infestations exist within the burned area of the Holiday Farm Fire. Both the McKenzie Highway (OR-126) and the McKenzie River run the length of the burned area from east to west. Several other well-known pathways also exist within the fire area, including public and private forest roads, trails and drainages. Furthermore, the widespread use of straw and seed in post-fire recovery efforts can easily lead to the unintended introduction of new weeds.

Recommendations include: mandate the use of vehicle wash stations for vehicles travelling into burned areas along forest roads; implement and enforce clean equipment, footwear and gear policies; ensure straw and seed mixes used in post-fire recovery come from reputable sources (use certified weed-free straw to the maximum extent possible); and only use seed that has documented weed analysis with values less than 0.5%.

Control Known Noxious Weeds. Both established and new introductions of weeds have potential for rapid expansion into moderate and severe SBS areas. Species such as false brome, herb Robert, spotted knapweed and knotweed are known within the burned area in limited distribution, but are well-poised to rapidly spread with increased soil nutrient and light availability, fire disturbance and increased vehicle traffic/vector potential. Additional, not yet detected species may be of even greater concern. Common species such as scotch broom, blackberry, ivy, herb Robert, foxglove, reed

canarygrass, and several others also threaten the numerous Critical Values identified in this assessment.

Recommendations include control known populations of priority perennial or biennial noxious weeds such as false brome and herb Robert within the burn area as soon as temperatures start to warm to 50F in the early spring while many natives are either dormant or have yet to resprout from viable roots. Focus first on high traffic corridors such as boat ramps, trailheads and arterial forest roads. Timely attention should also be given to any new or threatening infestations near sensitive natural habitat protection areas such as oak, meadow, wetlands and T&E habitat as soon as possible once they have been observed.

Survey High Risk Areas. The newly burned areas are highly vulnerable to rapid establishment of noxious weeds and invasive, non-native plants. Add to the presence of fire suppression disturbances, it is clear that without prompt action, the potential for an explosion of invasive weeds on high and moderately SBS area is extremely high. This is especially a concern in locations near rare natural habitats and known weed presence.

Recommendations include rapid implementation of EDRR priority locations identified by GIS modelling and analysis. These areas have been prioritized due to their proximity to known weed locations (50 m buffer), potential to impact adjacent sensitive habitat types (i.e. “Natural Vegetation Protection Areas”) and presence within severe burn areas.

Develop Public Awareness. Resources do not exist to effectively monitor all potential areas for priority weed establishment. Fire and invasive plants do not adhere to property boundaries. Overlooked new infestations are likely to occur outside even the most comprehensive monitoring strategy, especially when so many properties are held in different ownership. As these infestations grow, they threaten critical resource values elsewhere in the fire.

Recommendations include installing signage at popular informational community gathering hubs alerting and educating the public about the threats from invasive species. Posting threat awareness to local forums such as social media and newsletters (e.g. River Reflections). If funds are available, consider posting roadside signs at west and east entrances to burn area. Install boot brushes and invasive species signage at boat ramps and trailheads. Encourage reports be made to OregonInvasivesHotline.org and assign local weed management contacts to receive alerts when a community report is made.

Revegetate to Promote Resiliency. Restore and revegetate valued areas where soil and water quality impacts from weeds are particularly concerning. The post-fire landscape will continue to be favor the establishment of weeds for years following fire.

Successes with emergency mitigation efforts will be more effective in the long-term if susceptible areas with high vegetation mortality are revegetated quickly with suitable, competitive native plant material. Restoration will also improve soil and water quality. Given the rapid-fire progression it is likely that many understory plants will resprout from the roots, therefore account for the possibility of passive revegetation. Monitor, evaluate and perform maintenance as needed for desirable native vegetation to become established.

Continue Survey and Monitoring Efforts. For 3-5 years conduct follow-up monitoring of the survey and treatment programs to control target weeds. Evaluate efficiency, identify any gaps in the approach, modify and adapt management methods appropriately for desired outcomes and protection of critical resource values.

IV. Upper Willamette CWMA Priority Weed List 2014

WEEDS/PLANTS OF CONCERN: Upper Willamette Cooperative Weed Management Area 2014				
¹ UWCWMA status: 1=New invaders; 2=locally established; 3=widely established; W=watch list				
COMMON NAME	SPECIES	List ¹	2014 status	ODA
List 1: New Invaders, potential invaders or eradicated from the Upper Willamette				
Garlic mustard	<i>Alliaria petiolata</i>	1	Eradicated	B
Portuguese broom	<i>Cytisus striatus</i>	1	Eradicated	B
Distaff thistle	<i>Carthamus lanatus</i>	1	Potential	A
Diffuse knapweed	<i>Centaurea diffusa</i>	1	Rare/erad.	B
Yellow starthistle	<i>Centaurea solstitialis</i>	1	Eradicated	B
Patterson's curse	<i>Echium plantagineum</i>	1	Potential	A
Giant hogweed	<i>Heracleum mantegazzianum</i>	1	Eradicated	A
Hawkweed complex	<i>Hieracium aurantiacum</i> , <i>H. floribundum</i>	1	Rare	A
Hydrilla	<i>Hydrilla verticillata</i>	1	Potential	A
Spotted jewelweed	<i>Impatiens capensis</i>	1	Rare/Potential	unlisted
Dyers woad	<i>Isatis tinctoria</i>	1	Rare	A
Yellow archangel	<i>Lamium galeobdolon</i>	1	Expanding	B
Water primrose willow	<i>Ludwigia peploides</i> , <u><i>hexapetala</i></u>	1	Expanding	B
Yellow floating heart	<i>Nymphoides peltata</i>	1	Eradicated	A
Pokeweed	<i>Phytolacca americana</i>	1	Rare/Potential	unlisted
Sulfur cinquefoil	<i>Potentilla recta</i>	1	Slight exp.	B

WEEDS/PLANTS OF CONCERN: Upper Willamette Cooperative Weed Management Area 2014

Spanish broom	<i>Spartium junceum</i>	1	Rare	B
Puncturevine	<i>Tribulus terrestris</i>	1	Slight exp.	B
Himalayan knotweed	<i>Polygonum polystachyum</i> (= <i>Persicaria wallichii</i>)	1	Rare	B
Coltsfoot	<i>Tussilago farfara</i>	1	Potential	A
Gorse	<i>Ulex europaeus</i>	1	Stable	B

List 2: Locally Established in the Upper Willamette

Tree of Heaven	<i>Ailanthus altissima</i>	2	Slightly exp.	B
Totalote; Malta thistle	<i>Centaurea melitensis</i>	2	Stable	unlisted
Spotted knapweed	<i>Centaurea stoebe</i>	2	Stable	B, T
Old man's beard	<i>Clematis vitalba</i>	2	Increasing	B
Cotoneaster species	<i>Cotoneaster spp.</i>	2	Increasing	unlisted
Spurge laurel	<i>Daphne laureola</i>	2	Slight exp.	B
Common fennel	<i>Foeniculum vulgare</i>	2	Slight exp.	Unlisted
Policeman's helmet	<i>Impatiens glandulifera</i>	2	Expanding	B
Yellow flag iris	<i>Iris pseudacorus</i>	2	Expanding	B
Italian, slenderflower thistles	<i>Carduus tenuiflorus</i> & <i>C. pycnocephalus</i>	2	Stable	B
French broom	<i>Genista monspessulana</i> (= <i>Cytisus monspessulanus</i>)	2	Expanding	B
Purple loosestrife	<i>Lythrum salicaria</i>	2	Stable	B, T
Harding grass	<i>Phalaris aquatica</i>	2	Expanding?	unlisted
Firethorn	<i>Pyracantha coccinea</i>	2	Expanding	unlisted

WEEDS/PLANTS OF CONCERN: Upper Willamette Cooperative Weed Management Area 2014

Japanese, giant, hybrid knotweeds	<i>Fallopia ×bohemica</i> (<i>Polygonum X bohemicum</i>) <i>Fallopia cuspidata</i> (<i>P. cuspidatum</i>)*, <i>Fallopia sachalinensis</i> (<i>P. sachalinense</i> *)	2	Slight exp.	*B, T
Lesser celandine	<i>Ranunculus ficaria</i>	2	Expanding	B
Bladder campion	<i>Silene vulgaris</i>	2	Slight exp.	B
Milk thistle	<i>Silybum marianum</i>	2	Stable	B

List 3: Widely Established in the Upper Willamette

False brome	<i>Brachypodium sylvaticum</i>	3	Increasing	B
Butterfly bush	<i>Buddleja davidii</i>	3	Stable	B
Meadow knapweed	<i>Centaurea ×moncktonii</i>	3	Increasing	B
Canada thistle	<i>Cirsium arvense</i>	3	Fully est.	B
Bull thistle	<i>Cirsium vulgare</i>	3	Fully est.	B
Poison hemlock	<i>Conium maculatum</i>	3	Fully est.	B
English/single seed hawthorn	<i>Crataegus monogyna</i>	3	Expanding	unlisted
Scotch broom	<i>Cytisus scoparius</i>	3	Fully est.	B
Shining geranium	<i>Geranium lucidum</i>	3	Expanding	
Herb robert	<i>Geranium robertianum</i>	3	Expanding	B
English and Irish ivy	<i>Hedera helix</i> *, <i>hibernica</i>	3	Expanding	*B
English holly	<i>Ilex aquifolium</i>	3	Expanding	unlisted
Perennial peavine	<i>Lathyrus latifolius</i>	3	Expanding	B
Oxeye daisy	<i>Leucanthemum vulgare</i>	3	Fully est.	unlisted
Reed canarygrass	<i>Phalaris arundinacea</i>	3	Expanding	unlisted
Portugal laurel	<i>Prunus laurocerasus</i>	3	Expanding	unlisted

WEEDS/PLANTS OF CONCERN: Upper Willamette Cooperative Weed Management Area 2014

Feral pear	<i>Pyrus communis</i>	3	Expanding	unlisted
Lesser celandine	<i>Ranunculus ficaria</i>	3	Expanding	
Multiflora rose	<i>Rosa multiflora</i>	3	Slight exp.	unlisted
European blackberry	<i>Rubus vestitus</i>	3	Expanding	unlisted
Armenian & Evergreen blackberries	<i>Rubus armeniacus</i> (<i>R. discolor</i> , <i>misapplied</i>), <i>R. laciniatus</i>	3	Expanding	B

Watch List

Common bugloss	<i>Anchusa officinalis</i>	W		B, T
Bentgrass (escaped, non-ag pops)	<i>Agrostis capillaris</i> , <i>stolonifera</i> , <i>alba</i> , <i>tenuis</i> ,	W		unlisted
Jubata grass	<i>Cortaderia jubata</i> , <i>C. selloana</i>	W		B
Weeping lovegrass	<i>Eragrostis curvula</i>	W		unlisted
Creeping velvetgrass	<i>Holcus mollis</i>	W		unlisted
Rough peavine, Flat peavine	<i>Lathyrus hirsutus</i> , <i>L. sylvestris</i>	W		unlisted
Bristly oxtongue	<i>Picris echioides</i> (= <i>Helminthotheca echioides</i>)	W		unlisted
Creeping buttercup	<i>Ranunculus repens</i>	W		unlisted
Brazilian verbena	<i>Verbena bonariensis</i>	W		unlisted
Waxy mannagrass	<i>Glyceria declinata</i>	W		unlisted

V. Field Assessment Photos – Identified Threats



Above: Scotch broom (foreground) is highly resistant to fire and can fuel much more intense fires. It is common along forest roads and expands readily into disturbed and open habitat. Scotch broom is a threat to life and safety for nearby residents and impedes seedling establishment.
Quartz Creek Road



Above: Knotweed readily resprouts following fire in an otherwise healthy floodplain along the mid- reach McKenzie River (South Fork) (adjacent to several incinerated homes). Knotweed further exacerbates current erosion, soil loss and sedimentation challenges since it lacks fibrous roots and goes dormant in the winter months. It also resprouts from small fragments and can easily be transported via waterways.



Above: Forest roads like Quartz Creek and NF-805 require roadside treatment to manage critical weed source populations such as false brome and herb Robert (both are very limited but are poised to explode into high burn severity areas).



Above: False brome populations are currently only scattered along road ways, and present at public access points such as boat ramps. If they aren't managed quickly they threaten to quickly dominate the landscape. False brome drives more intense fires by building up layers of dead vegetated plant matter and spreads easily by seed in corridors such as here on NF-805, adjacent to Quartz Creek Rd.



Above: False brome is also present in other concerning locations such as the riparian floodplain at Silver Creek Boat Ramp, where it could easily be spread by recreation users.



Above and Lower Left: Spotted knapweed thrives in the high power utility corridor and is expected to be a source population for weed spread in adjacent burned areas with high mortality. Any time vehicles or equipment enter an area they may bring weeds.



See caption above.



Lower Right: Debris flows carry more than sediment and logs—they also carry seeds.

Field Assessment Photos – Critical Values



Above: Finn Rock Landing is an active riparian and salmonoid habitat restoration site managed by McKenzie River Trust. *Finn Rock Landing*



Above: Bracken fern flourishes in the post-burn landscape at Finn Rock Landing.



Above: High vegetation mortality has left bare ground exposed, which was recently seeded with native grasses.



Photos taken by Michelle Delepine, WMSWCD Nov 7th 2020 Holiday Farm Fire

Appendix C – Supporting Soil Information

Table 1. Indicators of Soil Burn Severity

Indicator	Importance	Low	Moderate	High
Ash depth and color	Ash, while nutrient rich, is susceptible to loss through wind and rain	May be black or gray, and ash is shallow. Natural duff remains	Dominantly gray and variable depths. All duff consumed.	Typically gray and white, with areas of deep ash. All duff is consumed, and in some places, reddish oxidized soil may be present on the surface. In some instances, ash is lost from wind erosion during the fire.
Soil Char	Indicates soil organic matter consumption in the upper portions of the soil	Nonexistent or very thin	Thin, from 0.5 to 2 cm deep	Thick or variable, with charred soil extending 2 cm and deeper
Roots	Live roots may indicate speedier vegetation recovery, while loss of live roots may signal slower recovery	Fine roots are alive, flexible, and intact	Fine roots are brittle or charred, deeper and larger roots may remain viable	Fine roots are entirely consumed. Larger roots may be brittle and charred.
Soil Structure	Soil structure provides resistance to erosion from rain drop impacts and overland flow. Loss of structure increases susceptibility to erosion	Soil retains natural structure.	Soil structure may be minimally altered at the surface, but not at depth	Soil structure is lost in the upper surface and has a powdery texture and appearance.

Indicator	Importance	Low	Moderate	High
Hydrophobicity	Hydrophobicity reduces water infiltration and increases runoff	Naturally present in volcanic ash soils and persisting at depth	Natural hydrophobic properties are minimally altered by heat. May be interrupted at surface, but alterations are patchy and inconsistent	Native hydrophobicity interrupted at soil surface with fire-induced hydrophobicity be present depths more than 4 cm below the soil surface

Table 2. Soils within the Holiday Farm Fire, and their characteristics

Map Unit	Name	Taxonomy	Texture	Soil Erosion Hazard	Total Map Unit Area (acres)
104E	Peavine silty clay loam, 3 to 30 percent slopes	Fine, mixed, active, mesic Typic Haplohumults	Silty Clay Loam	Severe	3538
104G	Peavine silty clay loam, 30 to 60 percent slopes	Fine, mixed, active, mesic Typic Haplohumults	Silty Clay Loam	Severe	11546
110	Pits	N/A	N/A	Not rated	16
113G	Ritner cobbly silty clay loam, 30 to 60 percent slopes	N/A	Silty Clay Loam	Severe	1
114	Riverwash	N/A	N/A	Not rated	84
115H	Rock outcrop-Kilchis complex, 30 to 90 percent slopes	N/A	Loam	Not rated	2393
122	Saturn clay loam	N/A	Clay Loam	Slight	1150
123	Sifton gravelly loam	N/A	Loam	Slight	7
130	Waldo silty clay loam	Fine, mixed, mesic Fluvaquentic Haplaquolls	Silty Clay Loam	Slight	5

Map Unit	Name	Taxonomy	Texture	Soil Erosion Hazard	Total Map Unit Area (acres)
137F	Winberry very gravelly loam, 10 to 45 percent slopes	Loamy-skeletal, mixed Lithic Cryochrepts	Loam	Moderate	134
13F	Blachly clay loam, 30 to 50 percent slopes	Fine, isotic, mesic Typic Dystrudepts	Clay Loam	Severe	3426
13G	Blachly clay loam, 50 to 70 percent slopes	Fine, isotic, mesic Typic Dystrudepts	Clay Loam	Severe	766
142G	Yellowstone-Rock outcrop complex, 10 to 60 percent slopes	Medial-skeletal, ferrihydritic Lithic Haplocryands	Loam	Severe	1338
15E	Blachly-McCully clay loams, 3 to 30 percent slopes	Fine, isotic, mesic Typic Dystrudepts	Clay Loam	Moderate	3661
16D	Bohannon gravelly loam, 3 to 25 percent slopes	Fine-loamy, isotic, mesic Andic Dystrudepts	Loam	Moderate	834
16F	Bohannon gravelly loam, 25 to 50 percent slopes	Fine-loamy, isotic, mesic Andic Dystrudepts	Loam	Severe	1652
16H	Bohannon gravelly loam, 50 to 90 percent slopes	Fine-loamy, isotic, mesic Andic Dystrudepts	Loam	Severe	4539
1A	Abiqua silty clay loam, 0 to 3 percent slopes	Fine, mixed, mesic Cumulic Ultic Haploxerolls	Silty Clay Loam	Slight	44
1B	Abiqua silty clay loam, 3 to 5 percent slopes	Fine, mixed, mesic Cumulic Ultic Haploxerolls	Silty Clay Loam	Slight	64
29	Cloquato silt loam	Coarse-silty, mixed, mesic Cumulic Ultic Haploxerolls	Silt Loam	Slight	79
35D	Cruiser gravelly clay loam, 3 to 25 percent slopes	Medial Andic Cryochrepts	Clay Loam	Moderate	292

Map Unit	Name	Taxonomy	Texture	Soil Erosion Hazard	Total Map Unit Area (acres)
35F	Cruiser gravelly clay loam, 25 to 50 percent slopes	Medial Andic Cryochrepts	Clay Loam	Severe	397
35G	Cruiser gravelly clay loam, 50 to 70 percent slopes	Medial Andic Cryochrepts	Clay Loam	Severe	219
36D	Cumley silty clay loam, 2 to 20 percent slopes	Clayey, mixed, mesic Typic Haplohumults	Silty Clay Loam	Moderate	2533
37C	Cupola cobbly loam, 3 to 12 percent slopes	Medial-skeletal, mesic Entic Dystrandepts	Loam	Slight	1149
37E	Cupola cobbly loam, 12 to 30 percent slopes	Medial-skeletal, mesic Entic Dystrandepts	Loam	Moderate	502
45C	Dupee silt loam, 3 to 20 percent slopes	Fine, mixed, superactive, mesic Aquultic Haploxeralfs	Silt Loam	Severe	25
48	Fluvents, nearly level	Fluvents	N/A	Not rated	1379
51B	Haflinger-Jimbo complex, 0 to 5 percent slopes	Sandy-skeletal, mixed, mesic Entic Haplumbrepts	N/A	Slight	1171
57F	Holderman extremely cobbly loam, 25 to 50 percent slopes	Medial-skeletal Andic Cryochrepts	Loam	Severe	17
57G	Holderman extremely cobbly loam, 50 to 75 percent slopes	Medial-skeletal Andic Cryochrepts	Loam	Severe	14
58D	Honeygrove silty clay loam, 3 to 25 percent slopes	Fine, mixed, active, mesic Typic Palehumults	Silty Clay Loam	Moderate	4176
58F	Honeygrove silty clay loam, 25 to 50 percent slopes	Fine, mixed, active, mesic Typic Palehumults	Silty Clay Loam	Severe	2048
60D	Hummington gravelly loam, 5 to 25 percent slopes	Medial-skeletal Dystric Cryandepts	Loam	Moderate	502

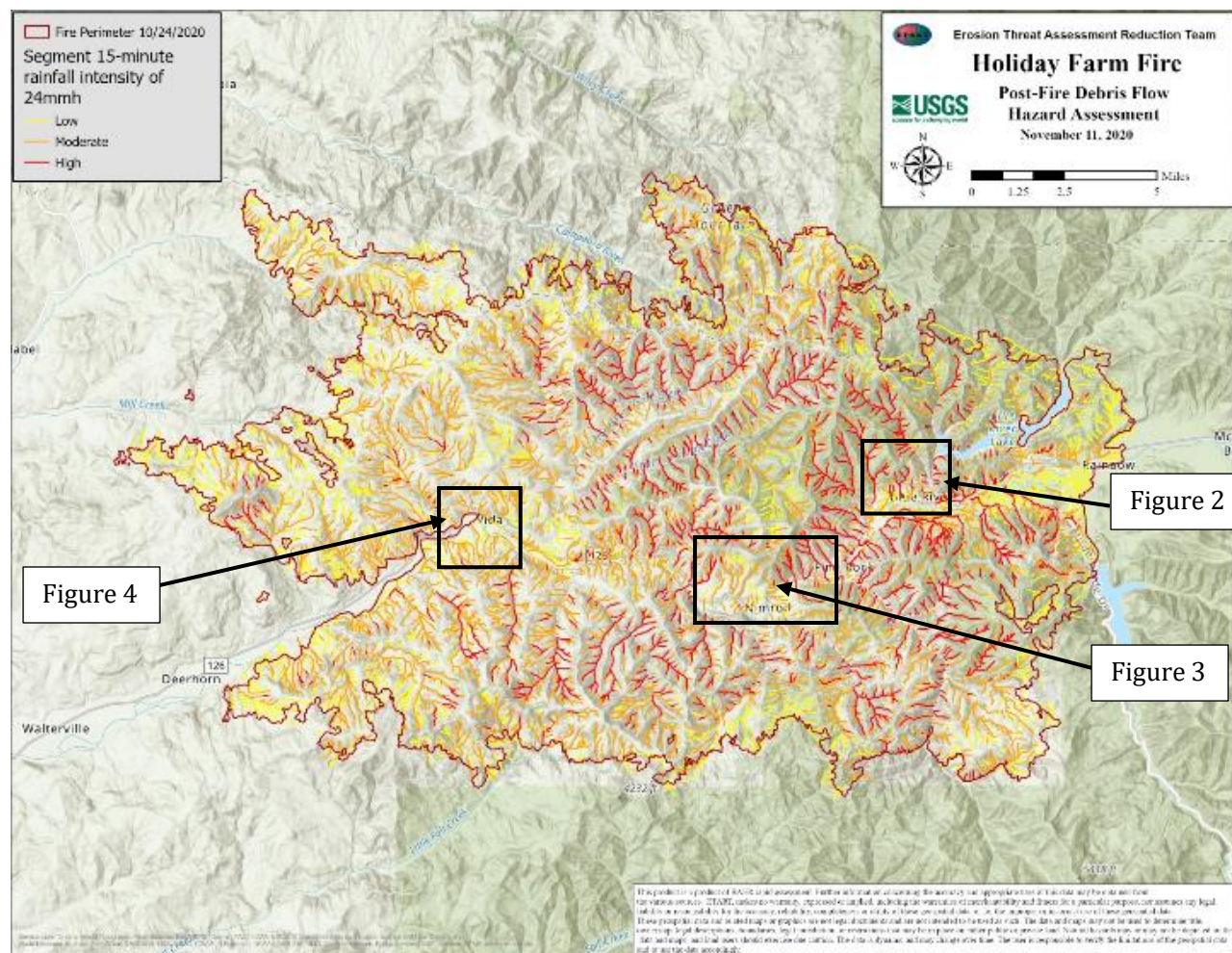
Map Unit	Name	Taxonomy	Texture	Soil Erosion Hazard	Total Map Unit Area (acres)
60F	Hummington gravelly loam, 25 to 50 percent slopes	Medial-skeletal Dystric Cryandepts	Loam	Severe	1085
60G	Hummington gravelly loam, 50 to 75 percent slopes	Medial-skeletal Dystric Cryandepts	Loam	Severe	5821
61	Jimbo silt loam	Medial, mesic Andic Haplumbrepts	Silt Loam	Slight	1456
62B	Jimbo-Haflinger complex, 0 to 5 percent slopes	Medial, mesic Andic Haplumbrepts	Silt Loam	Slight	570
64D	Keel cobbly clay loam, 3 to 25 percent slopes	Medial Dystric Cryandepts	Clay Loam	Moderate	2972
64F	Keel cobbly clay loam, 25 to 45 percent slopes	Medial Dystric Cryandepts	Clay Loam	Severe	4145
64G	Keel cobbly clay loam, 45 to 75 percent slopes	Medial Dystric Cryandepts	Clay Loam	Severe	2148
65G	Kilchis stony loam, 30 to 60 percent slopes	Loamy-skeletal, isotic, mesic Humic Lithic Dystrudepts	Loam	Severe	353
65H	Kilchis stony loam, 60 to 90 percent slopes	Loamy-skeletal, isotic, mesic Humic Lithic Dystrudepts	Loam	Severe	4221
66D	Kinney cobbly loam, 3 to 20 percent slopes	Fine-loamy, mixed, mesic Andic Haplumbrepts	Loam	Slight	2333
67F	Kinney cobbly loam, 20 to 50 percent north slopes	Fine-loamy, mixed, mesic Andic Haplumbrepts	Loam	Severe	4011
67G	Kinney cobbly loam, 50 to 70 percent north slopes	Fine-loamy, mixed, mesic Andic Haplumbrepts	Loam	Severe	9368
68F	Kinney cobbly loam, 20 to 50 percent south slopes	Fine-loamy, mixed, mesic Andic Haplumbrepts	Loam	Severe	4941

Map Unit	Name	Taxonomy	Texture	Soil Erosion Hazard	Total Map Unit Area (acres)
68G	Kinney cobbly loam, 50 to 70 percent south slopes	Fine-loamy, mixed, mesic Andic Haplumbrepts	Loam	Severe	4838
69E	Kinney cobbly loam, slump, 3 to 30 percent slopes	Fine-loamy, mixed, mesic Andic Haplumbrepts	Loam	Moderate	6121
70E	Klickitat stony loam, 3 to 30 percent slopes	Loamy-skeletal, mixed, mesic Typic Haplumbrepts	Loam	Moderate	1061
71F	Klickitat stony loam, 30 to 50 percent north slopes	Loamy-skeletal, mixed, mesic Typic Haplumbrepts	Loam	Severe	725
71G	Klickitat stony loam, 50 to 75 percent north slopes	Loamy-skeletal, mixed, mesic Typic Haplumbrepts	Loam	Severe	13804
72F	Klickitat stony loam, 30 to 50 percent south slopes	Loamy-skeletal, mixed, mesic Typic Haplumbrepts	Loam	Severe	4386
72G	Klickitat stony loam, 50 to 75 percent south slopes	Loamy-skeletal, mixed, mesic Typic Haplumbrepts	Loam	Severe	25661
78	McAlpin silty clay loam	N/A	Silty Clay Loam	Slight	15
79	McBee silty clay loam	Fine-silty, mixed, mesic Cumulic Ultic Haploxerolls	Silty Clay Loam	Slight	16
80F	McCully clay loam, 30 to 50 percent slopes	Fine, mixed, mesic Typic Haplumbrepts	Clay Loam	Severe	1775
80G	McCully clay loam, 50 to 70 percent slopes	Fine, mixed, mesic Typic Haplumbrepts	Clay Loam	Severe	1378
81D	McDuff clay loam, 3 to 25 percent slopes	Clayey, mixed, mesic Typic Haplohumults	Clay Loam	Moderate	259

Map Unit	Name	Taxonomy	Texture	Soil Erosion Hazard	Total Map Unit Area (acres)
81F	McDuff clay loam, 25 to 50 percent slopes	Clayey, mixed, mesic Typic Haplohumults	Clay Loam	Severe	29
81G	McDuff clay loam, 50 to 70 percent slopes	Clayey, mixed, mesic Typic Haplohumults	Clay Loam	Very Severe	5
83B	Minniece silty clay loam, 0 to 8 percent slopes	Fine, mixed, mesic Typic Umbraqualfs	Silty Clay Loam	Moderate	59
84D	Mulkey loam, 5 to 25 percent slopes	Medial, ferrihydritic Pachic Fulvicryands	Loam	Severe	81
89D	Nekia silty clay loam, 12 to 20 percent slopes	Fine, mixed, active, mesic Xeric Haplohumults	Silty Clay Loam	Severe	20
89E	Nekia silty clay loam, 20 to 30 percent slopes	Fine, mixed, active, mesic Xeric Haplohumults	Silty Clay Loam	Severe	0
95	Newberg fine sandy loam	Coarse-loamy, mixed, mesic Fluventic Haploxerolls	Sandy Loam	Slight	54
96	Newberg loam	Coarse-loamy, mixed, mesic Fluventic Haploxerolls	Loam	Slight	16
99H	Ochrepts and Umbrepts, very steep	Ochrepts	N/A	Not rated	314
DAM	Dam	N/A	N/A	Not rated	22
W	Water	N/A	N/A	Not rated	1045

Appendix D – Supporting Geohazards Information

Figures and Photos



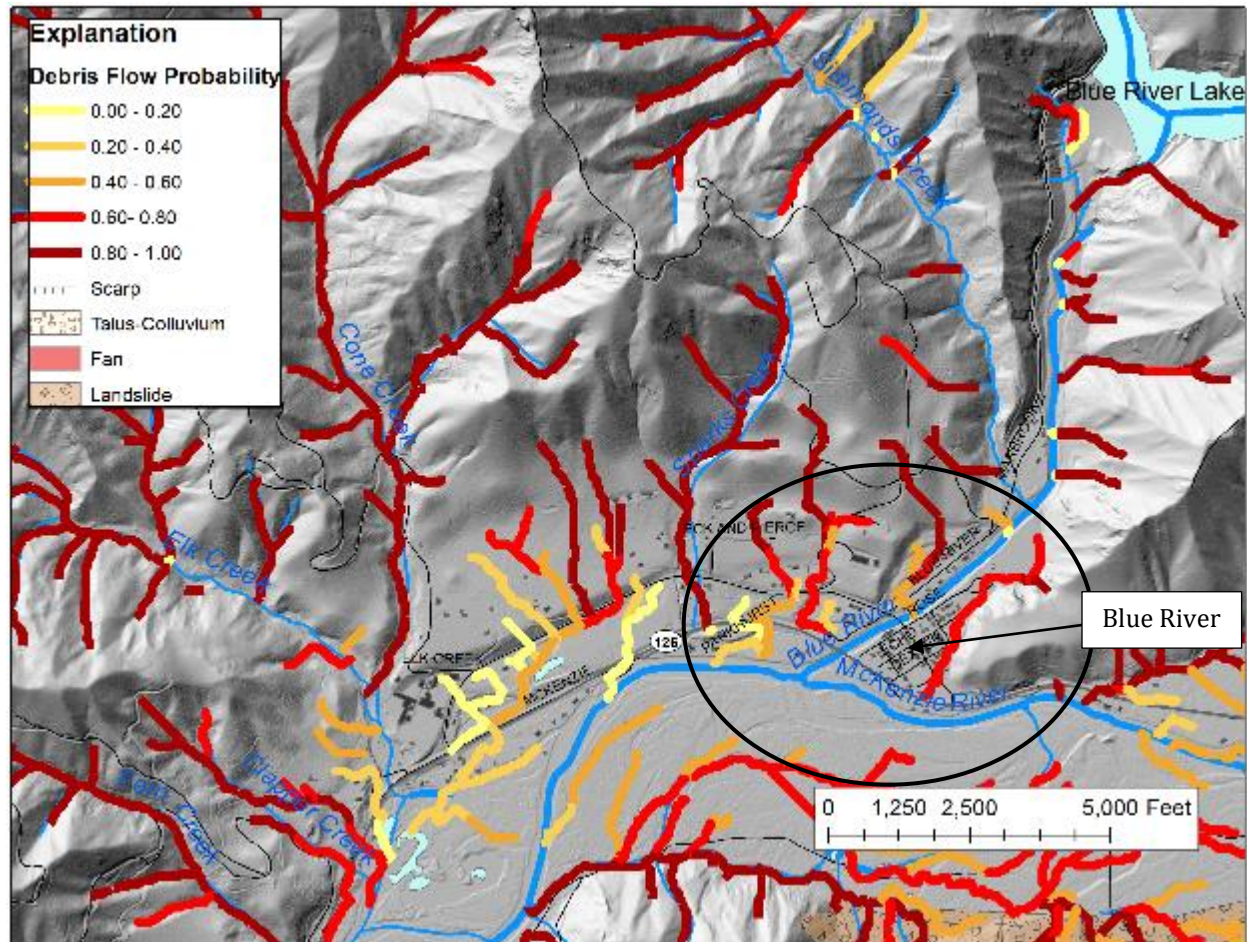


Figure 2: Buildings and infrastructure are at potential landslide risk in the town of Blue River. Map includes USGS debris flow hazard channels and DOGAMI SLIDO areas. Potentially high debris flow hazard emanating from drainages from the steep slopes on the east and west sides of town.

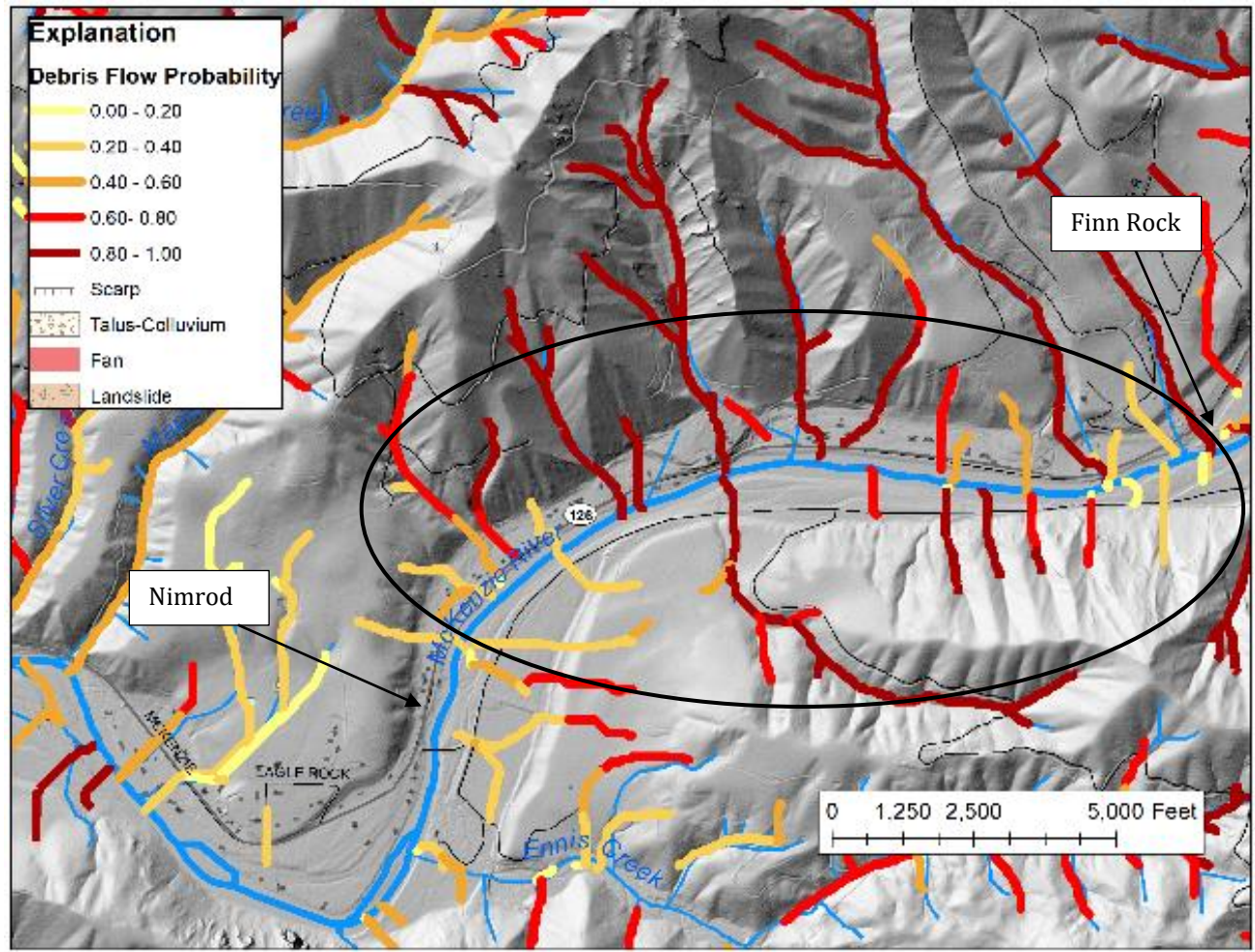


Figure 3: Communities between Nimrod and Finn Rock along OR126 are at risk of debris flow. Potentially high to very high hazard emanating from unnamed drainage above structures located near or at the base of steep channels. Map includes USGS debris flow hazard channels and DOGAMI SLIDO landslide areas.

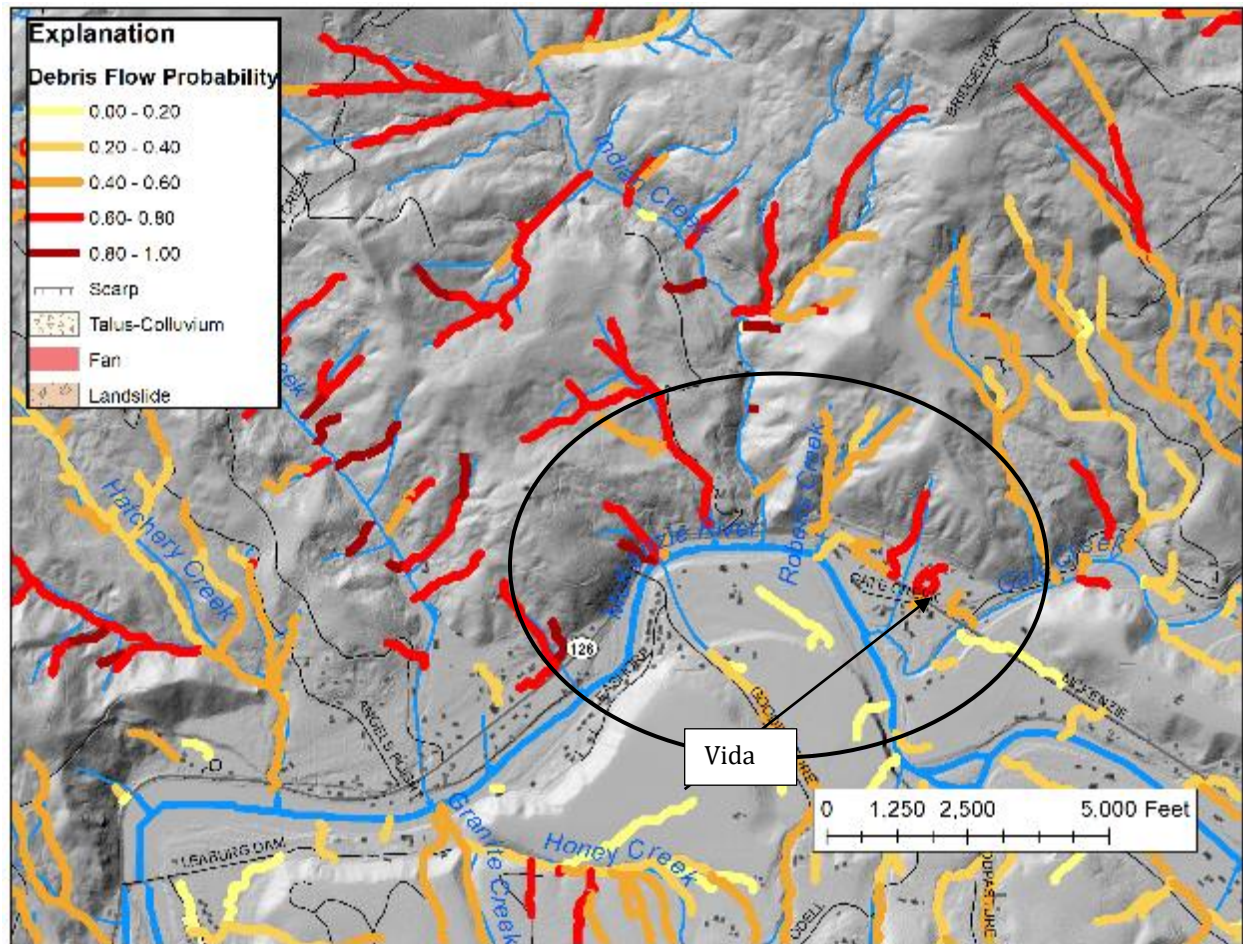


Figure 4: Communities near Vida and along OR126 are at risk of debris flow. Potentially high to very high hazard emanating from unnamed drainage above structures located near or at the base of steep channels. Map includes USGS debris flow hazard channels and DOGAMI SLIDO landslide areas.



Photo 1: Moderately to highly burned hills east of Blue River with high debris flow hazard. Expect increased sediment laden water runoff and possible debris flows in drainages that do not regularly receive much water.

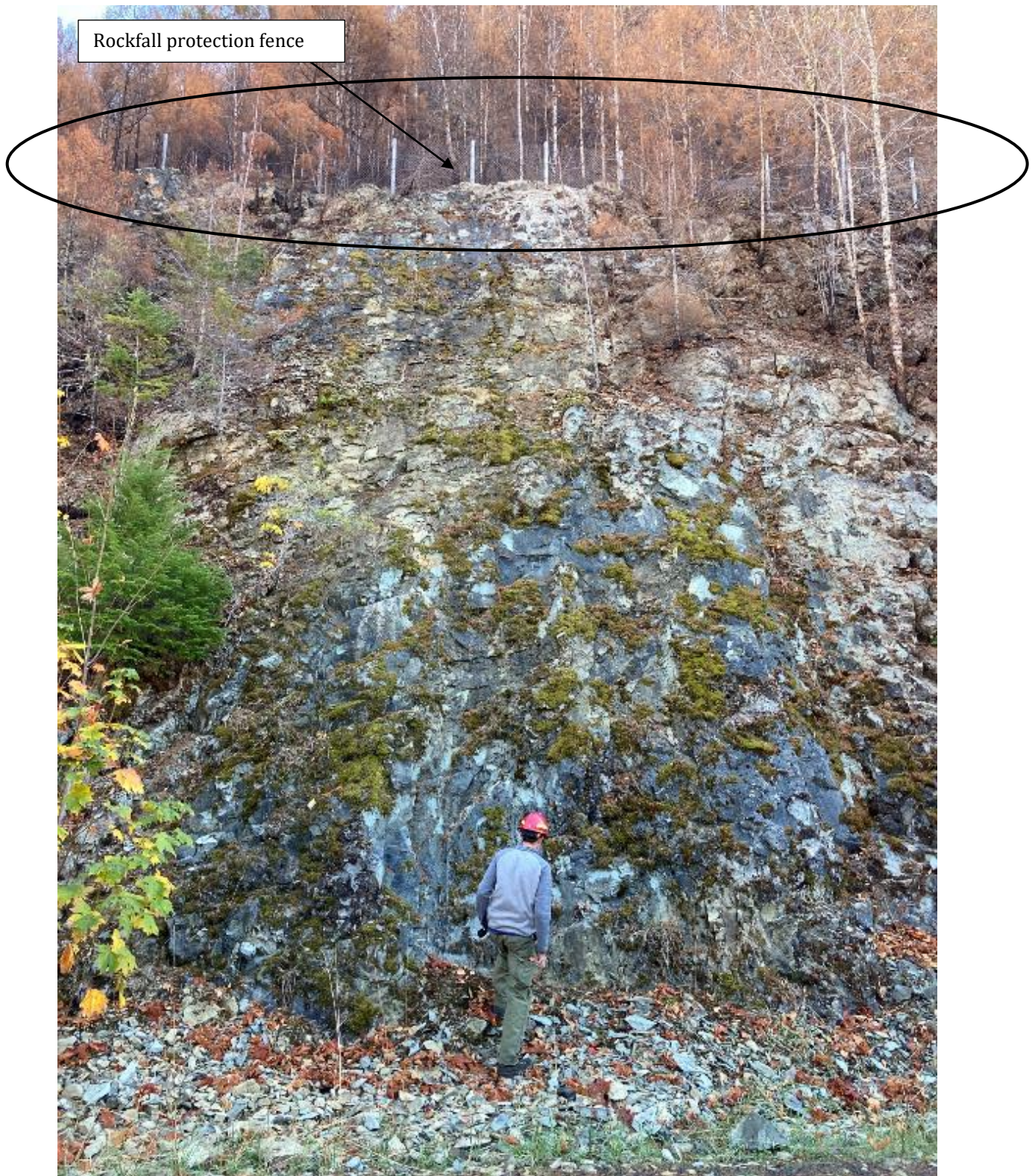


Photo 2: Rockfall hazards at the Blue River Dam facility. Very steep burned slopes burned above and along cliffs adjacent to the structure. There is a rockfall protection fence approx. 30 ft. above access road. The fence needs to be maintained to be functional. Loose rocks will fall during and after rain events.



Photo 3: Simmons Creek at Lucky Boy Road just upstream of bridge. Simmons Creek was not modeled by the USGS debris flow model because its drainage area is over 8km. The small upstream tributaries that contribute to Simmons Creek have a high to very high likelihood of a debris flow. This would increase the sediment load and flood this location.



Photo 4: Drainage along Gate Creek Road (Vida) with moderate debris flow hazard. This is a tributary to Gate Creek on private land. The channel is blocked by a driveway with an undersized culvert. Landowner stated that this channel does not regularly receive much water but did note that the 1996 floods did over top the driveway and diverted down the road. Expect increased sediment laden water runoff and possible debris flows in drainages that do not regularly receive much water.



Photo 5: Example of a debris flow hazard sign that can be placed along roads impacted by the fire. Signs must have large enough letters to be read at driving speed.

Appendix E – Supporting Hazard Tree Information

Table 1. Failure indicators for imminent, likely, and low-failure potentials for trees along forest roads and work sites in Oregon and Washington.

Failure Indicator		Failure Potential		
		Imminent	Likely	Low
Dead Trees	<i>Old dead trees</i> (≥ 5 years) No foliage or fine branches; bark is absent or falling off	All tree species except cedar, juniper, larch, or large (≥ 20 in. dbh) Douglas-fir	Cedar, juniper, larch, or large Douglas-fir with no other visible indicators	None
	<i>Recent dead trees</i> (< 5 years) All or some foliage; fine branches; bark mostly intact	All trees < 10 in. dbh	All trees ≥ 10 in. dbh except cedar, juniper, larch, or large Douglas-fir	Cedar, juniper, larch, or large Douglas-fir
	Recent dead trees in <i>root disease centers</i> (p. 59-66)	All tree species except cedar	Cedar	None
Roots	Live trees in laminated root rot centers (p. 64) <i>Phellinus sulphurascens</i>	Trees with signs or symptoms (ectotrophic mycelium or laminated decay; foliage thinning or yellowing)	Douglas-fir, mountain hemlock, or true firs <i>without</i> signs or symptoms and ≤ 25 ft. from an infected tree or stump	Douglas-fir, mountain hemlock, or true firs <i>without</i> signs or symptoms and > 25 ft. from an infected tree or stump; All other species <i>without</i> signs or symptoms

Failure Indicator		Failure Potential		
		Imminent	Likely	Low
	Live trees in Armillaria or Heterobasidion root disease centers <i>Armillaria</i> spp. (p. 60) <i>Heterobasidion</i> spp. (p. 62)	Trees with signs or symptoms (mycelial fans, resinosis, staining, conks, or wounds with decay; foliage thinning or yellowing) and adjacent (≤ 50 ft.) to windthrown trees with root disease	Trees with signs or symptoms but not adjacent to windthrown trees with root disease	Trees without signs or symptoms
	Live trees in black stain or Port-Orford-cedar root disease centers <i>Leptographium wagneri</i> (p. 62) <i>Phytophthora lateralis</i> (p. 65)	None	None	All trees
	Live trees with undermined or severed roots (p. 66)	Trees with $< 50\%$ of the structural roots remaining in the ground	Trees with 50 to 75% of the structural roots remaining in the ground	Trees with $> 75\%$ of the structural roots remaining in the ground

Failure Indicator		Failure Potential		
		Imminent	Likely	Low
Butt	Butt rot (p. 66-69) <i>Schweinitzii</i> (cow- pie conk) <i>Tomentosus</i> (spruce rot conk) <i>Ganoderma</i> (artist's and varnish conks)	Trees with ≥ 1 conk(s) associated with open cracks or exposed decay	Trees with ≥ 1 conk(s) not associated with open cracks or exposed decay	Trees with butt swell but no conks
	Living, fire-damaged trees for recent (<5yr) fire damage; use bole-wounds for old fire damage (p. 70)	True fir, hemlock, spruce, or hardwoods with >50% of the bole cross-sectional area burned and consumed, or more than one quadrant of burned and consumed structural roots Douglas-fir, pine, cedar, juniper, or larch with >75% of the bole cross-sectional area burned and consumed, or more than one quadrant of burned and consumed structural roots	True fir, hemlock, spruce, or hardwoods with 25 to 50% of the bole cross-sectional area burned and consumed, or one quadrant of burned and consumed structural roots Douglas-fir, pine, cedar, juniper, or larch with 50 to 75% of the bole cross-sectional area burned and consumed, or one quadrant of burned and consumed structural roots	True fir, hemlock, spruce, or hardwoods with <25% of the bole cross-sectional area burned and consumed, and no burned and consumed structural roots Douglas-fir, pine, cedar, juniper, or larch with <50% of the bole cross-sectional area burned and consumed, and no burned and consumed structural roots

Failure Indicator		Failure Potential		
		Imminent	Likely	Low
Bole/Stem	Bole wounds mistletoe cankers, fungal cankers, or old fire wounds (≥ 5 years) (p. 71-80)	True fir, hemlock, spruce, or hardwoods with $< 50\%$ cross-section of bole with sound wood Douglas-fir, pine, cedar, juniper, or larch with $< 25\%$ cross-section with sound wood	True fir, hemlock, spruce, or hardwoods with 50 to 75% cross-section of bole with sound wood Douglas-fir, pine, cedar, juniper, or larch with 25 to 50% cross-section with sound wood	True fir, hemlock, spruce, or hardwoods with $> 75\%$ cross-section of bole with sound wood Douglas-fir, pine, cedar, juniper, or larch with $> 50\%$ cross-section with sound wood
	Frost cracks (p. 82)	None	Trees with weeping cracks	Trees without weeping cracks
	Bole cracks (p. 82)	Trees with open splits or cracks with independent movement or exposed rot	Trees with open splits or cracks without movement or exposed decay	Trees with sealed cracks
	Burls (p. 82)	None	None	All trees
	Quinine conks (p. 86) <i>Laricifomes officinalis</i>	Trees with ≥ 1 conk(s)	None	None
	Indian paint fungus conks (p. 92) <i>Echinodontium tinctorium</i>	Trees with multiple, large (≥ 6 in. wide) conks; Single, large conk or multiple, small conks associated with open cracks or exposed rot	Trees with single, large conk or multiple, small conks not associated with open cracks or exposed rot	Trees with a single, small conk

Failure Indicator		Failure Potential		
		Imminent	Likely	Low
	Red ring rot conks, white speck (p. 90) <i>Porodaedalea pini</i>	Trees with ≥ 1 conk(s) associated with extensive advanced decay ² such as open cracks or exposed rot	True fir, hemlock, spruce, or hardwoods with ≥ 1 conk(s) not associated with extensive advanced decay; Douglas-fir, pine, cedar, juniper, or larch with ≥ 3 large conks (≥ 6 in. wide) within a 3-ft.-long trunk cylinder	Douglas-fir, pine, cedar, juniper, or larch with ≥ 3 large conks not within a 3-ft.-long trunk cylinder; ≤ 2 large conks within a 3-ft.-long trunk cylinder; any number or location of small conks
	Other heart-rot conks (p. 84-93)	Trees with ≥ 1 conk(s) associated with open cracks or exposed rot	Trees with ≥ 1 conk(s) not associated with open cracks or exposed rot	None
	Sap-rot conks <i>Cryptoporus volvatus</i> (pouch conk) (p. 95) <i>Fomitopsis pinicola</i> (red-belt conk) (p.94)	Dead trees with ≥ 1 red-belt conk(s)	Live trees with ≥ 1 red-belt conk(s) usually associated with bole wounds	Live trees with ≥ 1 pouch conk(s); check for extent of dead bark and sound wood
Tops and Branches	Forked or multiple tops or stems (p. 97)	Trees with any fork associated with open cracks, decay, or conks* (tops are imminent FP, not the whole tree unless fork is at the base)	Trees with V-shaped forks with embedded bark but not associated with open cracks, decay, or conks* (tops are likely FP, not the whole tree unless fork is at the base)	Trees with U-shaped forks and no open cracks, decay, or conks*; V-shaped forks with no embedded bark, open cracks, decay, or conks* (tops are low FP, not the whole tree unless fork is at the base)

Failure Indicator		Failure Potential		
		Imminent	Likely	Low
	Dead tops or branches (≥ 3 in. diameter) (p. 96)	True fir, hemlock, spruce, or hardwoods ≥ 5 years dead or with red-belt conks (tops and branches are imminent FP, not the whole tree)	True fir, hemlock, spruce, or hardwoods < 5 years dead; Douglas-fir ≥ 5 years dead (tops and branches are likely FP, not the whole tree)	Cedar, larch, juniper, or pine; Douglas-fir < 5 years dead (tops and branches are low FP, not the whole tree)
*Any conk except for red ring rot conks (<i>P. pini</i>) on forked Douglas-fir, pine, cedar, juniper, or larch.				
Tops and Branches	Detached tops, branches (≥ 3 in. diameter), or bark (≥ 1 ft. ²) (p. 96)	All detached parts (parts are imminent FP, not the whole tree)	Live and attached tops or branches but cracked or split (parts are likely FP, not the whole tree)	None
	Dwarf mistletoe brooms (p. 98)	None	Trees with large (≥ 10 ft. in diameter) dead brooms (broom is likely FP, not the whole tree)	Trees with small, dead brooms or live brooms (broom is low FP, not the whole tree)
	Cottonwood branches (p. 97)	Trees with large (≥ 3 in. diam.) dead branches (branches are imminent FP, not the whole tree)	Trees with large, live branches with evidence of decay or past breakage (branches are likely FP, not the whole tree)	Trees with large, live branches with no evidence of decay or past breakage
Whole Tree	Broken or uprooted trees supported by other trees (p. 99)	All	None	None

Failure Indicator		Failure Potential		
		Imminent	Likely	Low
	Leaning and/or root-sprung trees (p. 99)	Trees with recent (<5yr) leans ≥ 15 degrees or old, uncorrected leans with freshly disturbed soil or root damage	Trees with recent leans ≥ 15 degrees or old, uncorrected leans without freshly disturbed soil or root damage	Trees with old, corrected leans
	Height to diameter ratio (p. 100)	Trees with >100 H:D ratio ²	Trees with 80 to 100 H:D ratio	Trees with <80 H:D ratio
	Multiple indicators (p. 113)	Two or more likely-FP indicators with synergistic effects: one condition (indicator) worsens the other (i.e. recently killed true fir with a large, Indian paint fungus conk)	Two or more low-FP indicators with synergistic effects (i.e. 15% severed roots and an old, corrected lean); two or more likely-FP indicators without synergistic effects (i.e. true fir with a weeping frost crack and a recently killed top)	Two or more low-FP indicators without synergistic effects (i.e. top-killed cedar with two <i>P. pini</i> conks on the live bole)

¹Firm wood with white speck or firm wood with red discoloration is not considered advanced decay from *P. pini*. Advanced decay is very soft and crumbly.

²To calculate H:D ratio, divide the total tree height in feet by the diameter breast height (dbh)

Appendix F – Fish and Wildlife Values at Risk Table

Table 1. Holiday Farm fish and wildlife critical values, opportunities and threats, risks and rewards, and recommended treatments.

Critical Value	Opportunity to Benefit Value	Probability of Benefit	Magnitude of Benefit	Reward	Treatment Options Considered	Recommended Treatment
Early Seral Habitat in East Lane Travel Management Area (TMA)	Reseeding burned areas with palatable seed mix provides forage, stabilizes soil, and helps control invasive plant species.	Likely - ODFW is working with private timber company to reseed areas that are within the East Lane TMA to support soil stabilization and game forage. These areas are chosen because they had high vegetation mortality (91 - 100%) and are a high risk of debris flow.	Moderate - Reseeding is likely to provide valuable forage for deer and elk, stabilize soil, and reduce invasive plant species in areas of high vegetation mortality and high risk of debris flow.	High	Revegetation (seeding) for forage and invasive plant control	Work with partners on revegetation for forage and invasive plant management
Large Woody Debris (LWD): Various locations in the burn area	Maintaining standing or dead trees within the riparian zone will be critical to post fire recovery/long term improvement of habitat. As these trees enter the river they create high quality habitat for salmonids	Possible - Variable depending on extent of post fire salvage logging within riparian zone	Major - Many of these systems have historically low levels of LWD, this could potentially reset the system and provide significant long term benefits in terms of creating suitable habitat for aquatic and terrestrial spp.	High	Alternative salvage logging practices to retain LWD in streams	Work with partners to encourage salvage logging practices that retain LWD, to the extent practicable, for recruitment into stream channels

Table 1. Holiday Farm fish and wildlife critical values, opportunities and threats, risks and rewards, and recommended treatments.

Critical Value	Opportunity to Benefit Value	Probability of Benefit	Magnitude of Benefit	Reward	Treatment Options Considered	Recommended Treatment
Riparian Shade	Allowing a mix of hardwood/conifer in riparian areas provides more rapid recovery of intermediate shading	Possible - Will be variable depending on burn severity and extent of active management	Major - Many streams within the burn areas have summer temperatures close to thermal tolerance limits-rapid shading from hardwoods may be key to ensuring these streams remain suitable during summer in the near term	High	Revegetation practices and/or natural regeneration practices that will result in riparian shading more quickly	Work with partners to identify alternate revegetation practices and/or natural regeneration for riparian shading
Keystone species	Allowing for some proportion of the riparian area to regenerate with hardwoods provides conditions for beaver to construct dams that benefit a range of aquatic spp	Possible - Will be variable depending on management goals	Major - Beaver are ecosystem engineers that create habitat suitable for many aquatic species, including salmonids. To build dams, beavers require suitable plant material (typically willow, alder etc)	High	Revegetation practices and/or natural regeneration practices that will result in beaver habitat long-term	Work with partners to identify alternate revegetation practices and/or natural regeneration for long-term beaver habitat

Table 1. Holiday Farm fish and wildlife critical values, opportunities and threats, risks and rewards, and recommended treatments.

Critical Value	Opportunity to Benefit Value	Probability of Benefit	Magnitude of Benefit	Reward	Treatment Options Considered	Recommended Treatment
Connectivity	Replacement of burned/washed out culverts structures	Likely - Given scale of fires and the number of culverts on the landscape it is likely that some were or will be impacted.	Major - Restoration of passage allows fish to access habitat above these sites	High	Aquatic organism passage options at culvert blockages	Work with partners to identify priorities and options for fish passage at culverts

Appendix G – Supporting Hydrology Information

Values at Risk Table

Critical Value	Threat to Value	Probability of Damage or Loss	Magnitude of Consequence	Risk	Recommended Treatment	Notes
Bear Cr at mouth: Hwy 126 bridge	Flooding, debris flow, and erosion	Possible - Watershed extensively burned, high tree mortality, peak flow increases	Moderate - Bridge structure likely not compromised; debris impacts on bridge	Intermediate	Channel clearing/Storm patrol	In burned area. Stream has oversteepened banks upstream of Hwy 126 bridge; may slump into creek. Bridge may not be high enough to pass large woody debris. All residential properties nearby are burned. Some home debris may wash into creek due to flooding and/or overland flow.
Rough Cr at mouth: Water diversion infrastructure, Hwy 126 bridge	Flooding, debris flow, and erosion	Possible - Very small contributing watershed with inadequate box culvert	Moderate - Nuisance flooding and sediment across road, no expected loss of crossing structure	Intermediate	Channel clearing/Storm patrol	In burned area. Highway opening for creek probably not adequate to pass debris and flood flows. Diversion headgate and a couple footbridges a short distance upstream were damaged by fire and may be further damaged by flooding. A residential property burned; some home debris may wash into creek due to flooding and/or overland flow.

Critical Value	Threat to Value	Probability of Damage or Loss	Magnitude of Consequence	Risk	Recommended Treatment	Notes
Cone Cr near mouth: Residential property	Flooding and debris flow	Possible - Extensive burn of upstream watershed resulting in increased peak flows, evidence of prior debris flows and high debris flow potential based on modeling	Major - Structure damage, unlikely to experience complete loss	High	Channel clearing	In burned area. Residential property survived fire but may be in danger from flooding and debris flow. Owner said that flood insurance has been purchased already.
Blue River Park: Picnic shelter, play structure, picnic tables, ball field, hiking trail	Tree hazards, fall hazard, rock fall, erosion	Likely - High tree mortality, steep slopes	Major - Injury or loss of life	Very High	Maintain closure, mitigate hazard trees, signage for rock fall along trail. Signage for unstable banks along Blue River. Fill or remove vertical culvert.	In burned area. Danger of falling trees; picnic shelter already damaged by one. Open vertical 4 ft culvert, dry at bottom to south of ball field. No increased risk due to fire. Poles of backstop for ballfield are damaged; could fall?? Increased danger of rock fall along walking trail that follows left bank of Blue River. Also there may be increased erosion along banks of Blue River, but because streamflow is regulated by dam, probably not a big issue.

Critical Value	Threat to Value	Probability of Damage or Loss	Magnitude of Consequence	Risk	Recommended Treatment	Notes
County road along Upper Calapooia River	Flooding	Unlikely - Low burn severity, small burned area	Minor - Limited infrastructure, minor loss of access	Very Low	None Considered signage.	Mix of burned and unburned areas. All affected private lands appear to be owned by Weyerhaeuser. Impact of fire on mainstem peak flows is likely to be minor. Portions of county road immediately adjacent to the river may be at increased risk of flooding. No additional assessment was done.
Old McKenzie Fish Hatchery County Park: water intake on Hatchery Cr.	Tree hazards, debris flows	Likely - Unstable slopes and proximity to channel	Minor - Limited infrastructure to be damaged	Low	Remove and cap intake prior to damaging storm	Mix of burnt and unburnt areas. There is a trail that may have tree hazards. There's a water intake in Hatchery Creek that feeds into old impoundments for fish rearing. This intake piping may be damaged by debris and flooding of Hatchery Cr
Visitors to Old McKenzie Fish Hatchery County Park: Walking trail	Tree hazards, debris flows	Unlikely - Moderate to low tree mortality	Major - Injury or loss of life	Intermediate	Hazard tree mitigation, signage	Mix of burnt and unburnt areas. There is a trail that may have tree hazards. There's a water intake in Hatchery Creek that feeds into old impoundments for fish rearing. This intake piping may be damaged by debris and flooding of Hatchery Cr

Critical Value	Threat to Value	Probability of Damage or Loss	Magnitude of Consequence	Risk	Recommended Treatment	Notes
Simmonds Cr: Residential property and county bridge	Flooding and debris flow	Likely - Extensive burn of the watershed and expected increase in peak flow and debris flow	Moderate - Temporary loss of access without complete loss of infrastructure	High	Channel clearing, storm patrol, information sharing with USACE, and inform Lane County of upstream residents	In burnt area. No structure burned but looks like drain field was being installed for a new house. Depending on where the future building is placed, it might be impacted by flooding. Bridge opening may not be adequate to pass large debris
Quartz Cr at mouth: Blue River Dam	Increased sediment	Likely - Modeling indicates increased erosion and sedimentation	Minor - Not expected to compromise sediment structure above Blue River Lake	Low	Further conversation with USACE about consequences of fire in Quartz Creek near Blue River Dam	Much of watershed burned. Two bridges cross the creek and they appear adequate to pass flood flows and debris. USACE is concerned about sediment load into McKenzie R and it's potential impact to Leaburg Dam. Likely that sediment load will increase, but not sure what action can be taken to mitigate this
Gate Cr: Residents living in homes adjacent to creek	Flooding, debris flow, and erosion	Possible - Modeling indicates increased peak flows	Major - Potential flood/debris flow impacts to homes. Injury or loss of life	High	Inform county Emergency Management, signage	In burnt area. Two or three homes that survived the fire may be in danger of flooding. Expect increased sediment load to McKenzie River. Bridge looks OK for passing high flows and debris

Critical Value	Threat to Value	Probability of Damage or Loss	Magnitude of Consequence	Risk	Recommended Treatment	Notes
Homes along Gate Cr and tribs	Flooding, debris flow, and erosion	Possible - Modeling indicates increased peak flows	Major - Potential flood/debris flow impacts to homes.	High	Inform county Emergency Management, signage	In burnt area. Two or three homes that survived the fire may be in danger of flooding. Expect increased sediment load to McKenzie River. Bridge looks OK for passing high flows and debris
County access road to Blue River Dam	Rock fall	Likely - Extremely steep slopes, over 60% grade	Minor - Very low traffic volume, moving target	Low	General clearing of road, signage	Increased risk of rock fall. Recommend storm proofing road and storm patrol
Leaburg Hydropower Canal	Sediment	Unlikely - Moderate slopes, low soil burn severity near canal, buffer of vegetation	Minor - small area impacted by fire	Very Low	None	Small burnt area on north bank, east of road crossing for transfer station; little impact. Cogswell Cr flows into the canal between Hwy 126 crossing and Leaburg Dam. Watershed burned, so there's an increased chance of sediment and debris being washed into the canal.

Critical Value	Threat to Value	Probability of Damage or Loss	Magnitude of Consequence	Risk	Recommended Treatment	Notes
McKenzie River: EWEB Intake at Hayden Bridge	Sediment and flooding	Unlikely - River flow not likely vary greatly. Much of flow comes from a large spring; flows of larger tributaries are regulated by dams. Leaburg Lake will likely catch most sediment and debris	Major - Municipal water supply	Intermediate	EWEB inspection when high flows occur	Cities of Eugene and Springfield have concerns due to increase in sediment and debris load caused by landslides, erosion, and debris flows. The physical intake structure at Hayden Bridge is unlikely to be impacted by increased flooding associated with fire.

Critical Value	Threat to Value	Probability of Damage or Loss	Magnitude of Consequence	Risk	Recommended Treatment	Notes
McKenzie Schools at Blue River	Erosion of steep slopes	Possible - Exposed, burned hillside	Minor - Limited amount of sediment, greenup already occurring	Low	Natural recovery and maintenance of Elk Creek Road and ditch	Mix of burnt and unburnt areas. Steep slopes on the north side of the school property may experience increased erosion, but there doesn't appear to be much risk of rock fall. Would be good to clean ditch on Elk Creek Road above the school to keep slopes stable and encourage natural recovery

Under-sized culvert on unnamed drainage on Goodpasture Rd near Vida	Debris flows and erosion	Likely - Culvert is already partially blocked by vegetation and burned debris	Moderate - Low traffic volume but single access for homes farther up road	High	Clear culvert opening, Storm patrol	In burned area (lat. 44.148812, long - 122.557092). Undersized culvert may clog with debris and form a small impoundment. Recommend storm patrol check on this site and clear debris as needed. Directly upstream of crossing is a residential property with an exposed bank that may erode back, but it probably will not impact the physical integrity of the building. Downstream of the crossing is another residential property, similar issue.
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Critical Value	Threat to Value	Probability of Damage or Loss	Magnitude of Consequence	Risk	Recommended Treatment	Notes
Forest Glen Boat Landing	Hazard trees, open vault	Likely - High tree mortality	Major - Injury or loss of life	Very High	Mitigate hazard trees	In burnt area. Remains of outhouse with open holes that drop into vault. County locked the doors while assessment team was onsite.
Blue River Dam (USACE)	Rock fall and erosion	Likely - Pre-existing rock fall	Minor - Small rock and low volume of rock, limited targets	Low	Repairing and maintaining current rock safety structure	In burned area. Fence to catch falling rock from slopes above service road is damaged or at capacity in many places. Fencing above emergency spillway has failed in several spots
Visitors to Blue River Dam (USACE)	Rock fall and erosion	Unlikely - Pre-existing rock fall	Major - Injury or loss of life	Intermediate	Repairing and maintaining current rock safety structure	In burned area. Fence to catch falling rock from slopes above service road is damaged or at capacity in many places. Fencing above emergency spillway has failed in several spots
McKenzie River Recreational Boaters	Woody debris	Likely - Debris already observed in river	Major - Injury or loss of life	Very High	Signage at boat put-ins, outreach and education	Marine Safety Board
Marten Cr: bridge on Goodpasture Rd.	Debris flows and large woody debris	Possible - Much of watershed burned. Modeled peak flow and debris flow increases	Major - Low traffic volume but single access to homes farther up road.	High	Clear channel. Storm patrol	Bridge deck may not be high enough for passage of large woody debris.

VI. Streamflow and Storm Analysis Peak Flow Modeling

Regional regression equations were used in order to estimate pre-fire peak flows for western Oregon streams. The prediction equations were developed for estimating peak discharges at ungaged sites for various return intervals by relating peak discharges to physical and climatological watershed characteristics (Cooper, 2005). The equations are valuable for estimating peak flows in rural, unregulated drainages which derive a significant portion of their streamflow from storm runoff and/or snowmelt and are a commonly accepted method for estimating peak flows in ungaged basins. Regression equations were developed specific to hydrologic regions defined by the processes which largely influence peak flows, such as rain only, snowmelt, and/or rain-on-snow. Watersheds within each hydrologic region show similar flood frequency relationships, and display similarities in watershed, geomorphological, and meteorological characteristics. It is important to note that prediction equations do not account for reservoir operations, diversions, or urbanization, and the estimates of peak flows represent a hypothetical situation of the watershed, not the actual condition. For further discussion of the assumptions, methodologies, and errors associated with the prediction equations, refer to Cooper (2005).

Basins were delineated for poursheds of interest, which typically contained critical values that required further assessment to understand elevated risk associated with increased peak flows. ArcGIS was used to delineate basins and extract watershed characteristics. The methodology developed by Cooper (2005) contains equations to estimate instantaneous peak flows with annual exceedance probabilities of 50, 20, 10, 4, and 2 percent, corresponding to recurrence intervals of 2, 5, 10, 25, and 50 years, respectively. Given the setting of the burned areas in the upper McKenzie and Calapooia watersheds, equations 1 and 2 were used to estimate pre-fire peak flows (2-year return interval) for watersheds with mean elevations below and above 3000 feet:

Elev<3000 ft:

$$Q_2 = 10^{0.9607} \text{Area}^{0.9004} \text{Slope}^{0.4695} I_{24-2}^{0.8481} \quad [1]$$

Elev>3000 ft:

$$Q_2 = 10^{-2.506} \text{Area}^{1.021} \text{Slope}^{0.8124} I_{24-2}^{2.050} \text{MinJanTemp}^{3.541} \text{MaxJanTemp}^{-1.867} \quad [2]$$

where Area = drainage area (sq mi), Slope = mean watershed slope (degrees), I_{24-2} = 2-year, 24-hour rainfall intensity (inches), MinJanTemp = mean minimum January temperature (degrees F), and MaxJanTemp = mean maximum January temperature (degrees F). Coefficients were also calibrated to develop additional equations for estimating peak flows at return intervals of 5, 10, 25, and 50 years for each region (see Cooper, 2005). In circumstances where a stream gage is located on the same stream as the ungaged watershed of interest, and the gaged watershed is between 50 and 150 percent of the ungaged watershed area, it is advised that peak discharges for ungaged watersheds, $Q_u(T)$, be determined directly from peak discharges for the gaged watershed using equation 3:

$$Q_u(T) = Q_g(T) * (A_u/A_g)^{C_a(T)} \quad [3]$$

where $Q_a(T)$ = peak discharge for gaged watershed at return interval T (cfs), A_u = area of ungaged watershed (sq mi), A_g = area of gaged watershed (sq mi), and $C_a(T)$ is the coefficient for area for the specified hydrologic region and return interval T .

Post-fire peak flows were estimated by modifying pre-fire peak flow estimates based on the weighted area of low, moderate, and high soil burn severity. Q_{50} was applied to high burn severity, Q_{25} was applied to moderate burn severity, and the area of low burn severity was split evenly between Q_{10} and Q_5 peak flows ([USDA, 2009]; note: Q_n represents the discharge in cubic feet per second associated with the n -year recurrence interval). Post-fire peak flows at the 2-year and 5-year recurrence intervals were estimated using equations 4 and 5:

$$Q_{2\text{post}} = (\%Area_{\text{unburned}})(Q_2) + (\%Area_{\text{low}})(Q_5) + (\%Area_{\text{mod}}/2)(Q_5) + (\%Area_{\text{mod}}/2)(Q_{10}) + (\%Area_{\text{high}})(Q_{10}) \quad [4]$$

$$Q_{5\text{post}} = (\%Area_{\text{unburned}})(Q_5) + (\%Area_{\text{low}}/2)(Q_5) + (\%Area_{\text{low}}/2)(Q_{10}) + (\%Area_{\text{mod}})(Q_{25}) + (\%Area_{\text{high}})(Q_{50}) \quad [5]$$

Where %Area represents the percent of watershed area classified based on soil burn severity (i.e. unburned/outside, low, moderate, or high) and Q_n represents the pre-fire peak flow at the specified return interval.