Erosion Threat Assessment and Reduction Team (ETART)

Water Quality/Drinking Water Supply Resource Report

Fire: Oregon Wildfires in 2020
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1. Objectives

The ETART Water Quality (WQ) team was tasked to evaluate the risk to surface-derived drinking water sources and community water systems posed by watershed damage caused by wildfires and to propose projects to mitigate the most critical risks. In addition, this report does contain some information on groundwater sources associated with the drinking water systems on surface water and wells within the burn areas.

The focus of this report is drinking water systems and sources affected by the following fires: Almeda, Archie Creek, Beachie Creek, Echo Mountain Complex, Holiday Farm, Lionshead, South Obenchain, and Riverside. Most of the area affected by these fires is within one or more drinking water source areas for public water systems.

Number of Public Water System Intakes Considered by Wildfire Incident and Sub-basin

Wildfire Name	No. of PWS System Intakes	Subbasin	No. of PWS System Intakes
Almeda	3	Clackamas Subbasin	6
Archie Creek	10	McKenzie Subbasin	5
Beachie Creek	11	Molalla-PuddingSubbasin	6
Echo Mountain Complex	1	Rogue Subbasin	7
Hager Ridge,Horse	1	Santiam Subbasin	15
Holiday Farm	6	Umpqua Subbasin	12
Lionshead	4	Other Subbasin	3
Riverside	8	TOTAL	54
Slater	1		
South Obenchain	7		
Steinmetz Creek	1		
Thielsen	1		
TOTAL	54		

(For concerns specific to aquatic ecosystems and fisheries, please refer to the ETART Fish and Wildlife Report.)

2. Critical Values

Critical Values include: Safety of Drinking Water Treatment Personnel; Health of Resident Populations Not Served by Public Water Systems; Finished Drinking Water-Volume and Quality; Drinking Water Intake Structures, Ponds, and Treatment Facilities; Raw (Untreated) Water-Volume and Quality; Stability and Function of Riparian Areas and Hillslopes; and Sediment, Nutrient, and Organic Matter Processing Capacity of Stream Networks.

See Appendix Table A.1 for details of values, threats, and risk assessment.

3. Resource Condition

a. Impact of Watershed Damage Caused by Wildfires to Water Quality/Drinking Water

Wildfires cause changes in watersheds that increase the susceptibility to flooding and erosion. For drinking water systems that rely primarily on surface water, these changes can have both short- and long-term impacts, such as increased treatment costs, need for alternative water supplies, and diminished reservoir capacity (Smith et al 2011). The impact of the wildfire on water quality and quantity depends on the extent and intensity of the wildfire, post-wildfire precipitation, watershed topography and soil characteristics, local ecology, and stream network and connected aquifer characteristics.

Quantity

Wildfire removes trees, shrubs, surface litter and duff, and other vegetation and organic matter from watershed hillslopes. At sufficient fire intensities, riparian areas can also burn, especially during dry weather conditions. Soil can become temporarily hydrophobic (water repellent) from combustion of surface organic material (litter and duff) volatilizing then condensing within the soil profile (Robichaud et al 2008). On naturally water-repellent soils, such as volcanic ash soils, wildfire may remove surface water repellency and create a strong water repellent layer beneath the surface. As a result, precipitation is not intercepted and slowed by vegetation or surface organic material and infiltration into soil may be reduced (Day, Ringo, and Ager 2020 and references cited therein). If this occurs, more water will run off directly into stream and river networks and less infiltrates into groundwater storage to provide flow to streams during dry periods. Fire induced water repellency will slowly decline as soil is intermittently exposed to moisture (DeBano 1981, Letey 2001). This changes the magnitude and timing of peak flows, leading to higher, more erosive peak flows and lower base flows. There is a greater potential for damaging floods and debris flows during periods of intense precipitation which can damage drinking water infrastructure and reduce water quality (Bladon and Behan 2020a and references cited therein). Lower base flows may be especially pronounced and problematic for water systems during late summer and early fall, when flows are normally at their lowest and demand at its highest. As a result, water systems may need to modify or relocate intake structures and ponds, add or expand pre- or post-treatment storage tanks, and/or treatment plant operation practices.

Quality

Wildfire removes vegetation and plant litter and can change the nature of the soils in the watershed. In high severity fire regimes, the immediate post-fire period accounts for the majority of soil movement over long time scales (Roering and Gerber 2005). From a drinking water provision and water quality perspective, that eroded soil becomes turbidity-causing sediment in the water source. Erosion also carries organic matter, ash, and nutrients into waterbodies. Post-fire water sources have been shown to have significantly higher turbidity (fine particles of sediment and organic matter), nitrogen, and phosphorus (Day, Ringo, and Ager 2020 and references cited therein). The fire may also increase stream nutrients, major ions, and metals. In addition, changes in the loading and characteristics of dissolved organic matter in the water may complicate flocculation and disinfection byproduct removal. Higher sediment loading may shorten reservoir lifetimes and increase maintenance costs such as dredging and structure repair and replacement. These source water quality changes may require operational or system modifications to address water treatment challenges (Davis, Souder, and Behan 2020 and references cited therein). Modifications to treatment practices might include chemical use for sediment and organic matter removal and disinfection, backwashing of filters, system maintenance, and utilizing water sources differently. If source quality is too poor to treat, water systems will have to switch to alternate sources (if available) or shut down treatment until source conditions improve. Prolonged periods of poor water quality will lead to an insufficient volume of finished drinking water to meet community needs or an inability to meet Safe Drinking Water Act contaminant limits.

Post-fire increases in waterbody nutrient concentrations (e.g. nitrogen, phosphorous, calcium) are common as a result of reduced nutrient uptake by plants and by leaching from soil and adsorption to detached soil particles. These nutrient fluxes typically last until vegetation regrowth reduces available nutrient concentrations in the soil. More growth of single-celled and multicellular aquatic plants could contribute to elevated natural organic matter is drinking water sources. Under the right conditions, the increase in available nutrients, especially nitrogen and phosphorous, can contribute to harmful algal bloom (HABs). Some water bodies important for drinking water supplies (e.g. Detroit Lake on the Santiam River) have pre-fire HAB issues. Post-fire nutrient flushes may exacerbate or trigger more frequent or intense blooms.

Fire severity is often lower in riparian areas (Reeves et al 2006, Pettit and Naiman 2007). However, fuel loads are often higher, so fire severity can be worse under sustained drought conditions. Headwaters streams often burn at similar intensity to surrounding hillslopes (Olson and Agee 2005). Riparian zones are often steeper than the surrounding landscape. Combined with the by-definition proximity to waterbodies, riparian zones represent a major source of sediment and organic matter to streams and lakes when disturbed by fire and/or human activities. Alternatively, intact or less damaged riparian areas offer an opportunity to filter and capture sediment and soil eroded from surrounding hillslopes. Dead and dying trees in riparian areas and upslope colluvial hollows can also provide large woody debris to stream systems, enhancing habitat, trapping and filtering fine sediment, slowing stream flow velocities, and providing processing (digestion) sites for organic matter (Reeves et al 1995, Gomi et al 2006, Bryant et al 2007, May 2007). Protection and restoration of riparian areas is highly beneficial to water quality and drinking water protection in the post-fire recovery period.

Land use and management practices in the post-fire period can affect erosion, vegetation regrowth, and water quality for better or worse. Early successional vegetation stabilizes and builds soils, traps nutrients, and provides wildlife habitat (Swanson et al 2011). Residual woody debris and tree boles provide wildlife habitat, nesting sites for animals who disperse seeds, slow surface water flows and trap eroded sediment. Dead and dying trees falling into streams and hollows are critical components of aquatic ecosystems. Removal of these biological legacies and ecosystem responses to disturbance can prolong or exacerbate the sensitive post-fire period (Lindenmayer, Burton, and Franklin 2008, Slesak et al 2015). Soil disturbance from felling and yarding and suppression of early successional vegetation can increase the magnitude of soil erosion and nutrient leaching into stream networks. Vehicle traffic on waterlogged roads increases sediment generation from the road surface. Intensively managed lands could become significant sediment sources, especially on steeper, intensely burned hillslopes and riparian areas. Minimizing management-based soil disturbance and utilizing natural recovery processes is encouraged.

Urban and suburban areas are sources of toxic compounds and metals during normal precipitation events (Hughes et al 2014). Toxic metals and compounds would be created and/or released at greater rates when buildings, vehicles, infrastructure, and even vegetation combust. Possible contaminants are mercury and other metals, volatile organic compounds like benzene, polyaromatic hydrocarbons, flame retardants, and perfluorinated compounds (PFAS), which are the key component of many firefighting foams. (There is no specific knowledge about use of AFFF firefighting foams in these fires, but evaluation of the potential is advisable.) These can be washed, leached, or carrying into drinking water sources. Some (e.g. mercury, PFAS) can enter the food web and bioaccumulate. Many treatment methods are limited in capacity to remove contaminants of this type, so the entrance of fire-released or –created toxicants into DWSAs will increase the risk to human health.

b. Assessment Methodology

Watershed Concerns for Public Water Systems

The goal of assessing the public water system was to rank the public water systems concerning the public health and safety of the public. In determining the systems to be included in this assessment, the WQ team used a spreadsheet developed by the Oregon Health Authority (OHA) and Oregon Department of Environmental Quality (DEQ) for this purpose. In addition, this list was cross referenced with lists provided by Oregon Association of Water Utilities (OAWU) and United States Department of Agriculture Rural Development (USDA-RD).

This report summarizes public water systems with known direct damage impacts of the fire to system infrastructure and/or fire damage to the drinking water source area. It includes an assessment of watershed changes on water system operations. The direct impacts portion summarizes the possible intake damage where the wildfires burned over the source water structures (i.e. wells and surface water intakes) and potential damage to distribution systems for finished drinking water.

The assessment of drinking water systems due to the watershed changes provides a scoring system to indicate systems that have the largest concern. Systems with the highest score have the most vulnerability and can be used to help prioritize resource allocations. In scoring the public water systems, we considered severity of erosion risk factors in the watershed, available alternate sources, anticipated raw water total organic carbon (TOC) increase, drinking water treatment technology, disinfection byproducts (DBPs), water plant operator certification levels, and the general size of the population served. The score weights given to each of these categories can be found in the Public Water System Weighted Scoring Criteria table below:

Public Water System Weighted Scoring Criteria

Watershed		Available Sources		TOC Increase		Treatment		TTHM		HAA5		Operator		Population	
H	15	H	15	VH	12	H	12	H	5	H	5	H	12	H	3
M	10	M	10	H	8	M	8	M	3	M	3	M	8	M	2
L	1	L	1	M	4	L	4	L	1	L	1	L	4	L	1
				L	1										

The watershed factors were calculated by DEQ and OHA using High (H)/Moderate(M)/Low(L) rankings of four primary factors within individual drinking water source areas (DWSAs): % of drinking water source area burned (H=>40%, M=15-40%, L=<15%), % private land use within the portion of the DWSA inside the fire perimeter, as public lands have relatively higher levels of protection for riparian zones, steep slopes, and other sensitive locations compared to private (H=>50%, M=25-50%, L=<25%; Souder and Behan 2020), erosion risk as the interaction of soil burn severity and NRCS off-road erosion hazard ratings, and % of HUC12 (subwatershed) units with 60% or greater probability of debris flows (H=>40%, M=15-40%, L=<15%; USGS analysis, see Geology/Geohazards reports). The average ranking of these four factors was then modified by wildfire proximity to the intake and whether the water source is surface water or surface-influenced groundwater. Erosion risk was later refined to be consistent with BAER processes by intersecting soil burn severity and slope categories (see diagram). Where available, we used soil burn severity (SBS) to represent fire damage. For the Echo Mountain Complex and South Obenchain fires we used the soil burned area reflectance classification (BARC), as SBS data were not available. (See Soils reports for more details on evaluation of burn severity.) The evaluation results are summarized in Table A.2 of Appendix A.

		Slope Category		
		>60%	30-60%	<30%
Burn Severity	H	H	H	M
	M	H	M	M
	L	M	L	L

The available resource factors consider the quality and type of water sources for each public water system. In discussions with drinking water systems staff in Colorado and Wyoming, the plant operators typically allowed the initial high ash runoff event to pass by their surface water intakes to manage their operations. Thus, the systems with only surface water intakes were given the highest concern. Systems with groundwater sources under the direct influence of surface water were given medium level of concern. If a system has alternate groundwater wells available, then there was a lower level of concern.

The anticipated raw water TOC increase level of concern was determined by modeling changes in soil erosion and sediment delivery in each critical drainage. We assessed erosion risk using the Watershed Erosion Prediction Project (WEPP) Disturbed framework. For more information on the specific methodology, please refer to the WEPP Erosion Modeling in Critical Drainages section below.

The drinking water treatment systems were evaluated by OHA to determine the treatment capacity for the systems to handle changes in the source water quality. The factors used to account for this capacity was the technology used for turbidity and total organic carbon (TOC) removal, number of storage days available, operator staff availability, the ability to measure the source water quality, and the coagulation controls.

- For turbidity removal, slow sand and cartridge were the highest concern. Medium concern was given to slow sand systems with coagulation and direct filtration systems. The lowest concern was given to membranes and all conventional systems.
- For TOC removal, cartridge and membranes without coagulation were the highest concern. Medium concern was given to slow sand, membranes with coagulation, and direct filtration systems. The lowest concern was given to conventional and any filter type with granular activated carbon (GAC) or powdered activated carbon (PAC).
- For the number of storage days available, this was determined by looking at all storage volumes versus average and rainy season demands. The systems with less than 1 day of storage were given the highest priority. Medium concern was given to systems with 1 to 3 days of storage. The lowest concern was given to systems with more than 3 days of storage.
- "Drinking operator staff availability" evaluates the status of a drinking water operator being present at the water treatment plant. The highest concern was given to those systems with no water operator physically present during times of operation. Medium concern was given to those systems with no water operator present; however, there is auto-shutdown controls based on the turbidity in the individual or combined filter effluents. The lowest concern was given to systems with water operators always present during the times of operation.
- The source water quality measurements evaluated the ability of the operator to measure raw water nephelometric turbidity units (NTUs). The highest concern was for systems that rely on grab samples. Medium concern was given to those systems with online analyzers. The lowest concern was given to those online analyzers with alarms to notify the operators.
- The coagulation controls were evaluated on the sophistication implemented for the operator to adjust dosages depending on changes in raw water quality. The highest concern was given to those systems that have no coagulation adjustment based on water quality. Medium concern was given to systems that manually adjust the coagulation dosage and rely on jar testing methods. The lowest concern was given to those systems with streaming current monitors (SCMs) or automated coagulant adjustments.

The DBPs were analyzed looking that the highest Total Trihalomethanes (TTHMs) and Haloacetic Acids (HAA5s) reported in the past two years in the water distribution system prior to the fire event. The maximum contaminant levels (MCLs) for TTHMS and HAA5s are 0.080 and 0.060 mg/L, respectively. If the reported values were within 0.005 mg/L of the MCLs, there was a high DBP concern. If the reported values were greater than half of the MCLs, there was a medium DBP concern, and a low concern for lower values.

The maximum water treatment operator certification levels were evaluated for each of the systems. Level 3 and 4 drinking water operators are reasonably expected to have the knowledge, skills, and abilities to investigate, diagnose, and troubleshoot drinking water operations, and thus, there is a low level of concern. Level 2 operators are reasonably expected to understand the operations of surface water treatment operations and a variation of applications, and thus, there is a medium level of concern. Level 1 operators are entry level operators expected to operate the minimum requirements of a basic groundwater drinking water system, and thus, there is a high level of concern due to changes in water quality.

Lastly, in the overall scoring of the affected public water systems was the population served by the system. If the systems served greater than 10,000 persons, a highest priority was issued for the system. Medium priority was given to those system serving between 1,000 and 10,000 persons. The lowest priority was given to systems serving less than 1,000 persons. It should be noted that larger populated systems were considered due to the level of resources required to serve larger populations; however, it is recognized that smaller systems have less resources available. Thus, the population had the lowest weighting score in the overall process.

WEPP Erosion Modeling in Critical Drainages

The team modeled changes in soil erosion and sediment delivery in each critical drainage and assessed erosion risk using the Watershed Erosion Prediction Project (WEPP) Disturbed framework. WEPP Disturbed generates outputs using data from various climate monitoring systems, the Soil Survey Geographic Database (SSURGO) produced by the NRCS, the National Land Cover Database (NLCD), and soil burn severity maps. For the Echo Mountain Complex and South Obenchain burned area reflectance classification (BARC) mapping was used, as SBS mapping was not available. Climate variability within each drainage was generated using the gridded surface meteorological dataset (GRIDMET) with Parameter-elevation Regression on Independent Slopes Model (PRISM) revision.

Surface water intake locations were modeled due to their proximity to the burned areas and the size of the basin contributing runoff. Systems with contributing basins that were too large to model were given a lower priority, because of the ability of unburned areas to contribute higher quality water to dilute or delay the source water concerns of the wildfires. In some instances, it was noted that the surface water intakes were significantly downstream from any burn area and considered to have a lower level of concern, as basin hydrologic processes have the capacity to store and slow sediment movement.

In the systems modeled, the pre- and post-fire conditions of the basin were modeled for comparison. The total sediment discharge at the surface water intakes was determined along with the total organic matter loading among all particle sizes. In water treatment, particle sizes less than 0.030 mm are typically considered unsettleable solids, which requires the use of coagulants or filtration practices to remove. Thus, the unsetteable organic matter in the model was determined using the 42.9 percent organic matter fraction for particle sizes less than 0.030 mm .

For the modeled systems, a very high concern was given to those systems with increases greater than 100%. A high concern was given for those systems with increases greater than 25%. A medium concern was given for those systems greater than 10%, and low concern for systems less than 10% or not modeled.

c. Risk Assessment

Watershed Assessment

Extent of Burned Land in Drinking Water Source Areas and Soil Erosion Risk

Risk of soil erosion and transport to waterbodies increases substantially in the post-fire environment. The primary risk factors are slope steepness and burn severity as measured by soil or vegetation burn severity. Combinations of steeper slopes and greater burn severity will have higher erosion risk, while gentler slopes and areas of low burn severity will have lower risk. We used soil burn severity where available. For the Echo Mountain Complex and South Obenchain, we used burned area reflectance classification (BARC) as soil burn severity was unavailable. Maps of soil burn severity (where available; otherwise BARC) and slope gradient class (30-60%, >60%) are in Appendix A.

Slope Class and Soil Burn Severity Area (acres) by Fire--All Lands

Fire	0-20% Low or UB	0-20% Moderate	0-20% High	20-30% Low or UB	20-30% Moderate	20-30% High	30-60% Low or UB	30-60% Moderate	30-60% High	>60% Low or UB	>60% Moderate	>60% High	Grand Total
Archie Creek	5342	11515	10145	5640	9829	7725	12999	23132	17353	6179	13384	8021	131263
Beachie Creek	24309	27756	2405	12566	15167	1966	24427	36014	8904	9286	22854	6774	192427
Echo Mountain	608	408	8	343	225	6	501	330	7	44	23	0	2504
Holiday Farm	12719	21290	1885	8027	16832	2357	19238	46374	8230	9394	22771	3631	172747
Lionshead	47858	31592	6656	17077	12005	3208	29568	24965	5849	12039	10828	2030	203675
Riverside	21323	12091	2581	12404	7108	2048	24220	21079	8263	7550	14784	4033	137483
South Obenchain	9617	6359	162	5158	3906	81	4199	2820	79	78	65	2	32527
Grand Total	121777	111011	23841	61215	65072	17391	115152	154714	48685	44569	84709	24489	872626

Slope Class and Soil Burn Severity by Fire--Non-Federal Lands

Fire	0-20% Low or UB	0-20% Moderate	0-20% High	20-30% Low or UB	20-30% Moderate	20-30% High	30-60% Low or UB	30-60% Moderate	30-60% High	>60% Low or UB	>60% Moderate	>60% High	Grand Total
Archie Creek	2219	7373	5478	2070	5955	4132	5419	12522	8023	2661	5481	3273	64605
Beachie Creek	18111	20176	1369	8050	9830	868	12400	17531	1970	3487	7631	1038	102460
Echo Mountain	488	364	8	236	194	6	324	288	7	26	19	0	1959
Holiday Farm	10260	15630	1605	6408	12708	1941	12536	32084	5708	5169	15011	2230	121291
Lionshead	2445	980	192	1126	454	118	1151	567	151	144	130	70	7529
Riverside	8105	6847	921	4174	3149	371	7754	5511	590	2282	2170	143	42017
South Obenchain	5821	3501	104	2682	1866	41	2156	1460	49	37	51	1	17769
Grand Total	47448	54872	9677	24746	34156	7478	41740	69962	16497	13805	30493	6755	357629

Debris Flow Hazard Frequency

Debris flows are a slurry of soil, rocks, water, logs, and other debris that occur on steep slopes and drainages during intense rainstorms and/or snowmelt. Debris flow hazard and frequency can increase substantially following vegetation removal by fire or management and soil disturbance. Slopes subject to shallow, rapidly moving landslides that can trigger debris flows are generally greater than 60% slope angle. Debris flows can directly damage drinking water infrastructure like intakes, treatment plants, and storage ponds and tanks. The large amounts of sediment and soil mobilized can also contribute substantial volumes of turbidity-causing fine sediments and organic matter to waterbodies, resulting in water quality challenges for drinking water supplies that can take months or years to resolve (Bladon and Behan 2020b and references cited therein).

The US Geological Survey estimated probability of debris flow occurrence within 12-digit hydrologic units (i.e. subwatersheds) in most of the wildfire boundaries. To characterize debris flow risk to water quality of drinking water sources, the WQ team calculated debris flow hazard frequency, the percent of 12-digit hydrologic units (i.e. subwatersheds) having significant debris flow hazard (≥60% probability of debris flow occurrence within the HUC12 boundary) within individual drinking water source areas. The frequency of HUC12 subwatersheds with significant probability of debris flows gives an indication of risk to water quality from shallow landslides and debris flows. Debris flow hazard will peak later than surface erosion impacts and remain elevated for several years, due to the loss of vegetation effects on steep slopes such as root stabilization of soil and canopy interception of precipitation; regrowing trees and shrubs will restabilize the sites, reducing failure hazard over the next couple decades.

Percent of HUC12 Subwatersheds with USGS Debris Flow Hazard >60%			
Wildfire Name	PWS Name	Debris Flow Hazard Frequency	Subbasin
Archie Creek	GLIDE WATER ASSOCIATION	55%	Umpqua
Archie Creek	ROSEBURG	53%	Umpqua
Archie Creek	SUTHERLIN (Calapooya Cr.)	40%	Umpqua
Archie Creek	USFS STEAMBOAT WORK CENTER	50%	Umpqua
Archie Creek	USFS WOLF CREEK JOB CORPS	21%	Umpqua
Archie Creek	CASCADE PACIFIC PULP LLC	16%	Umpqua
Archie Creek	ELKTON	53%	Umpqua
Archie Creek	UMPQUA BASIN WATER ASSOC	53%	Umpqua
Archie Creek	OAKLAND	40%	Umpqua
Beachie Creek	ALBANY (Santiam R.)	48%	Santiam
Beachie Creek	JEFFERSON	48%	Santiam
Beachie Creek	LYONS MEHAMA WATER DISTRICT	49%	Santiam
Beachie Creek	OPAL CREEK ANCIENT FOREST CTR	78%	Santiam
Beachie Creek	SALEM PUBLIC WORKS	48%	Santiam
Beachie Creek	SILVERTON (Abiqua Cr.)	25%	Molalla-Pudding
Beachie Creek	SILVERTON (Silver Cr.)	7%	Molalla-Pudding
Beachie Creek	STAYTON WATER SUPPLY	48%	Santiam
Beachie Creek	WILSONVILLE	49%	Santiam
Beachie Cr., Lionshead	GATES	37%	Santiam
Holiday Farm	BROWNSVILLE	28%	McKenzie
Holiday Farm	EUGENE WATER & ELECTRIC BOARD	55%	McKenzie
Holiday Farm	LEBANON	0%	Santiam
Holiday Farm	RAINBOW WATER DISTRICT	52%	McKenzie
Holiday Farm	SHANGRI LA WATER DISTRICT	55%	McKenzie
Holiday Farm	SPRINGFIELD UTILITY BOARD	16%	McKenzie
Lionshead	BREITENBUSH HOT SPRINGS	32%	Santiam
Lionshead, Beachie Cr.	DETROIT WATER SYS. (Breitenbush R.)	31%	Santiam
Lionshead	DETROIT WATER SYSTEM (Mackey Cr.)	100%	Santiam
Lionshead	IDANHA CITY WATER (Mud Puppy Cr.)	0%	Santiam
Lionshead	IDANHA CITY WATER (Rainbow Cr.)	0%	Santiam
Riverside	CANBY UTILITY (I.G.-Springs Gallery)	38%	Molalla-Pudding
Riverside	CANBY UTILITY (Molalla)	38%	Molalla-Pudding
Riverside	CLACKAMAS RIVER WATER	47%	Clackamas
Riverside	COLTON WATER DISTRICT	0%	Molalla-Pudding
Riverside	ESTACADA	50%	Clackamas
Riverside	LAKE OSWEGO - TIGARD WATER SUPPLY	47%	Clackamas
Riverside, Beachie Cr.	MOLALLA	39%	Molalla-Pudding
Riverside	NORTH CLACKAMAS COUNTY WC	47%	Clackamas
Riverside	SOUTH FORK WATER BOARD	47%	Clackamas

Volatile Organic Compounds and Other Toxic Substances

Toxic substances (metals and compounds) can be created or released during wildfire events. Structures, vehicles, roads, and other infrastructure can generate or release toxic substances. Precipitation flowing over burned urban and suburban areas can transport fire-generated or –released toxics to water bodies. Toxic substance risk is greatly dependent on the efficacy of debris and hazardous waste removal and stormwater routing and management within burned urban and suburban areas and around structures such as wildland homes. Density of burned structures and proximity to waterbodies and surface flow paths is key.

There is a potential for volatile organic compounds (VOCs) to enter the system when a wildfire burns through a service area. This may occur when VOCs are present near a location where a service line is damaged, allowing the compounds to enter the water system if use in another location creates a vacuum. VOCs may also be emitted by plastic or rubber components of the distribution system itself when they are exposed to the extreme heat of a wildfire (see below).

Fluorine-containing firefighting foams (i.e. AFFF) are often used for fire suppression in urban and suburban areas and for vehicle fires and other situations with liquid fuels. The perfluorinated compounds (i.e. PFAS) used in these firefighting foams and released from burned non-stick cookware, stain resistant carpeting, and other goods degrade slowly, bioaccumulate, and present health risks.

Precise estimates of toxic substance amounts, pathways, and loading within the burned areas is not possible. To give an indication of the potential for toxic substance loading from burned buildings, vehicles, and infrastructure, we generated tables of burned structures by drinking water source areas (DWSAs) using data from the US Army Corps of Engineers (USACE) and Oregon State Fire Marshall. Those DWSAs with a higher number of structures have greater potential to deliver toxic substances to surface water, dependent on size of DWSA and control measures taken, such as debris clean up. See below for discussion of system capacity to remove toxic substances during treatment; not all of the public water systems in the burned areas have the capacity to test for or remove these substances when they are not bound in particulate matter subject to filtration. In particular, public water systems downstream of the Almeda, Beachie Creek, and Holiday Farm fires have higher risk of toxic substances from burned structures and vehicles.

USACE Damaged Structures by Surface Water Drinking Water Source Area					
Surface Water Drinking Water Source Area	Not Assessed	Not Damaged	Unconfirmed	Damaged	Grand Total
BREITENBUSH HOT SPRINGS	66			21	87
BROWNSVILLE, CITY OF	1				1
CANBY UTILITY	216	122	4	6	348
CAVE JUNCTION, CITY OF	49				49
CLACKAMAS RIVER WATER - CLACKAMAS	573	256	17	132	978
COUNTRY VIEW MH ESTATES	33				33
DETROIT WATER SYSTEM	83			21	104
ESTACADA, CITY OF	177	141	7	57	382
GATES, CITY OF	481	141		406	1,028
GLIDE WATER ASSOCIATION	186	206	43	124	559
GOLD HILL, CITY OF	310	980	38	2,247	3,575
GRANTS PASS, CITY OF	310	980	38	2,247	3,575
HILAND WC - SHADY COVE	46				46
LEBANON, CITY OF	1				1
LYONS MEHAMA WATER DISTRICT	706	861	6	1,050	2,623
MEDFORD WATER COMMISSION	261	149	4	97	511
MOLALLA, CITY OF	44				44
PANTHER CREEK WD	1	6		2	9
PP&L-TOKETEE VILLAGE	89				89
RAINBOW WATER DISTRICT	21	597		737	1,355
ROSEBURG, CITY OF	254	223	44	124	645
SALEM PUBLIC WORKS	745	939	6	1,077	2,767
SHANGRI LA WATER DISTRICT	21	597		737	1,355
SILVERTON, CITY OF	63				63
SPRINGFIELD UTILITY BOARD	4				4
STAYTON WATER SUPPLY	751	939	6	1,077	2,773
SUTHERLIN, CITY OF	6	6	6		18
USFS WOLF CREEK JOB CORPS	4				4
WILSONVILLE, CITY OF	774	1,537	6	1,814	4,131
Grand Total	**6,276**	**8,680**	**225**	**11,976**	**27,157**

OSFM Damaged Structures by Surface Water Drinking Water Source Area			
Surface Water Drinking Water Source Area	Commercial Structures Destroyed	Residential Structures Destroyed	Outbuilding Structures Destroyed
CANBY UTILITY	0	6	12
CLACKAMAS RIVER WATER - CLACKAMAS	3	54	178
ESTACADA, CITY OF	0	12	32
GATES, CITY OF	28	321	289
LYONS MEHAMA WATER DISTRICT	63	719	874
MOLALLA, CITY OF	0	2	2
RAINBOW WATER DISTRICT	31	486	493
SALEM PUBLIC WORKS	63	727	884
SHANGRI LA WATER DISTRICT	31	486	493
STAYTON WATER SUPPLY	63	727	884
WILSONVILLE, CITY OF	94	1,213	1,377
Grand Total	**376**	**4,761**	**5,576**

Public Water Systems Impacted due to Infrastructure Damage

The public water systems (PWSs) were mapped using geographic information systems (GIS) and the extent of the soil burn areas were mapped with the locations of well(s) and surface water intakes. This is considering the possibility of infrastructure damage to these drinking water structures.

Public Drinking Water Sources

The groundwater well sources exposed to excessive heat can damage the well seals, wellhead covers, well casing near the surface, electrical cables and appurtenances. Due to the loss of vegetation, the wellheads could be exposed to significant debris and sediment. In each wildfire, the *Affected Well County By Fire and Fire Burn Severity* table summarizes the total wells mapped within the burn areas.

Affected Well Count By Fire and Fire Burn Severity					
Incident Name	Unburned or Underburned	Low Soil Burn Severity	Moderate Soil Burn Severity	High Soil Burn Severity	Grand Total
Almeda Drive	7	4			11
Archie Creek			5	1	6
Beachie Creek		7	8		15
Echo Mountain Complex	1	3	1		5
Holiday Farm	1	6	10		17
Lionshead	1				1
Riverside		8	5		13
Grand Total	**10**	**29**	**29**	**1**	**69**

The surface water source intakes exposed to excessive heat could have effects on head gate structure and seals. Due to loss of vegetation, the surface water structure's foundations could be compromised and exposed to significant debris and sediment. In each wildfire, the *Affected Intakes Count By Fire and Fire Burn Severity* table summarize the total surface water intakes mapped within the burn areas.

Affected Intakes Count By Fire and Fire Burn Severity			
Incident Name	Low Soil Burn Severity	Moderate Soil Burn Severity	Grand Total
Beachie Creek		1	1
Echo Mountain Complex		1	1
Lionshead	2	1	3
Grand Total	**2**	**3**	**5**

Soil Burn Severity Indicators (Parsons et al 2010)

Not Burned or Underburned: This is a location within the boundaries of the fire that doesn't appear to have been burned. The underburned areas consist of areas where the canopy or tall surface features are unburned, but the vegetation on the soil surface could have been burned.

Low soil burn severity: Surface organic layers are not completely consumed and are still recognizable. Structural aggregate stability is not changed from its unburned condition, and roots are generally unchanged because the heat pulse below the soil surface was not great enough to consume or char any underlying organics. The ground surface, including any exposed mineral soil, may appear brown or black (lightly charred), and the canopy and understory vegetation will likely appear "green."

Moderate soil burn severity: Up to 80 percent of the pre-fire ground cover (litter and ground fuels) may be consumed but generally not all of it. Fine roots (~0.1 inch or 0.25 cm diameter) may be scorched but are rarely completely consumed over much of the area. The color of the ash on the surface is generally blackened with possible gray patches. 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. The prevailing color of the site is often “brown” due to canopy needle and other vegetation scorch. Soil structure is generally unchanged.

High soil burn severity: All or nearly all of the pre-fire ground cover and surface organic matter (litter, duff, and fine roots) is generally consumed, and charring may be visible on larger roots. The prevailing color of the site is often “black” due to extensive charring. Bare soil or ash is exposed and susceptible to erosion, and aggregate structure may be less stable. White or gray ash (up to several centimeters in depth) indicates that considerable ground cover or fuels were consumed. Sometimes very large tree roots (> 3 inches or 8 cm diameter) are entirely burned extending from a charred stump hole. Soil is often gray, orange, or reddish at the ground surface where large fuels were concentrated and consumed.

The PWSs groundwater wells were mapped in relation to the burn areas. A summary of the number of groundwater wells for individual PWSs is in *Table B.1: Individual Affected Well By Fire and Fire Burn Severity* in Appendix B. The surface water wells affected for each PWS is summarized in the *Individual Affected Surface Intake By Fire and Fire Burn Severity* table below:

Individual Affected Surface Intake By Fire and Fire Burn Severity

Incident_1	PWS_NAME	Low Soil Burn Severity	Moderate Soil Burn Severity	Grand Total
Beachie Creek	GATES, CITY OF		1	1
Beachie Creek Total			**1**	**1**
Echo Mountain Complex	PANTHER CREEK WATER DISTRICT		1	1
Echo Mountain Complex Total			**1**	**1**
Lionshead	BREITENBUSH HOT SPRINGS	1		2
	DETROIT WATER SYSTEM	1	1	2
Lionshead Total		**2**	**1**	**3**
Grand Total		**2**	**3**	**5**

Public Drinking Water Distribution Service Areas

The extent of the drinking water service areas was mapped in relation to the wildfire burn areas. It is possible that the fire hydrant components, booster pumps, water storage tanks, water service lines, water meters and other appurtenances could be damaged due to extensive heat.

Heat from fire can destroy or damage distribution systems, rendering pipes cracked, melted, or blocked and incapable of delivering water to homes and businesses during and after rebuilding. A less immediately obvious form of damage is changes in chemical composition of plastic pipes and components; these can release volatile organic compounds (e.g. benzene, plastic polymers) into finished drinking water. This process of chemical breakdown can continue for months or years and cause distribution system failures and toxic chemical leaching for extended periods of time. This damage may not be immediately apparent but only manifest after water lines are put back in service as homes and businesses are reconnected following repair and rebuilding. We give an indication of the possible public health risk from distribution system damage using burned structure data from the Army Corps of Engineers (USACE) and Oregon State Fire Marshall (OSFM). Water systems with more burned structures in their service area footprint are more likely to have damage to water distribution systems that could threaten public health (Schulze & Fischer 2020).

OHA has tested water samples from a number of systems in burn areas for VOCs. No samples have tested positive thus far. However, as rebuilding and repair of homes, businesses, and water distribution systems proceeds, VOCs may occur in treated drinking water. Further testing is needed.

Water systems are more likely to be contaminated with VOCs when there is extensive damage to the structures, or a very high intensity fire burned in the vicinity of water system components. The tables below give numbers of structures burned in water system service areas; those with more burned structures may have a higher likelihood of VOC contamination due to greater heat exposure to distribution system components. If operators suspect that their system has been contaminated with VOCs, they should contact OHA to discuss the most appropriate course of action.

The numbered of damaged structures being assessed by the United States Army Corps of Engineers (USACE) and the Oregon State Fire Marshall (OSFM). The USACE summary of damaged structures is in the table below.

USACE Damaged Structures in Area Served by Drinking Water System					
Drinking Water System	Not Assessed	Not Damaged	Unconfirmed	Damaged	Grand Total
Ashland Water Department		31			31
Blue River Water District	1	60		113	174
Canyonville, City of	2				2
Lincoln City Water District	16	38	3	2	59
Lyons Mehama Water District	3	18			21
Mapleton Water District	1				1
Mill City Water Department	2	133	1	36	172
Phoenix, City of	9	128	19	454	610
Roberts Creek Water District	81				81
Roseburg Forest Prod - Dillard	2				2
Roseburg, City of	1,042				1,042
Sutherlin, City of	238				238
Talent, City of	4	181	3	624	812
Tri-City JW&SA	1				1
Umpqua Basin Water Assoc	182				182
Winston-Dillard Water District	63				63
Grand Total	**4,917**	**3,552**	**120**	**4,683**	**13,272**

The OSFM appears to be narrowing their efforts on the following water systems in the table below.

OSFM Damaged Structures in Area Served by Drinking Water System			
Drinking Water System	Commercial Structures Destroyed	Residential Structures Destroyed	Outbuilding Structures Destroyed
Blue River Water District	8	54	41
Colton Water District	0	0	0
Mill City Water Department	2	19	19
Grand Total	97	1,278	1,619

Capacity of Drinking Water Treatment Facilities

The overall rankings for concerns to treatment plants were based on the ability of the treatment plant to treat the water. However, it should be recognized that there is a risk in the event that the water quality causes failure at the drinking water plant. The drinking water treatment technology for the systems were classified into conventional, direct filtration, membranes, cartridges and slow sand filters.

In the event, the water plant should incur turbidity and organic loadings that damage the treatment process, the levels of concern and proceeding with caution should be as follows:

- High Caution: The systems with highest concerns were membranes and slow sand filters. Membranes are a concern due to the fouling and cost of replacement of this technology. Slow sand filters were considered to be high concern due to the operation of the Schmutzdecke layer, which is the biological layer, and the time of recovery, since slow sand filters require the removal of the top sand layer for servicing.
- Medium Caution: Conventional and direct filtration plants incorporate a coagulation/flocculation technology, allowing for jar testing investigations for recovery, and these were considered to be of medium concern.
- Low Caution: The cartridge filtration was considered to be a low concern due to anticipated replacement time and costs.

The systems were evaluated to understand which systems were at most risk due to the proximity of the fire and only have one surface water source available. These systems are identified in *Table B.2: Public Water Systems with No Alternate Water Sources Available* in Appendix B. These were identified due to the risk present if the water source is compromised and unable to produce water. These are the communities that may be required to provide bottle water or another alternate source of water to their communities.

Public Water Systems Operations Impacted due to Watershed Changes

The public water systems (PWSs) were evaluated in relation to the operational capacity for the systems to continue providing safe drinking water during runoff events and watershed impacts due to wildfire burn areas.

Using the methodology outlined in Section 3.b, the systems were provided a total score. Higher scores have an increased risk on the PWSs' abilities to adjust for the changes in water quality due to the wildfires. The summary of all water systems evaluated is provided in *Table B.3: Statewide Public Water Systems Concern Rankings* in Appendix B.

Overall, the systems with the highest concern were Detroit Water System (Score 61), City of Gates (Score 61), Panther Creek Water District (Score 61), Lyons Mehama Water District (Score 59), and Breitenbush Hot Springs (Score 57). The main reasons are the high likelihood of watershed impacts, limited alternate sources available, and the need for operator training at these locations.

The summary of water systems was organized into the subbasins, which is provided in *Table B.4: Public Water systems Concern Rankings by Sub basin* in Appendix B. In general, the average score of all public water systems. The average score of systems in each sub basin ranged from 31.7 to 43.0. The basin with the largest concern was the Santiam subbasin. Therefore, this subbasin would be high value for implementing erosion control measures. Several of the other basins had an individual system with significant high concerns. In particular, the Umpqua subbasin has a higher number of systems with elevated concerns; it is another area where erosion control measures are especially advisable.

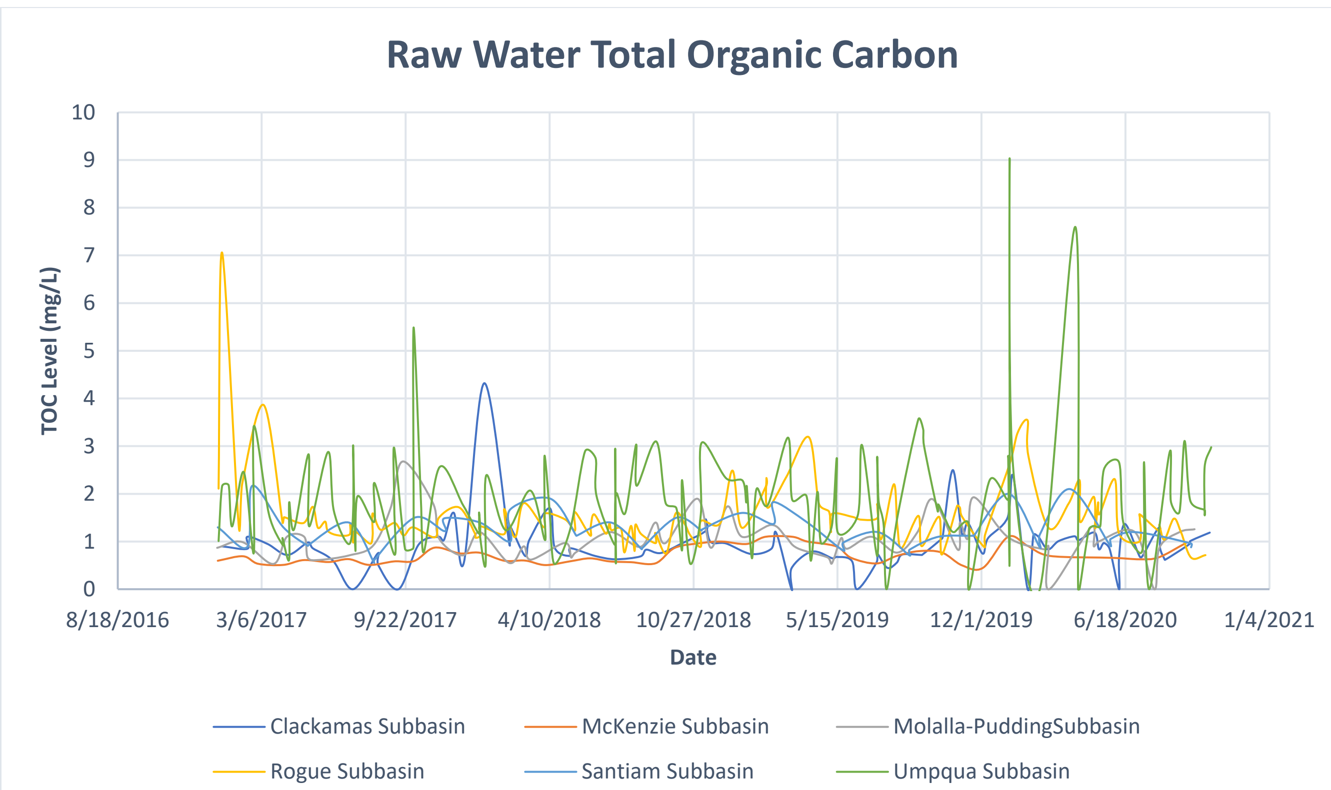
The summary of water systems was organized into the wildfire incidents, which is provided in *Table B.5: Public Water Systems Concern Rankings* by Wildfire in Appendix B. The wildfire with the largest impact on multiple drinking water systems was Beachie Creek with an average score of 48.8. The wildfires of Archie Creek, Holiday Farm, Lionshead, and Riverside had significant impacts to multiple systems; however, these ranked about the same concern on average.

The organic matter in watersheds is a disinfection byproduct (DBP) precursor, which is measured as total organic carbon (TOC). This TOC chemically reacts with chlorine in the treatment process to develop DBPs. These are a health-based regulation in the National Primary Drinking Water Regulations (NPDWRs).

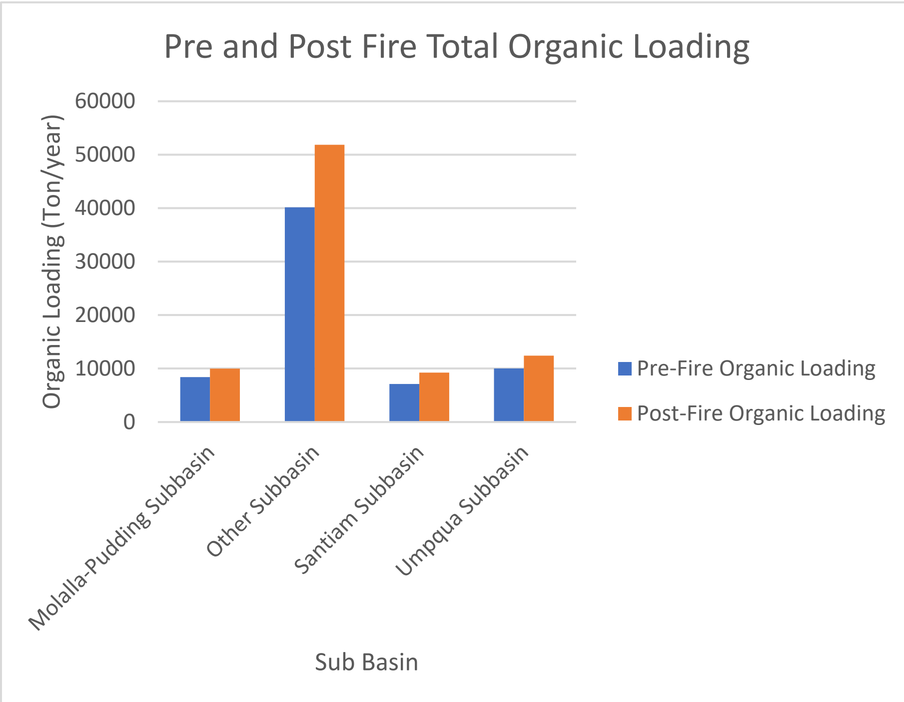
Historical Total Organic Carbon Monitoring at Water Treatment Plants

	Raw Water TOC					Alkalinity
	Min		Max		Average	Average
Subbasin	Date	(mg/L)	Date	(mg/L)	(mg/L)	(mg/L)
Clackamas Subbasin	3/12/2019	0.44	1/9/2018	4.32	0.99	24.72
McKenzie Subbasin	12/3/2019	0.45	1/7/2020	1.1	0.72	23.51
Molalla-PuddingSubbasin	3/22/2017	0.531	9/18/2017	2.68	1.08	22.69
Rogue Subbasin	9/17/2020	0.664	1/10/2017	7.06	1.54	22.69
Santiam Subbasin	8/9/2017	0.557	2/21/2017	2.17	1.22	27.04
Umpqua Subbasin	1/11/2018	0.51	1/9/2020	9.04	1.93	32.47

For the PWSs affected by the wildfire, the systems using conventional water treatment are required to monitor for TOC in the raw water intake. Conventional treatment plants consist of coagulation, flocculation, sedimentation, filtration, and disinfection processes. The *Historical Total Organic Carbon Monitoring at Water Treatment Plans* table above summarizes the past three years of TOC raw water monitoring results for each of the conventional treatment plants affected by the wildfires organized by subbasin. It should be noted that on average the TOC monitoring results are below 2.0 mg/L, which indicates typically low levels of DBP precursors in all locations.



The Raw Water Total Organic graph displays the trends in raw water TOC monitoring results for the past 3 years. It appears that the Rogue and Umpqua Sub basins have the highest fluctuations in the TOC measurements. Thus, it appears that these watersheds may have less ability for TOC buffering capacity and the TOC values may fluctuate more in these sub basins. For individual Basin graphs, refer to *Appendix B.8: Raw Water at Surface Water intake Average Total Organic Carbon (Convention Plants)*.

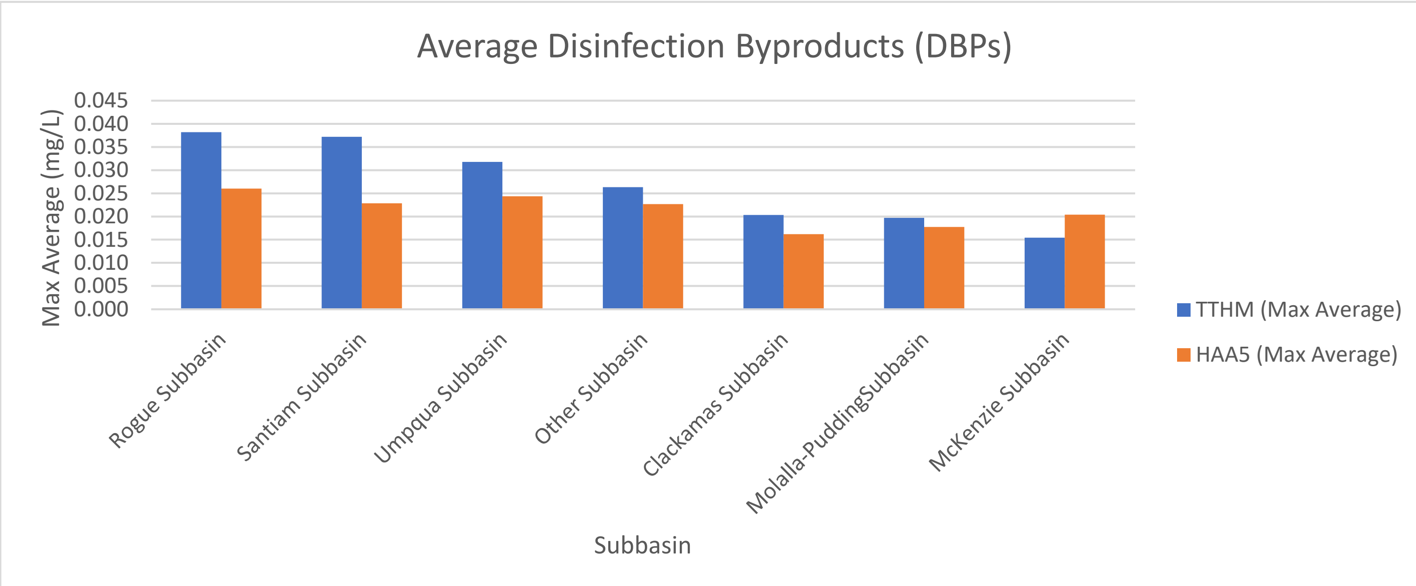


Where the wildfires have burned the vegetation, it is anticipated that there may be an increase in organic loading for public water systems downstream of the burn areas. The Watershed Erosion Prediction Project (WEPP) modeling software was used within limitations to predict the organic loading increases at public water system intakes.

For the actual results of the organic matter loading, see *Appendix B.6: WEPP Modeling – Sediment Loads to PWS Intakes (Modeled Systems Only)*. In this table, you will notice the organic matter for diameters less than 0.030 mm is determined. This is because particle sizes less than 0.030 mm are typically considered to be unsettleable without the use of coagulants and flocculation processes. These are important because this requires the drinking water operators to make treatment chemical adjustments to meet the water quality changes. It should be noticed that almost 98% of the total organic matter in the model is unsetteable.

All public water systems considered in this study were considered for WEPP modeling; however, several basins were too large for the modeling software or simply too far from the wildfires to be reasonably modeled. At these distances, basin hydrogeography will temporally lag or attenuate many of the impacts. For additional information, refer to *Appendix B7: WEPP Modeling – Sediment Loads to PWS Intakes*.

We analyzed the public water systems for historical disinfection byproduct (DBP) performance. The PWSs using chlorine measure DBPs in the form of Total Trihalomethanes and Haloacetic Acids (HAA5s). The Oregon Health Authority provided the highest TTHMs/HAA5s over the past two years for each affected system. The average of these TTHMs/HAA5s maximum monitoring values are visually seen in this graph.



These values were sorted by the highest TTHM levels in *Table B.9: Total Trihalomethanes and Haloacetic Acids Summary* in Appendix B. It should be noted that these are the maximum values collected and compliance with the DBP regulations are based on a locational running annual average (LRAA). Thus, some individual fluctuations of DBPs could go over the maximum contaminant levels (MCLs) for TTHMs and HAA5s, which are 0.080 and 0.060 mg/L, respectively. The system with the highest concern for DBPs was the City of Gates, which is using microfiltration which has a pore size of 0.1 micron (.0001 mm). Thus, the organic matter contributing to this system may require the use of coagulants to increase the TOC particulate size.

In further looking at the DBP issue, the PWSs were organized by sub basin and the average TTHMs and HAA5s determined for each basin in *Table B.10: Total Trihalomethanes and Haloacetic Acids Summary by Basin* in Appendix B. The three basins of higher DBPs than the others appear to be Rogue, Santiam, and Umpqua Sub basins. This correlates with the average raw water TOC values above. However, among these three sub basins, the Umpqua Sub basin appears to have the highest TOC values, but the lower average of measure DBPs.

It should be acknowledged that any treatment plant's ability to adjust their processes to account for changes in the source water quality depends on the water treatment operators. Thus, the level certifications of the water plant operators were evaluated.

The level of certified operators located at the treatment plants affected by the wildfires is in the table. It should be acknowledged that the majority treatment operators located at these affected plants are highly skilled and reasonably have the capability to anticipate and adjust treatment plant operations.

Impacted Water Systems: Certified Operators

Level 4 Operators	20
Level 3 Opreators	11
Level 2 Operators	13
Level 1 Operators	4

In general, Level 3 and 4 operators have the ability to diagnose and troubleshoot drinking water quality operations. Level 2 operators generally have the ability to operate surface water treatment plants and conceptual concepts of raw water impacts on the treatment process. Level 1 operators have the ability to conduct basic drinking water operations and manage the water quantity in the distribution system.

d. Recommended Response Actions

Watershed Monitoring and Management Approaches/Recommendations

The primary purpose of these recommendations for post-fire watershed management is water resource protection and ecosystem remediation in drinking water source areas. The majority of the geographic areas involved in the Cascade fires (Archie Creek, Beachie Creek/Lionshead, Holiday Farm, and Riverside) and the other fires examined (Echo Mountain Complex, South Obenchain, Almeda) lie within the contributing areas for drinking water intakes. In most cases, detailed on-the-ground evaluation and treatment is not feasible. Therefore, these recommendations are best implemented in the locations most likely to benefit drinking water systems (e.g. nearer to affected intakes, geographically lower in source areas). Combining implementation of these recommendations with assistance programs to small landowners could increase the reach and benefit.

Erosion control and soil protection measures are advised in areas where slopes and soil burn severity make treatments feasible and potentially beneficial.

- Hillslope locations with slope gradients of 30-60% and moderate or high soil burn severity could benefit from mulching and other erosion reduction activities. Covering the soil surface will reduce soil displacement and surface sealing from raindrop impacts and encourage infiltration of water. Log barriers, woven fiber mats, or straw wattles are other examples of erosion mitigation methods and can be combined with replanting. See maps for each fire in Appendix A.
    - Gentler slopes (<30%) are at lower risk of surface erosion, and steeper slopes are likely to experience severe erosion or mass wasting that will render moot any mulching or other surface erosion reduction methods. There may be site-specific cases where gentler slopes may need erosion treatments.
    - Locations with low burn severity will quickly recover surface vegetation and likely have significant soil surface roughness and cover (e.g. unburned woody debris and vegetation) in place.
    - Prioritize sites nearer to drinking water intakes for the most immediate benefit.
    - Detailed information on soil protection techniques and erosion mitigation can be found at the Natural Resources Conservation Service's "After the Fire" website (https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/?cid=stelprdb1261654) or in the BAER treatments catalog (https://www.fs.fed.us/eng/pubs/pdf/BAERCAT/lo_res/06251801L.pdf).
    - Detailed maps can be generated using existing data and analyses for use by public water systems, agencies, landowners, and local partners such as watershed councils.
- Implement recommendations in the ETART Engineering reports for roads, stream crossings, and culverts.
- Avoid operations such as salvage harvest or replanting on landslide-prone slopes (>60-80% gradient, depending on soil characteristics, topography, and vegetation history). If activity is necessary, retain substantial portions (30-50%) of the surviving or fire-killed trees to reduce wind erosion, surface disruption, and provide large woody debris to stream networks in the event of slope failure.
    - Additional soil surface disruption, damage to surviving or colonizing vegetation, and loss of surface cover provided by fire legacies (e.g. standing or downed dead trees) could exacerbate

slope failure hazard or contribute to initiation of channelized surface water flows that lead to severe surface erosion or mass wasting.
  - Woody debris and dead and damaged trees have water quality benefits during and after slope failures and debris flows. Debris flows with high wood content generally travel shorter distances. Large wood delivered to stream networks traps and filters fine sediment, retains gravel and other coarse sediment, provides processing (digestion) sites for organic matter, and creates aquatic habitat.
- Timber salvage and replanting operations can take measures to reduce the potential for water quality impacts and aid site restoration and recovery.
  - If burn severity is low, defer operations while assessing survival of trees. Salvage may not be necessary.
  - In locations where burn severity and tree mortality are moderate or high, assess whether natural recovery or assisted natural recovery (e.g. underplanting conifers in areas of high mortality) are viable options and whether densities of dead trees are low enough.
  - Leave wider-than-required riparian buffers on all fish-bearing streams (e.g. 100-120ft) and non-fish-bearing streams (e.g.30-50ft). Even if riparian vegetation mortality is high, buffering all streams will reduce near-stream disturbance, allow growth of fast-growing herbaceous plants, and retain the ecological/water quality benefits of dead wood. In severely impacted riparian areas, consider planting trees to aid revegetation.
  - During and after harvest, use techniques such as lop-and-scatter of branches and limbs during ground-based harvest (using yarding machinery to press material to the ground) or chipping and mulching with smaller diameter wood to protect the soil surface. Install erosion mitigation measures such as log barriers and straw wattles on 30-60% slopes, as recommended, and on shallower slopes as needed. Do not mulch in riparian zones, as it will increase organic matter loading to the stream network.
  - Avoid operations on landslide-and erosion-prone slopes (see above).
- Stream enhancement activities for aquatic habitat, such as large woody debris (i.e. dead tree) placement in streams and draws, also has benefits for drinking water-relevant water quality parameters. Large wood delivered to stream networks traps and filters fine sediment, retains gravel and other coarse sediment, and provides processing (digestion) sites for dissolved and particulate organic matter that interferes in water treatment and is a precursor for disinfection by-products. During recovery efforts, find opportunities to align fisheries/aquatic habitat enhancement projects with drinking water protection and remediation activities.
- Monitoring of water quality and streamflow changes will give drinking water systems improved capacity to plan and respond to water quality challenges.
  - Real-time monitors at the intake and upstream of intakes for parameters such as turbidity, pH, and flow (e.g. velocity) can give warning of high turbidity and high flow events in time to take protective measures such as filling pre-treatment storage.
  - Monitor organic carbon (total and/or dissolved) and alkalinity of raw water throughout daily operations to ensure coagulant and disinfectant use is appropriate.
  - Frequent testing of source water for nutrients (nitrogen and phosphorous), algal toxins, organic carbon, turbidity/suspended sediment, and pH can characterize water quality patterns and post-fire changes so operations can evolve, and source water protection activities can be prioritized and evaluated.

- Upstream flow monitoring can provide early warning of when dangerous conditions are immanent, so staff and infrastructure can be protected from floods and debris flows.
- After a wildfire, state and federal agencies monitor water quality and sediment characteristics in rivers and reservoirs. This data helps scientists and system operators evaluate the fire's impact and take actions to minimize the adverse effects. Collaboration between agencies, universities, and public water systems can reduce duplication of effort and make monitoring resources go farther.

Watershed Source Water Toxic Substances

The following management approaches/recommendations are to reduce risk from exposure to toxic substances from burned and damaged buildings, vehicles, and infrastructure.

- Ensure that hazardous waste and post-fire debris are removed and properly disposed. (EPA, FEMA, and Oregon state agencies have likely accomplished this work.)
- Frequently inspect stormwater facilities and locations where stormwater best management practices (BMPs) are in use to verify efficacy and make improvements as needed to protect downstream water quality. The Oregon DEQ Construction Stormwater BMP Manual (https://www.oregon.gov/deq/FilterPermitsDocs/BMPManual.pdf) is a good source of information and techniques.
- Identify locations where fluorine-containing firefighting foams (i.e. AFFF) were used (and volumes used if possible) during suppression efforts as a potential risk. Test soil and nearby water if necessary.
- In burned urban and suburban locations, ensure proper management of stormwater to prevent untreated storm flows. Changes to stormwater systems may be necessary to catch, filter, and infiltrate municipal stormwater that might otherwise flow directly to surface water. This will be especially necessary within the footprints of the Almeda, Beachie Creek, and Holiday Farm fires.
- Reseed and/or mulch burned areas to reduce surface water movement and promote infiltration of water into the ground.
- Reseed and/or mulch burned areas to reduce surface water movement and promote infiltration of water into the ground.
- In burned urban and suburban locations, ensure proper management of stormwater to prevent untreated storm flows. Changes to stormwater systems may be necessary to catch, filter, and infiltrate municipal stormwater that might otherwise flow directly to surface water. This will be especially necessary within the footprints of the Almeda, Beachie Creek, and Holiday Farm fires.
- Monitor water quality downstream and at intakes when the upstream contributing area has burned urban and suburban sites. The comprehensive test suite used by Oregon's Drinking Water Protection program for toxics testing, with the addition of PFAS, is suggested. (See Appendix B, Table 2 here: https://www.oregon.gov/deq/FilterDocs/dwpSourceMonPhase1-2Rpt.pdf) A less comprehensive list would include metals and volatile organic compound methods from the linked report.

Impact Mitigation Projects

List projects that would mitigate the impact of the watershed damage. Projects may be directly related to erosion and flooding control or may be water system intake or treatment improvements that address the quality and quantity changes in post-fire sources. It is recommended to rank the projects in regard to the following priorities.

- First, prioritize projects that directly protect the structural integrity of a drinking water source. This would include the physical infrastructure and localized sediment and debris located at the intake location.

    - Projects that rank higher in the scoring system in *Table B.3 Statewide Public Water Systems Concern Rankings* in Appendix B. Systems with a higher score should be given priority over systems with a lower concern.
- Second, prioritize projects within basins of the highest concern in Table B.4 Public Water Systems Concern Rankings by Sub-basin in Appendix B. Projects located in sub-basins with the highest score should be given priority over projects located in a sub-basin with a lower score. It should be noted that the "other sub-basins" were grouped together, so it is recommended to look at the individual basin scores.
- Third, projects should be prioritized in terms of wildfire impact on drinking water systems in *Table B.5 Public Water Systems Concern Rankings by Wildfire* in Appendix B.
- Once the mitigation projects are prioritized in this manner, the estimated cost for each project should be listed. Then the projects at the top of the priority list should be funded, and a funding line should be drawn on the list at which the total sum of projects equals the available funding. All of the projects above the funding line should be recommended.

A mitigation funding toolkit was developed in a macro-enable excel format. This toolkit allows the user to enter the total funding available and each project with estimated costs. The user must select the associated PWS Name (if applicable), sub-basin, and wildfire incident for the proposed mitigation project. The PWS, sub-basin, and wildfire incident categories have decision weighting multipliers of 1.3, 1.2, and 1, respectively, to give priority to the recommended decision process described above.

Recommended Monitoring and Best Practices for Systems that Suspect Impact

If operators suspect that their system may have been impacted by watershed damage caused by wildfire, there are a few actions that may be taken to evaluate the risk, monitor for effects, and mitigate the impact.

To evaluate a system's risk, an operator should consider certain pre-fire characteristics of the system and the extent of the damage to the watershed. If any of the water quality parameters which are typically impacted by watershed damage (e.g. turbidity, DBPs, TOC) were at levels of concern before the fire, consider more frequent monitoring of this parameter. Work with state and federal agencies to prepare countermeasures to address these risks.

Additional training and technical and financial support from state and federal agencies may be needed for impacted public water systems and their operators. As more work will likely be needed for plant operation in response to raw water quality challenges, neighboring water systems could consider sharing a "relief operator" to prevent overwork of regular staff. Mental and physical health of staff should be prioritized.

Water system operators may also consider implementing the following mitigation measures to prepare for possible flash flooding and debris flow events following a wildfire:

- Monitor the watershed, as conditions may be different post-fire. Identify potential failure points within your service area: ensure culverts can handle increased flow and determine runoff points and areas where water will now collect.
- Install a rain gauge upstream of intake for early warning of heavy precipitation that could lead to high turbidity water and sensors to monitor the amount of debris and sediment coming downstream.
- Consider instituting erosion control measures (see above) to protect against runoff and sediment concerns that occur during suppression and precipitation.
- Assess treatment plants, intakes, and other infrastructure, as well as travel routes, for hazard trees, potential debris flow or flood paths, and other dangers. Have contingency plans in place to ensure staff can get to safety in an emergency.

The Oregon Health Authority drinking water services prepared a guidance document *Optimizing Water Treatment Plants* in Appendix C. This document provides guidance to source water management, water treatment, and distribution system operations. Some specific public water system recommendations are as follows:

- Water Systems are recommended to achieve water quality treatment goals more stringent than the National Primary Drinking Water Regulations (NPDWRs). This will allow an operational buffer as the water quality changes in the watershed are monitored.
- Source Water:
  - Water Systems are encouraged to monitor for turbidity, pH, total organic carbon (TOC), alkalinity, temperature, and conductivity (if groundwater) changes in the raw water sources in relation to weather events.
  - In most instances, water systems affected by wildfires shutdown their water intakes as the initial flush of ash and debris passes the intake. It is recommended to manage water storage and communicate with other water systems on the same water source to avoid this poor water quality in the treatment process.
- Treatment Systems:
  - Treatment systems that use coagulants should perform jar testing in order to adjust for changes in the water quality changes in the watershed. Wildfires have been known to alter the chemical composition of the dissolved organic matter (DOMs) and may require another type of coagulant.
  - Treatment systems using membrane treatment should consider using coagulants to increase TOC removals in the treatment processes.
- Distribution System:
  - The water storage tanks should be inspected. Due to smoke, ash, and fire debris entering the tank thru the air vent and overflows, it is recommended to drain and clean the water storage tanks.
  - The water storage tanks’ vent and overflow screens should be inspected and repaired.
  - All above-ground piping should be inspected and operated/tested. Specifically, fire hydrant valves are located at the bottom of the hydrant and all fire hydrants should be operated to inspect for damage. While operating fire hydrants, it is recommended to directionally flush the system by operating gate valves.
  - In service areas with burned structures, there is a possibility of water service and distribution system damage to polyethylene (PE) and polyvinyl chloride (PVC) pipes. Once the structures are rebuilt and the water service restored, there is a possibility of taste and odor complaints due to volatile organic carbons (VOCs) being released from damaged piping. In addition, this damaged piping may be able to hold pressure, but a reduction in the pipe integrity may reduce the life of service. It is recommended to conduct testing of VOCs, in particular benzene, for structures rebuilt in the burned areas.

Private Wells/Surface Water Intakes and Resources

Individual surface water rights for household domestic use are not uncommon in Oregon. Numerous household-sized domestic water rights have points of diversion within the footprints of major western Oregon wildfires. The number of private domestic surface water systems is based on the water rights filed with the State of Oregon and located in the table.

Fire Incident	# Private Domestic Surface Water Rights
"242"	4
Almeda Drive	2
Archie Creek	18
Beachie Creek	18
Echo Mountain Complex	2
Holiday Farm	8
Lionshead	3
Riverside	1
South Obenchain	2
Total	**58**

It is anticipated that individual surface water users have filtration units in their residences, and these systems should observe changes in the source water clarity. It is recommended that these users observe future weather events and look for the subsequent water quality patterns.

If the homeowner has the capacity, the homeowner should check with the manufacturer for water quality parameters for their treatment systems, and the homeowner should measure for these water quality parameters in the surface water source. These water quality parameters could consist of flow rate, pH, temperature, turbidity, total organic carbon (TOC), finished water coliforms, etc. If the water quality parameters are unknown, then the homeowner should, at minimum, observe changes in water pressure to understand solids fouling on their filters. If their system includes of a backwashing operation, the homeowner should observe the water use between backwashing cleaning operations.

Many private well owners will be concerned about possible impacts to their wells in wildfire affected areas. Private well owners may experience equipment damage and changes in their water quality of the well.

For equipment damage, the owner should inspect the following areas of concern. If you observe any damage, you should contact a licensed well constructor from the Oregon Water Resources Department https://apps.wrd.state.or.us/apps/gw/well_license/.

- Damage to electrical wires and connectors that supply power to your well.
- Damage to the well casing and any above-ground piping used with the well to bring water to your home.
- Damage to well houses and equipment such as chlorinators, water treatment equipment, and electronic controls.
- Damage to pressure tanks which could have been caused by exposure to excessive heat.
- Damage to storage tanks, vents, and overflow pipes.
- Possible loss of pressure and any associated damage.

In the water quality, the owner may notice that the water tastes or smells earthy, smoky, or burnt. If so, you may need to thoroughly flush your water lines. In the event that you experienced a loss of pressure, there is a possibility that the well has been contaminated with bacteria. Thus, you should collect a bacteria sample. The sample should be analyzed by a certified laboratory, which can be found at the Oregon Health Authority at https://www.oregon.gov/oha/PH/HEALTHYENVIRONMENTS/DRINKINGWATER/MONITORING/Pages/labs.aspx. In addition, a list a laboratories can be found in Appendix C, in which you will look for laboratories capable of testing for coliforms.

In the event the owner is waiting for the bacteria results or responding to a positive total coliform sample result, the owner could disinfect the well. A procedure for disinfecting the well can be found at the State of Minnesota https://www.health.state.mn.us/communities/environment/water/wells/waterquality/disinfection.html.

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Appendix A – Watershed Fire Tables & Maps (Critical Values at Risk Table, Watershed Vulnerability Assessment, Soil Burn Severity & Slope, Mulching Feasibility)

Appendix B – Drinking Water Impacts

Appendix C – Public and Private Drinking Water System Resources

Appendix A

Watershed Fire Tables and Maps

(Critical Values at Risk Table)
(Watershed Vulnerability Assessment)
(Soil Burn Severity & Slope)
(Mulching Feasibility)

Water Quality/Drinking Water ETART Critical Value Table

High / Very High Risk		
Intermediate Risk		
Low / Very Low Risk		

Life/ Property/ Resources	Critical Value	Threat to Value	Probability of Damage or Loss	Rationale for Probability	Magnitude of Consequence	Rationale for Magnitude	Risk	Treatment Recommendations
Life and Safety	Safety of Drinking Water Treatment Personnel	Flooding, debris flow, or other physical threats. Exhaustion/sickness due to overwork.	Unlikely	Drinking Water Operator Staff will required to increase monitoring and plant adjustment efforts	Major	The loss of drinking water operators would have dramatic effects on the plant operations.	Intermediate	Promote shared drinking water operator resources thru ORWARN (Oregon Water Agency Response Network). Promote operator techincal assistance providers and training to operators. Consider the use of shared relief operators among neighboring systems.
Life and Safety	Health of Resident Populations Not Served by Public Water Systems	Limited treated water availability due to streamflow changes, poorer water quality, contaminants, infrastructure damage.	Possible	Increased turbidity and dissolved organic matter, treatment processes may produce less water and damage home filtration. Consumption of poor water quality could lead to significant health risks.	Minor	The taste and odor may prevent the private resident from consuming the water, and the resident could rely on bottled water until stream conditions improve.	Low	Monitor for changes in the stream water quality. Once water quality deteriorates, shut of intake and use bottled water until stream conditions improve. Monitor for any damage on home filtration units.
Life and Safety	Finished Drinking Water-Volume	Limited treated water availability due to streamflow, poorer water quality, contaminants, infrastructure damage.	Possible	Reduction in water storage reduces available water for fire fighting purposes, lowers water pressures,	Major	Less water available for fire fighting and potential for loss of pressure in the distribution system which could cause backsiphonage issues leading to contamination.	High	Monitor watershed water quality for periods of high quality raw water and manage the water storage tank levels. Consider possible water restrictions if necessary and possible.

Life and Safety	Finished Drinking Water-Quality	Limited treated water availability due to poorer water quality, contaminants, infrastructure damage.	Possible	Water Storage tanks have vent openings susceptable to smoke. Fire hydrants suseptible to damage due to heat. Increased Disinfection Byproducts. Water service to burnt structures may produce VOC concerns. Exceeding turbidity limits in finished water could shelter pathogens.	Major	Disinfection Byproducts could increase leading to long term health concerns. Heat damage to polyethelene and polyvinyl chloride (PVC) pipes could lead to immediate health risks. Increased risk of waterborne disease.	High	Implement same practices for Finished Drinking Water- Volume. In addition, for technologies that make sense, consider implementing coagulation for dissolved organic matter (DOM) removal. Conduct jar testing to optimize coagulant dosage and possibly the coagulant type. For burnt structures facing VOC issues, implement a rigorous flushing program and possible pipe replacement, if necessary.
Property - Other	Drinking Water Intake Structures and Ponds	Fine sediment, logs, debris clogging facilities.	Likely	Drinking Water intakes are located in flooding areas. The watershed burn areas will contribute more sediment to this locations.	Major	The inactivation of the surface water intake would prevent any water being available for the public water system.	Very High	Implement erosion control measures around the intake, install stream stablization measures around the intake, and monitor/maintain a clear debris/sediment at the intake location. Implement erosion control measures in priority locations in source area.
Property - Other	Drinking Water Treatment Facilities	Fine sediment, logs, debris clogging facilities, increased organic loading. Flooding, debris flow, or other physical damage to infrastructure.	Likely	Increased turbidity and dissolved organic matter will affect treatment processes.	Major	The changes in water quality could foul the filtration processes and reduce filter water production. In addition, treatment processes may be inadequate to remove additional contaminants in the poor water quality reducing water plant's ability to meet drinking water regulations.	Very High	Monitor watershed water quality for periods of high quality raw water and manage the water storage tank levels. For technologies that make sense, consider implementing coagulation for dissolved organic matter (DOM) removal. Conduct jar testing to optimize coagulant dosage and possibly the coagulant type. Implement erosion control measures in priority locations in source area.

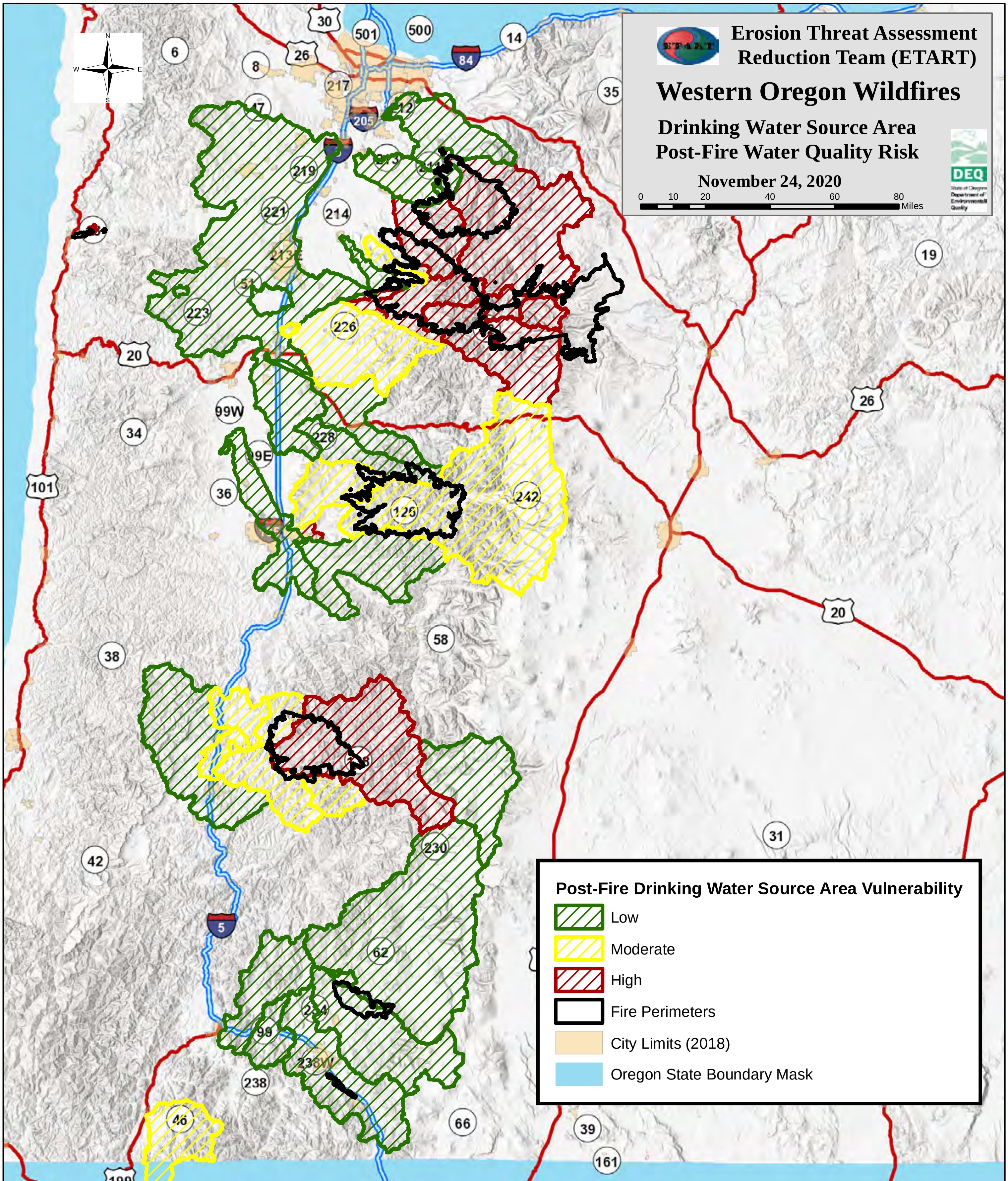
Natural Resources - Soil and Water	Raw (Untreated) Water-Volume	Less available water in late dry season due to changes in watershed processes (e.g. absorption and routing of precipitation) and evapotranspiration.	Possible	The loss of vegetation leads to the loss of natural water storage and decreases the peak runoff times for weather events.	Major	Reductions in available water in streams lead to drought type conditions. The lower volume of water allows less delilution and increases contaminant loadings.	High	State and federal engineers should manage reservoir levels to ensure water availability to meet surface water rights. Protect soil in burned areas from further disturbance.
Natural Resources - Soil and Water	Raw (Untreated) Water-Quality	Increases in suspended & bedded fine sediment, turbidity, organic matter, nutrients, ash. Changes in pH alkalinity.	Very Likely	The loss of vegetation leads to water transporting faster and increasing sediment transport into the stream channels. This will likely deteriorate water quality.	Moderate	Increases in the turbidity and nutrient loadings in the streams impact surface water treatment plants operations	Very High	Monitor watershed and stream tributaries for harmful algal blooms, total suspended solids (TSS), pH, and coliforms and ensure information is available to all affected public water systems. Individual water systems should monitor water conditions upstream and weather patterns. Protect soil in affected areas from further disturbance. Install erosion reduction measures and stream enhancement projects at priority locations. Utilize native herbaceous plants, shrubs, and trees to stabilize soil.
Natural Resources - Soil and Water	Stability and Function of Riparian Areas	Loss of overstory and understory vegetationw/ associated loss of soil protection and evapotranspiration. Increased erosion and movement of soil/sediment & organic matter. Greater fluxes of nutrients and mineral elements.	Very Likely	The loss of vegetation in the riparian zones will increase the likelihood of streamside erosion, increase water velocities and sediment transport within stream channels.	Moderate	This could affect water infrastructure. Increases in the turbidity and nutrient loadings in the streams impact surface water treatment plant operations. Affect the aesthetics and general public interest in the area.	Very High	Protect all riparian areas during management activities. Replant with native trees and shrubs as needed in locations with high tree mortality. Consider bank stablization projects in key areas to prevent stream erosion; bank stabilization could be the use of riprap, retaining walls, erosion fabrics and vegetation plantings.

Natural Resources - Soil and Water	Stability and Function of Hillslopes	Loss of overstory and understory vegetation w/ associated loss of soil protection and evapotranspiration. Increased erosion and movement of soil/sediment & organic matter. Greater fluxes of nutrients and mineral elements. Steep slopes may fail and deliver to streams. Changes in surface and subsurface water movement.	Very Likely	The loss of root structural reinforcement, lack canopy interception of precipitation/greater rainsplash force on soil particles, declining organic matter inputs, and soil health declines destablize hillslopes and increases surface erosion risk. Landslide-prone slopes are at signifcantly higher probability of failure during extreme precipitation events.	Moderate	Increased the sediment and organic matter loadings into the riparian zones and stream channels. Slope failures and debris flows deliver large volumes of soil and debris into stream networks. This will alter surface water treament plant operations. Possible direct threat to public and private infrastructure.	Very High	Prevent soil disturbance during management activities and apply mulch or other ground cover during activities. Retain live trees and shrubs. Allow native herbaceous plants, trees, and shurbs to stabilize soil. Replant with native trees and shrubs as needed in locations with high tree mortality. Avoid operations and vegetation/tree removal on landslide-prone slopes. Consider slope stablization techniques such as erosion control fabrics, vegetation plantings, staking fallen trees, rock gabions and terracing.
Natural Resources - Soil and Water	Sediment Processing Capacity of Stream Networks	In-stream sediment storage sites in stream may become saturated, leading to greater downstream fine sediment fluxes during high flows (could be partially offset by recuitment of large woody debris).	Very Likely	Changes in sediment transport likely to alter scouring and deposition zones in the stream.	Moderate	The banks of the stream could shift causing intake structures to be located in the wrong location. The pooled areas may fill in with sediment and deeper pools shifting up/downstream. Flow threshold for turbidity spikes lowers, causing more frequent water quality problems.	Very High	Implement bank stablization techiniques near the surface water intake structures, including bends in the channel up/downstream. Use stream enhancement projects (large woody debris placement) to increase sediment sorting/retention capacity. Protect and restore riparian areas.

Natural Resources - Soil and Water	Nutrient & Organic Matter Processing Capacity of Stream Networks	In-stream nutrient and organic storage sites in stream may become saturated, leading to greater downstream organic matter and nutrient fluxes (could be partially offset by recuitment of large woody debris). In some cases, nutrient loads may encourage harmful algal blooms.	Likely	Loss in vegetation reduced the ability for nutrients and organic matter to be stored in plants. Thus, the existing nutrients and organic matter will likely to be transported further down the watershed.	Moderate	Increased nutrient loadings in reservoirs and streams contribute to harmful algal blooms. Dissolved organic matter increases will affect surface water treatment plants.	High	Monitor reservoirs, streams, and rivers for total nitrogen (TP) and total phosphorus (TP) to understand nutrient loadings. Implement bank stabilizations to promote healthy riparian areas and possibily divert water thru unburned areas until vegetation efforts can be successful. Use stream enhancement projects (large woody debris placement) to increase in-stream organic matter processing capacity. Allow growth of native early successional plants in burned areas to serve as short-term nutrient sinks.

Table A.2: Watershed Ranking Analysis

PWS ID	PWS Name	burn location/ Intake proximity	Burn Location Multiplier	GU Multiplier	percentfire Rank	LandUse Rank	Erosion/Burn Severity Rank	Debris Flow Rank	Overall Watershed Rank	Overall Watershed Rank	Watershed Concern	percentfire	percentfireRank	LandUse %Private	LandUse Rank	Erosion	Burn Severity	Erosion/ Burn Severity Rank	debris flow%	Unit count Debris Flow Rank	Total Acres
OR4100012	ALBANY, CITY OF (S Santiam/Leb-Albany Canal)				NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
OR4100012	ALBANY, CITY OF (Santiam R.)	3	2	1	2	2	1	1	3.00	M	4	20%	M	25%	M	M	H	H	48%	H	1127069
OR4101483	ANGLERS COVE/SCHWC	2	1.5	1	3	1	3	NA	3.50	L	2	1%	L	67%	H	L	NA	NA	NA	NA	735452
OR4193461	BREITENBUSH HOT SPRINGS	1	1	1	1	3	1	2	1.75	H	8	100%	H	0%	L	NA	H	H	32%	M	35721.82
OR4100152	BROWNSVILLE, CITY OF	3	2	1.5	3	1	1	2	5.25	L	2	13%	L	89%	H	H	M-L	H	28%	M	100126.85
OR4100157	CANBY UTILITY (I.G.-Springs Gallery)	2	1.5	1.5	2	1	1	2	3.38	L	2	35%	M	62%	H	H	M-H	H	38%	M	219648.54
OR4100157	CANBY UTILITY (Molalla)	2	1.5	1	2	1	1	2	2.25	M	4	35%	M	62%	H	H	M-H	H	38%	M	219648.54
OR4192152	CASCADE PACIFIC PULP LLC	3	2	1	3	1	2	3	4.50	L	2		L		H	L	M-H	M	~16%	L	410867
OR4100971	CAVE JUNCTION, CITY OF	2	1.5	1	2	3	1	NA	3.00	M	4	34%	M	1%	L	H	NA	H	NA	NA	148774.58
OR4100187	CLACKAMAS RIVER WATER - CLACKAMAS	3	2	1	2	3	1	1	3.50	L	2	19%	M	13%	L	M	M-H	H	47%	H	599647.46
OR4100202	COLTON WATER DISTRICT	3	2	1	3	1	3	3	5.00	L	2	4%	L	87%	H	L	L	L	0%	L	2133.57
OR4100808	COUNTRY VIEW MH ESTATES	2	1.5	1	3	1	3	NA	3.50	L	2	1%	L	67%	H	L	NA	NA	NA	NA	734285.77
OR4100257	DETROIT WATER SYSTEM (Breitenbush R.)	1	1	1	1	3	1	2	1.75	H	8	80%	H	0%	L	NA	H	H	31%	M	67502.34
OR4100257	DETROIT WATER SYSTEM (Mackey)	1	1	1	1	3	1	1	1.50	H	8	100%	H	0%	L	NA	H	H	100%	H	183.65
OR4100276	ELKTON, CITY OF	3	2	1	3	2	1	1	3.50	L	2		L		M	M	H	H	53%	H	316071
OR4100279	ESTACADA, CITY OF	1	1	1	2	3	1	1	1.75	H	8	24%	M	5%	L	M	M-H	H	50%	H	431600.65
OR4100287	EUGENE WATER & ELECTRIC BOARD	2	1.5	1	2	1	1	1	1.88	H	8	19%	M	64%	H	H	M-H	H	55%	H	734284
OR4100317	GATES, CITY OF	1	1	1	1	3	1	2	1.75	H	8	45%	H	17%	L	H	H	H	37%	M	308763.75
OR4100326	GLIDE WATER ASSOCIATION	1	1	1	2	2	1	1	1.50	H	8	18%	M	37%	M	H	H	H	55%	H	652296.78
OR4100333	GOLD HILL, CITY OF	2	1.5	1	3	1	3	NA	3.50	L	2	3%	L	55%	H	L	NA	NA	NA	NA	1332444.24
OR4100342	GRANTS PASS, CITY OF	2	1.5	1	3	1	3	NA	3.50	L	2	2%	L	55%	H	L	NA	NA	NA	NA	1572390.71
OR4101520	HILAND WC - SHADY COVE	2	1.5	1	3	1	3	NA	3.50	L	2	1%	L	68%	H	L	NA	NA	NA	NA	744238.79
OR4100394	IDANHA CITY WATER (mud Puppy, only one in OHA datas	2	1.5	1	3	1	3	3	3.75	L	2	10%	L	100%	H	NA	L	L	0%	L	94.49
OR4100394	IDANHA CITY WATER (Rainbow, only one in OHA dataset)	1	1	1	1	2	2	3	2.00	M	4	83%	H	43%	M	NA	M-L	M	0%	L	519.78
OR4100408	JEFFERSON, CITY OF	3	2	1	2	2	1	1	3.00	M	4	20%	M	25%	M	M	H	H	48%	H	1131705
OR4101542	LAKE OSWEGO - TIGARD WATER SUPPLY	3	2	1	2	3	1	1	3.50	L	2	19%	M	13%	L	M	M-H	H	47%	H	601911
OR4100473	LEBANON, CITY OF	3	2	1	3	1	3	3	5.00	L	2	0%	L	100%	H	L	L	L	0%	L	439512.58
OR4100493	LYONS MEHAMA WATER DISTRICT	1	1	1	1	3	1	1	1.50	H	8	52%	H	24%	L	H	H	H	49%	H	416447.96
OR4100513	MEDFORD WATER COMMISSION	2	1.5	1	3	1	3	NA	3.50	L	2	3%	L	59%	H	L	NA	NA	NA	NA	1035685.10
OR4100534	MOLALLA, CITY OF	2	1.5	1	1	1	1	2	1.88	H	8	56%	H	61%	H	H	M-H	H	39%	M	129954.08
OR4100580	NORTH CLACKAMAS COUNTY WC	3	2	1	2	3	1	1	3.50	L	2	19%	M	13%	L	M	M-H	H	47%	H	600116
OR4100580	NORTH CLACKAMAS COUNTY WC	3	2	1	2	3	1	1	3.50	L	2	19%	M	13%	L	M	M-H	H	47%	H	600116
OR4100581	OAKLAND, CITY OF	2	1.5	1	2	1	1	2	2.25	M	4	16%	M	91%	H	H	H	H	40%	M	119563
OR4106169	OPAL CREEK ANCIENT FOREST CTR	1	1	1	1	3	1	1	1.50	H	8	100%	H	100%	L	NA	H	H	78%	H	0.00
OR4100603	PANTHER CREEK WD	1	1	1	2	1	1	NA	1.33	H	8	22%	M	101%	H	H	NA	H	NA	NA	1106.42
OR4100613	PENDLETON, CITY OF	3	2	1	3	3	NA	NA	6.00	L	2	0%	L	20%	L	L	NA	NA	NA	NA	283053.64
OR4101012	PP&L-TOKETEE VILLAGE	3	2	1	3	3	2	3	5.50	L	2	4%	L	0%	L	NA	M	M	1%	L	223876.66
OR4100839	RAINBOW WATER DISTRICT	2	1.5	1.5	2	1	1	1	2.81	M	4	18%	M	67%	H	H	M-H	H	52%	H	851848.24
OR4100712	ROGUE RIVER, CITY OF	2	1.5	1	3	1	3	NA	3.50	L	2	3%	L	55%	H	L	NA	NA	NA	NA	1401452
OR4100720	ROSEBURG, CITY OF	2	1.5	1	2	2	1	1	2.25	M	4	15%	M	39%	M	H	H	H	53%	H	841228.95
OR4100731	SALEM PUBLIC WORKS	2	1.5	1	1	2	1	1	1.88	H	8	51%	H	25%	M	H	H	H	48%	H	433596.26
OR4100835	SHANGRI LA WATER DISTRICT	2	1.5	1.5	2	1	1	1	2.81	M	4	20%	M	64%	H	H	M-H	H	55%	H	692941.03
OR4100823	SILVERTON, CITY OF (abiqua)	2	1.5	1	2	1	1	2	2.25	M	4	25%	M	81%	H	H	M-L	H	25%	M	31659.18
OR4100823	SILVERTON, CITY OF (silver)	2	1.5	1	3	1	3	3	3.75	L	2	11%	L	97%	H	L	M-L	L	7%	L	30390.29
OR4100591	SOUTH FORK WATER BOARD	3	2	1	2	3	1	1	3.50	L	2	19%	M	13%	L	M	M-H	H	47%	H	601443
OR4100837	SPRINGFIELD UTILITY BOARD	3	2	1	3	1	3	3	5.00	L	2	1%	L	98%	H	L	M-L	L	16%	L	871179.29
OR4100843	STAYTON WATER SUPPLY	2	1.5	1	1	2	1	1	1.88	H	8	51%	H	25%	M	H	H	H	48%	H	438128.06
OR4100847	SUTHERLIN, CITY OF (Calapooya)	2	1.5	1	2	1	1	2	2.25	M	4	35%	M	91%	H	H	H	H	40%	M	54669.17
OR4100847	SUTHERLIN, CITY OF (Cooper Cr)				NA	NA	NA	NA	NA	L	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	
OR4193438	TIMBER RIVER RV PARK				NA	NA	NA	NA	NA	L	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	
OR4100719	UMPQUA BASIN WATER ASSOC	2	1.5	1	3	2	1	1	2.63	M	4	14%	L	39%	M	H	H	H	53%	H	877640
OR4101091	USFS STEAMBOAT WORK CENTER	1	1	1	1	3	3	1	2.00	M	4		H	0%	L	NA	L	L	50%	H	0.00
OR4101095	USFS WOLF CREEK JOB CORPS	2	1.5	1	3	1	1	2	2.63	M	4	3%	L	66%	H	H	M-L	H	21%	M	57801.55
OR4100954	WILSONVILLE, CITY OF	3	2	1	3	2	2	1	4.00	L	2	9%	L	44%	M	L	M-H	M	49%	H	4157359.92



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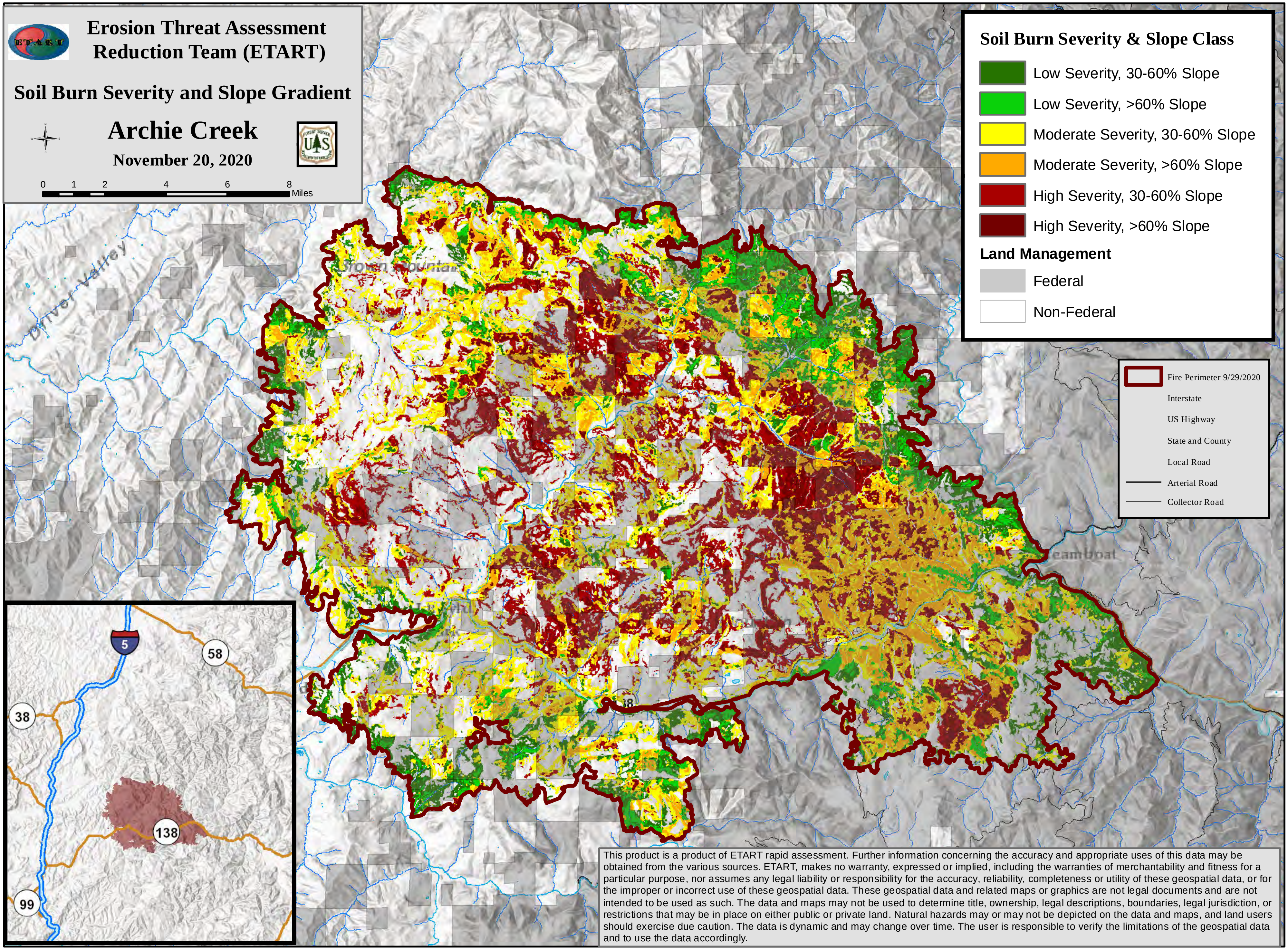

Erosion Threat Assessment Reduction Team (ETART)
Soil Burn Severity and Slope Gradient
Archie Creek
November 20, 2020
0 1 2 4 6 8 Miles
Soil Burn Severity & Slope Class
Low Severity, 30-60% Slope
Low Severity, >60% Slope
Moderate Severity, 30-60% Slope
Moderate Severity, >60% Slope
High Severity, 30-60% Slope
High Severity, >60% Slope
Land Management
Federal
Non-Federal
Fire Perimeter 9/29/2020
Interstate
US Highway
State and County
Local Road
Arterial Road
Collector Road
5
58
38
138
99
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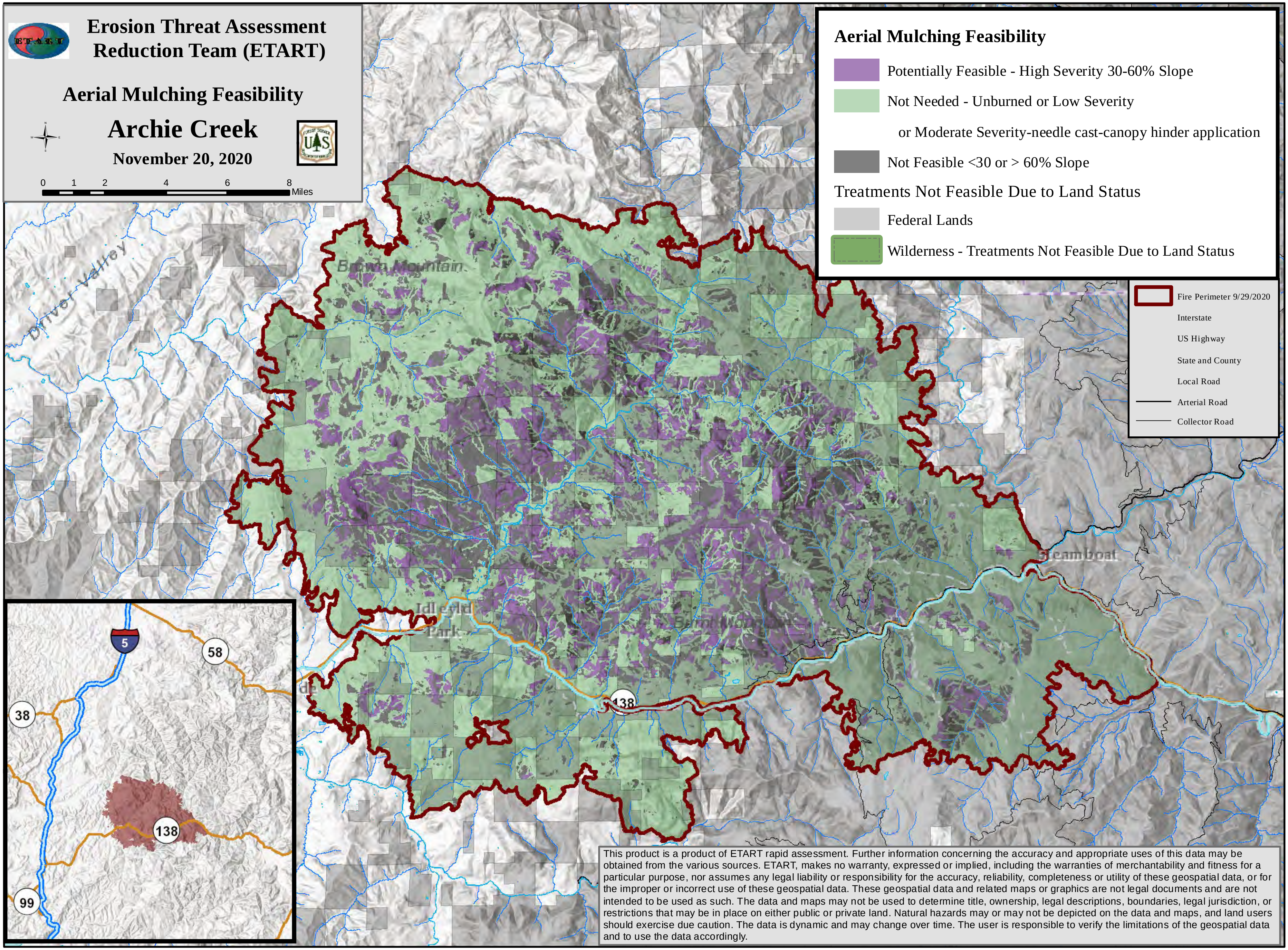

Erosion Threat Assessment Reduction Team (ETART)
Aerial Mulching Feasibility
Archie Creek
November 20, 2020
0 1 2 4 6 8 Miles
Aerial Mulching Feasibility
Potentially Feasible - High Severity 30-60% Slope
Not Needed - Unburned or Low Severity or Moderate Severity-needle cast-canopy hinder application
Not Feasible <30 or > 60% Slope
Treatments Not Feasible Due to Land Status
Federal Lands
Wilderness - Treatments Not Feasible Due to Land Status
Fire Perimeter 9/29/2020
Interstate
US Highway
State and County
Local Road
Arterial Road
Collector Road
Brown Mountain
Driver Valley
Idleyld Park
Steamboat
138
5
58
38
99
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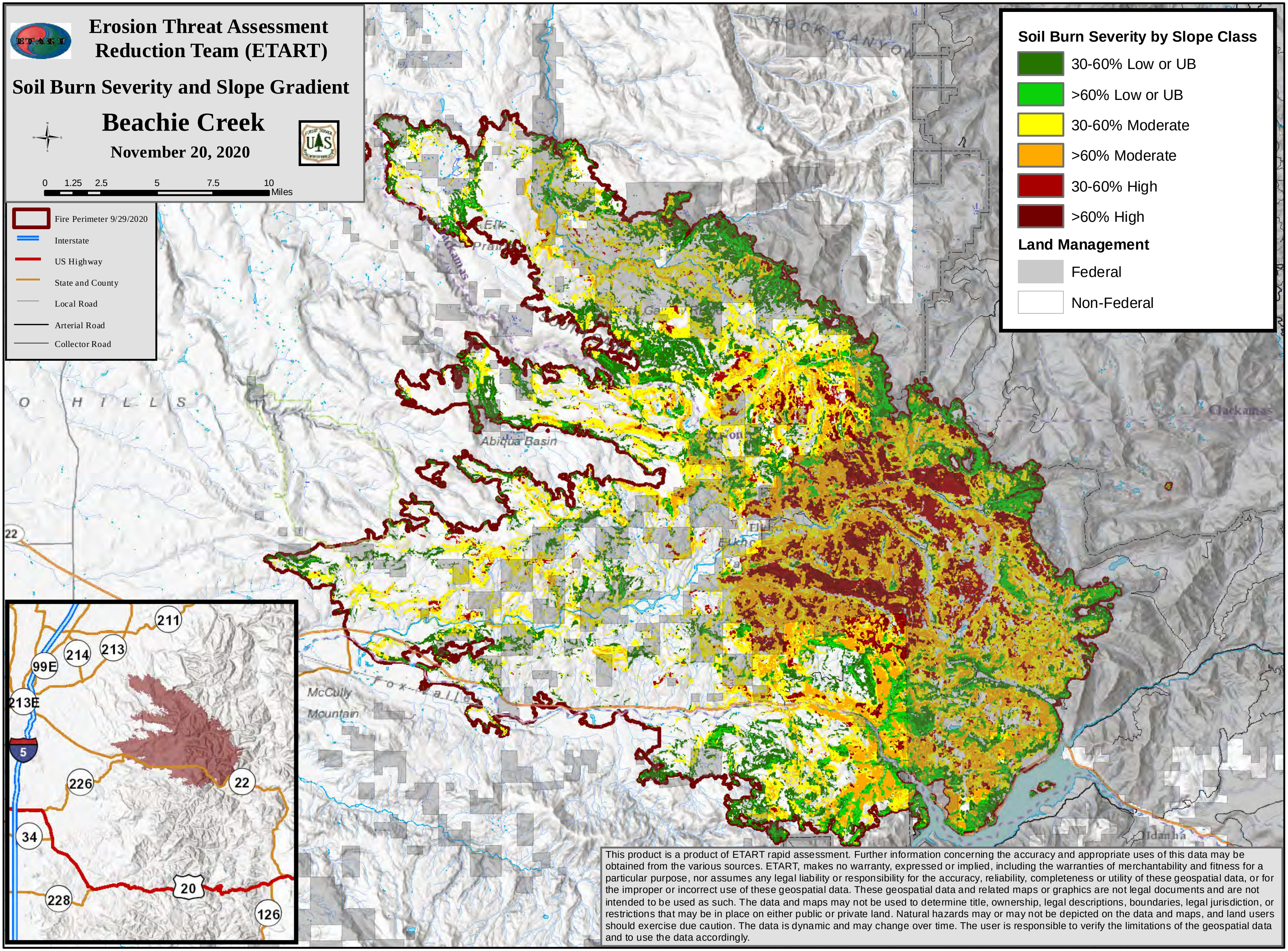
Erosion Threat Assessment Reduction Team (ETART)
Soil Burn Severity and Slope Gradient
Beachie Creek
November 20, 2020
0 1.25 2.5 5 7.5 10 Miles
Fire Perimeter 9/29/2020
Interstate
US Highway
State and County
Local Road
Arterial Road
Collector Road
Soil Burn Severity by Slope Class
30-60% Low or UB
>60% Low or UB
30-60% Moderate
>60% Moderate
30-60% High
>60% High
Land Management
Federal
Non-Federal
ROCK CANYON
O H I L L S
Abiqua Basin
McCully
Mountain
Clackamas
211
214
213
99E
213E
5
226
22
34
228
20
126
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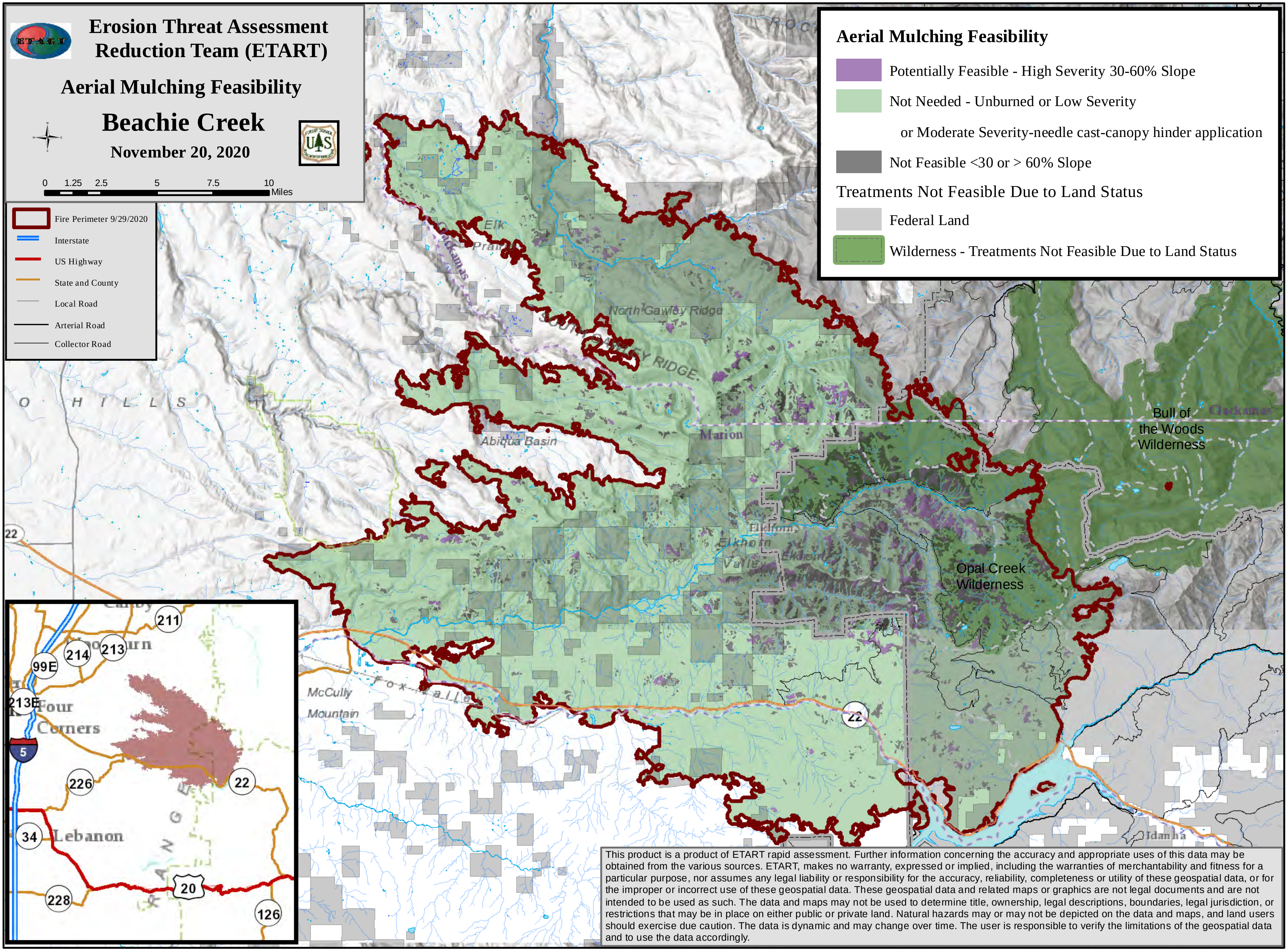
Erosion Threat Assessment Reduction Team (ETART)
Aerial Mulching Feasibility
Beachie Creek
November 20, 2020
0 1.25 2.5 5 7.5 10 Miles
Fire Perimeter 9/29/2020
Interstate
US Highway
State and County
Local Road
Arterial Road
Collector Road
Aerial Mulching Feasibility
Potentially Feasible - High Severity 30-60% Slope
Not Needed - Unburned or Low Severity
or Moderate Severity-needle cast-canopy hinder application
Not Feasible <30 or > 60% Slope
Treatments Not Feasible Due to Land Status
Federal Land
Wilderness - Treatments Not Feasible Due to Land Status
North Gawley Ridge
Abiqua Basin
Marion
Elkhorn
Opal Creek Wilderness
Bull of the Woods Wilderness
McCully Mountain
22
Four Corners
Lebanon
211
213
214
99E
213E
5
226
34
228
20
126
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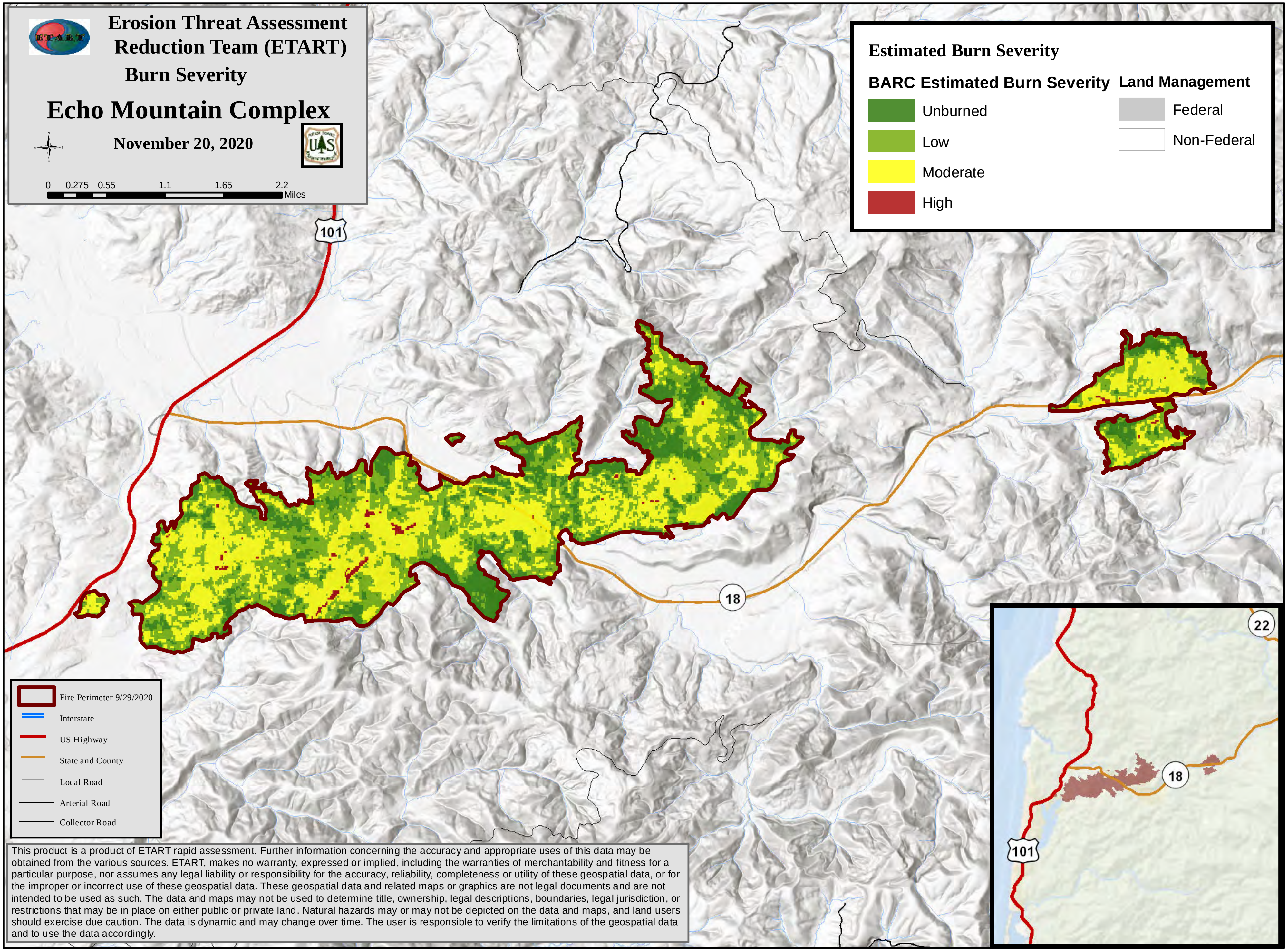

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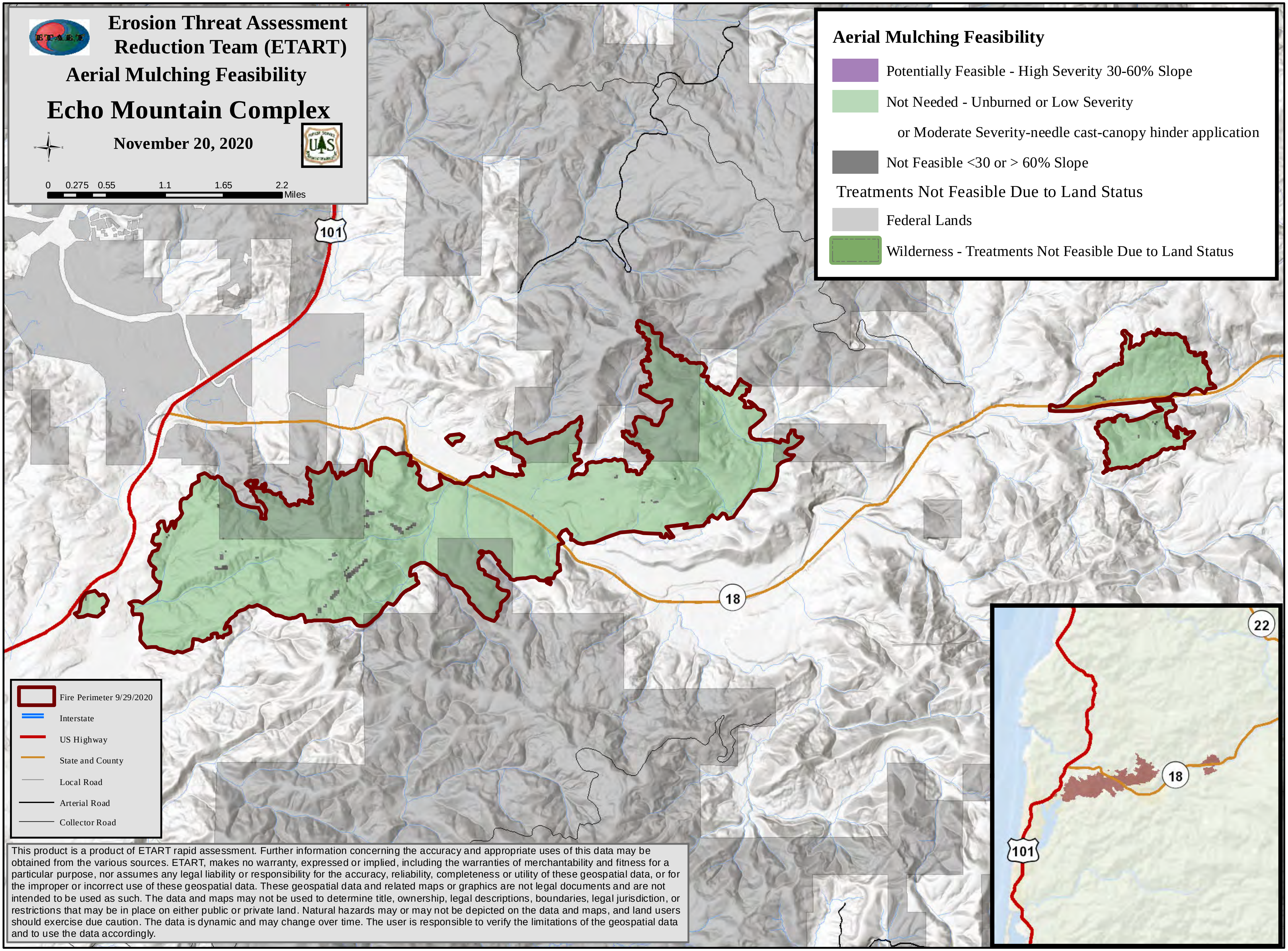

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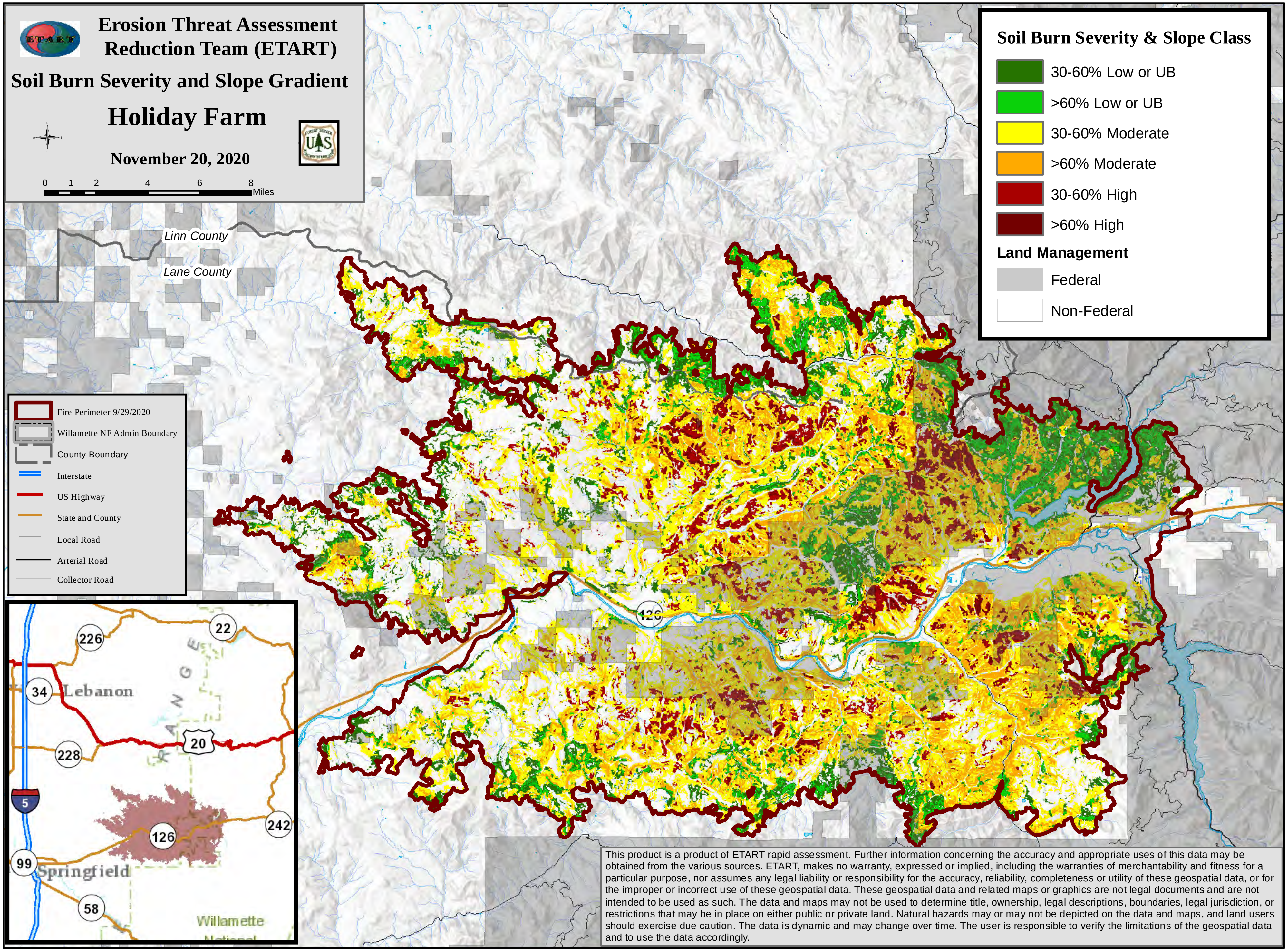
Erosion Threat Assessment Reduction Team (ETART)
Soil Burn Severity and Slope Gradient
Holiday Farm
November 20, 2020
0 1 2 4 6 8 Miles
Linn County
Lane County
126
Soil Burn Severity & Slope Class
30-60% Low or UB
>60% Low or UB
30-60% Moderate
>60% Moderate
30-60% High
>60% High
Land Management
Federal
Non-Federal
Fire Perimeter 9/29/2020
Willamette NF Admin Boundary
County Boundary
Interstate
US Highway
State and County
Local Road
Arterial Road
Collector Road
226
22
34
Lebanon
20
228
5
126
242
99
Springfield
58
Willamette
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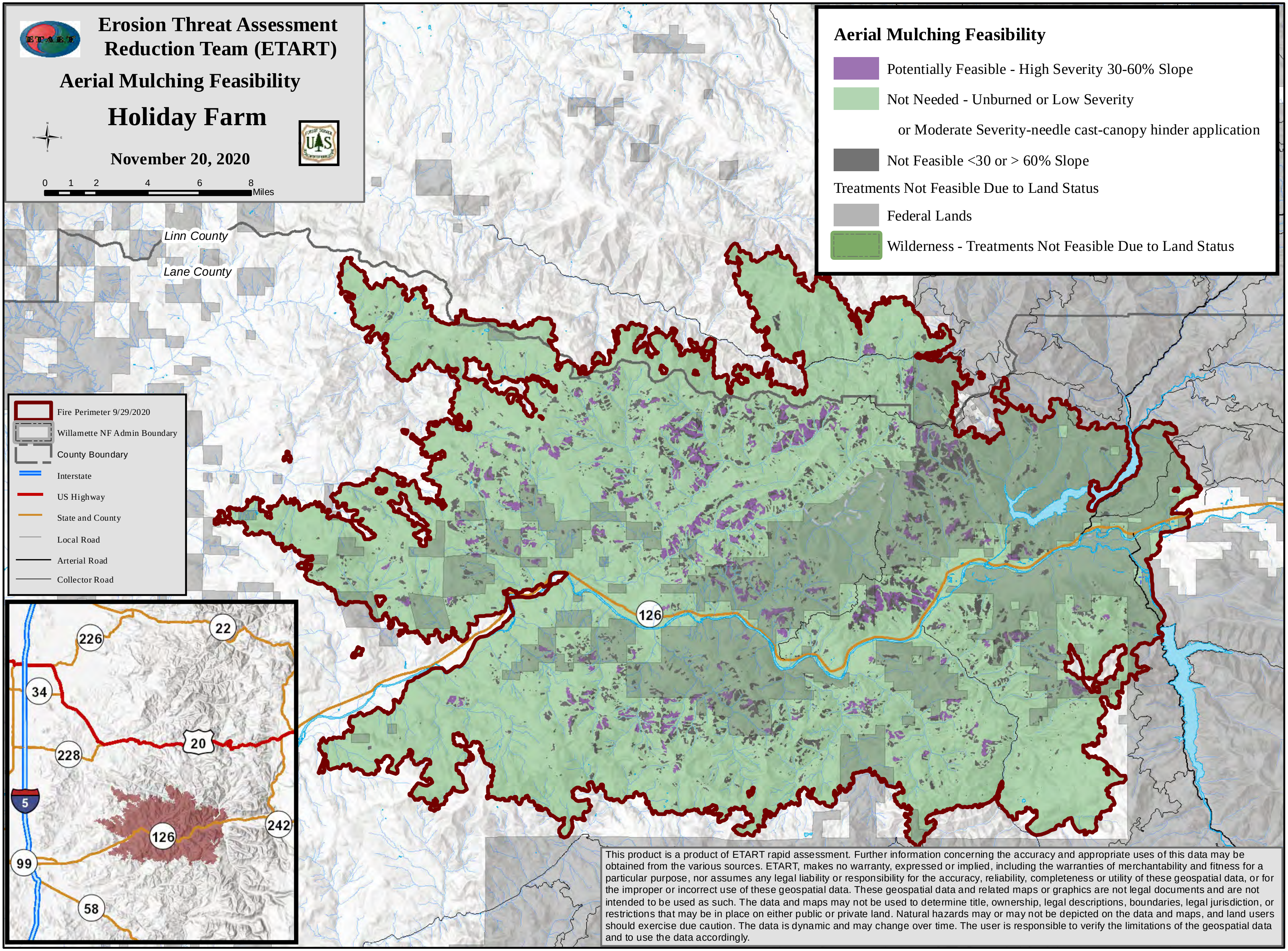

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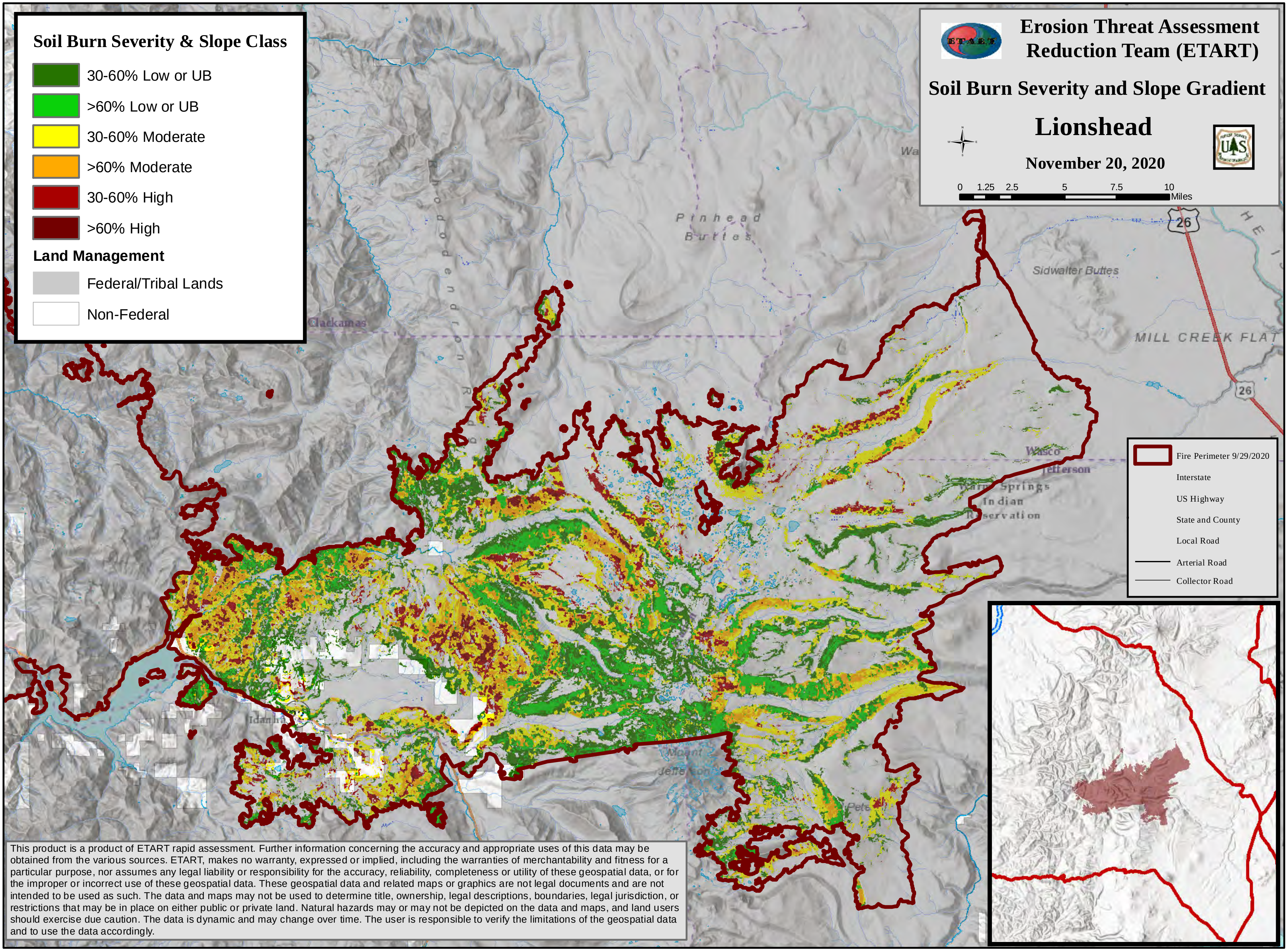

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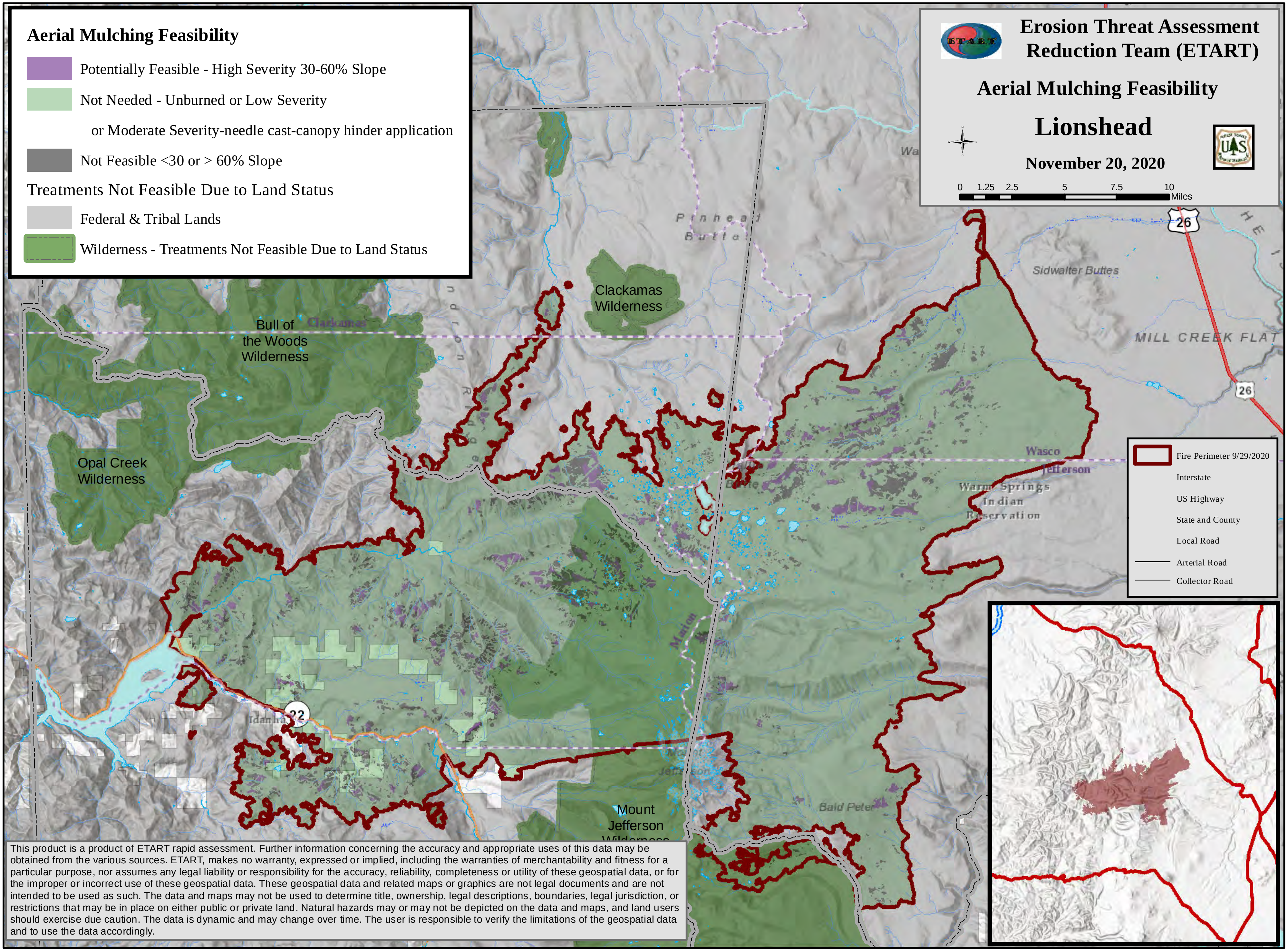

Aerial Mulching Feasibility
Potentially Feasible - High Severity 30-60% Slope
Not Needed - Unburned or Low Severity
or Moderate Severity-needle cast-canopy hinder application
Not Feasible <30 or > 60% Slope
Treatments Not Feasible Due to Land Status
Federal & Tribal Lands
Wilderness - Treatments Not Feasible Due to Land Status
Erosion Threat Assessment Reduction Team (ETART)
Aerial Mulching Feasibility
Lionshead
November 20, 2020
0 1.25 2.5 5 7.5 10 Miles
Fire Perimeter 9/29/2020
Interstate
US Highway
State and County
Local Road
Arterial Road
Collector Road
Clackamas Wilderness
Bull of the Woods Wilderness
Opal Creek Wilderness
Mount Jefferson Wilderness
Pinhead Butte
Sidwalter Buttes
MILL CREEK FLAT
Wasco
Jefferson
Warm Springs Indian Reservation
Marion
Bald Peter
Clackamas
26
22
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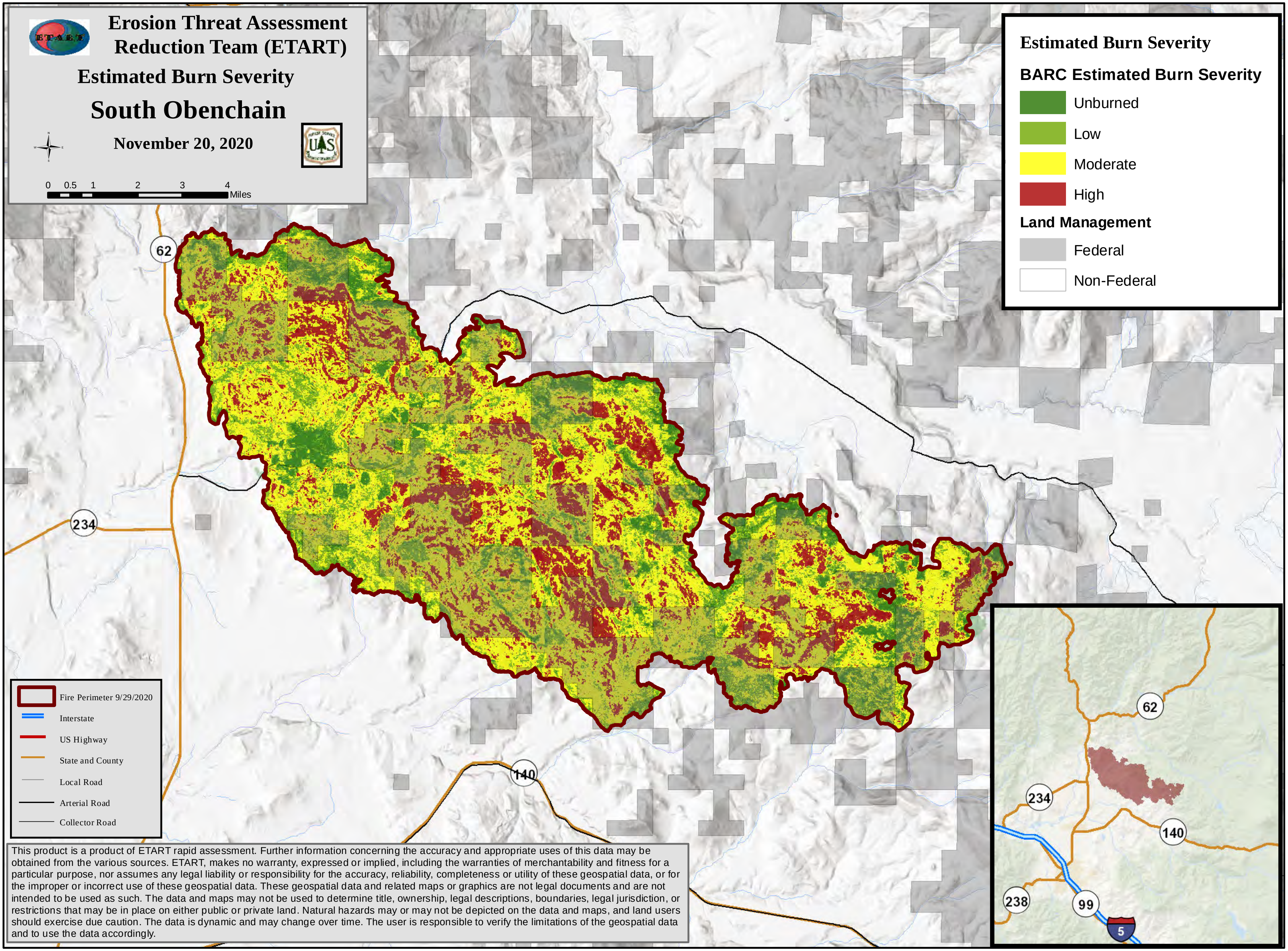

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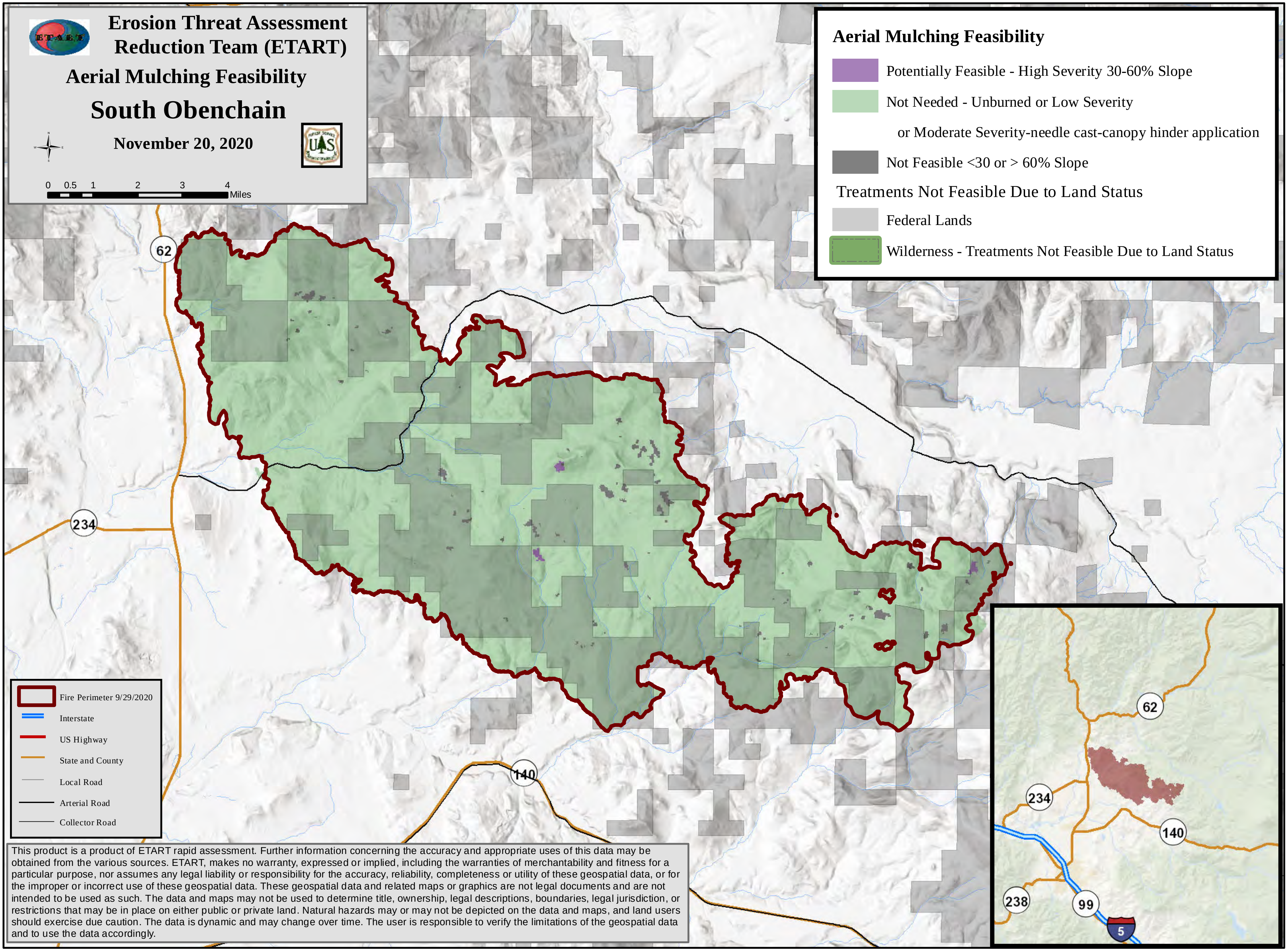

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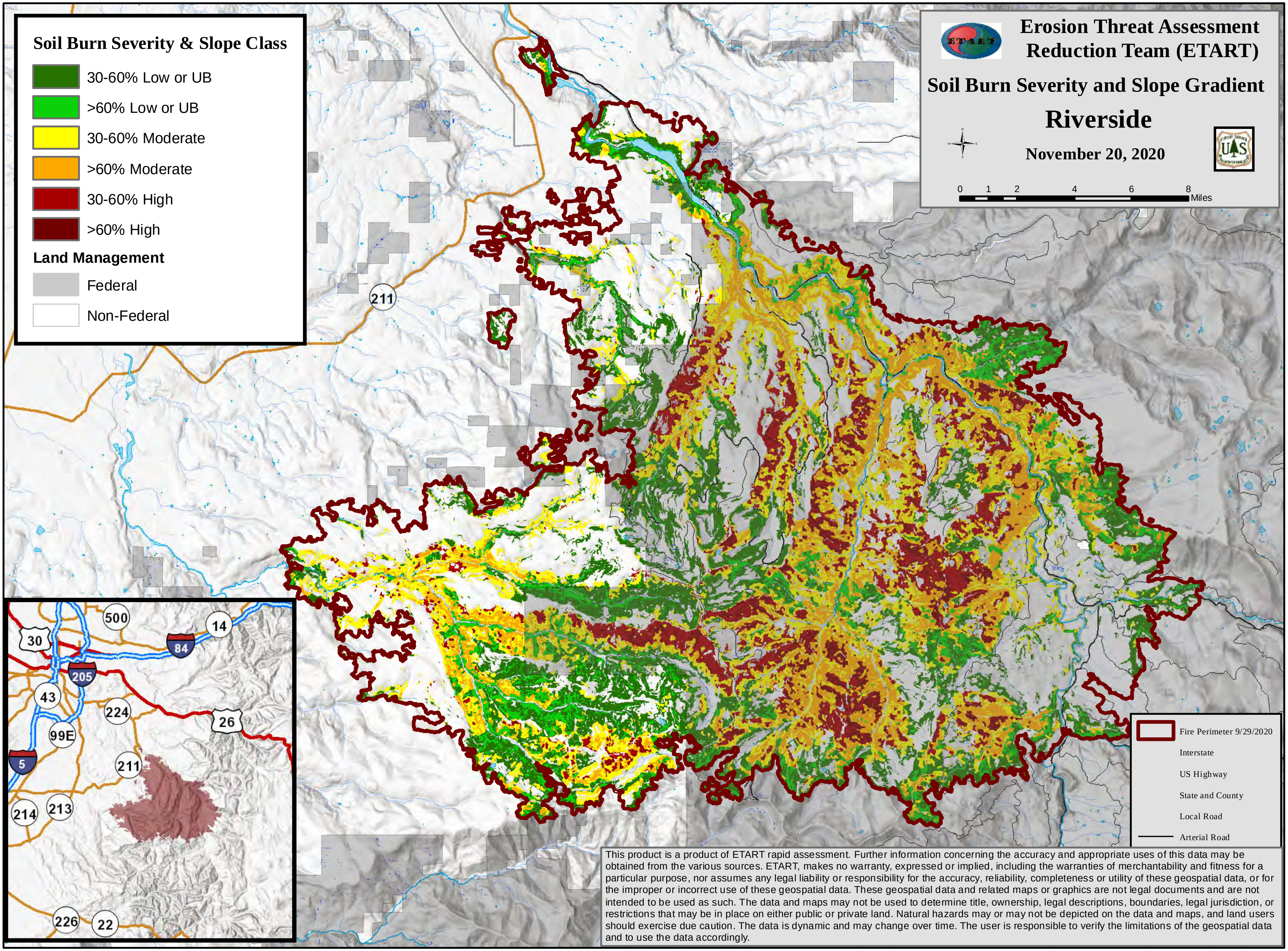

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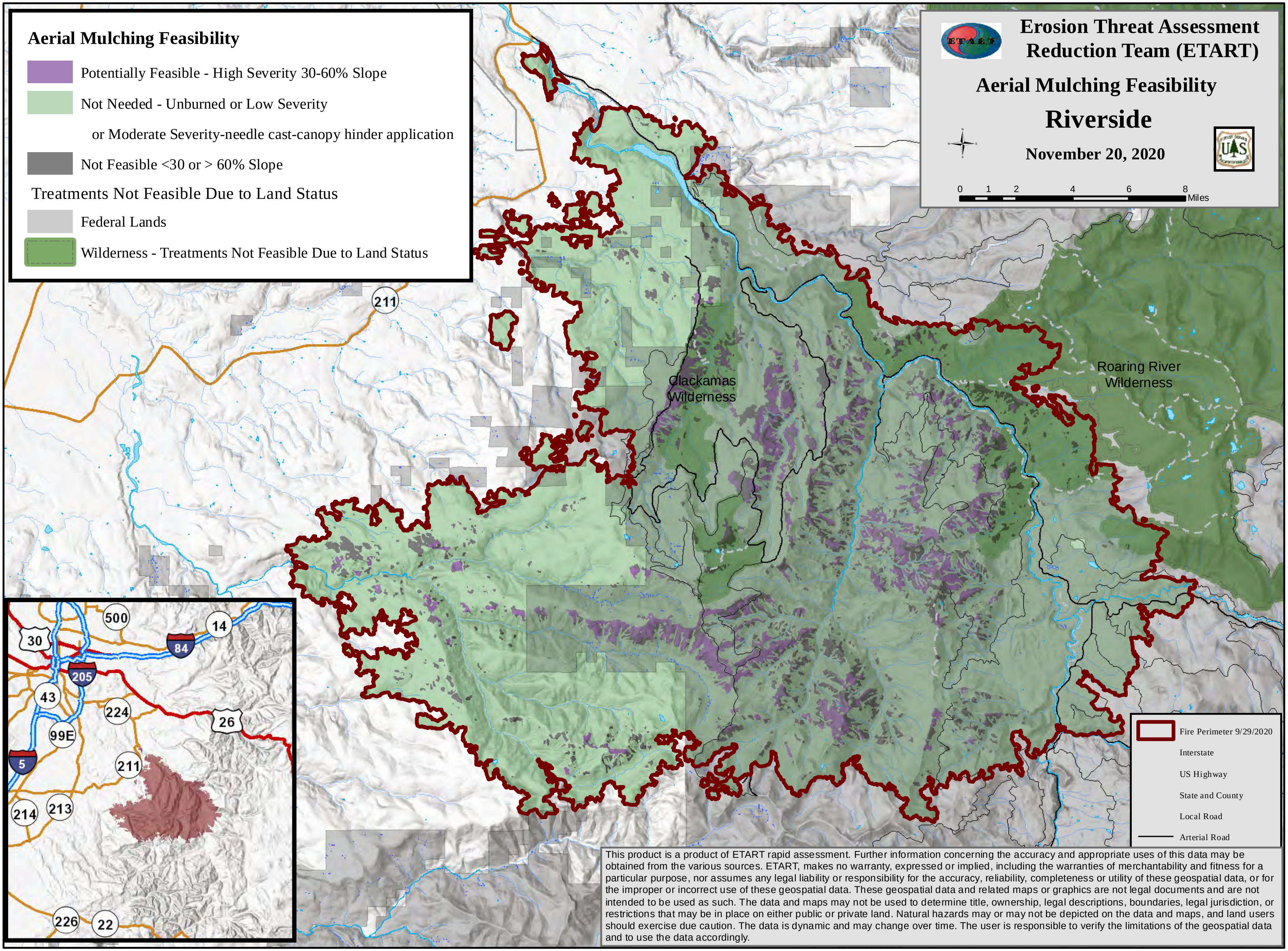

Aerial Mulching Feasibility
Potentially Feasible - High Severity 30-60% Slope
Not Needed - Unburned or Low Severity
or Moderate Severity-needle cast-canopy hinder application
Not Feasible <30 or > 60% Slope
Treatments Not Feasible Due to Land Status
Federal Lands
Wilderness - Treatments Not Feasible Due to Land Status
Erosion Threat Assessment
Reduction Team (ETART)
Aerial Mulching Feasibility
Riverside
November 20, 2020
0 1 2 4 6 8 Miles
Clackamas Wilderness
Roaring River Wilderness
211
Fire Perimeter 9/29/2020
Interstate
US Highway
State and County
Local Road
Arterial Road
30
500
14
84
205
43
224
26
99E
5
211
214
213
226
22
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Appendix B

Drinking Water Impacts

(Ranking Tables)
(Public Water System Risks)

Table B.1: Individual Affected Well By Fire and Fire Burn Severity						
Incident Name	**Well Name**	**Unburned or Underburned**	**Low Soil Burn Severity**	**Moderate Soil Burn Severity**	**High Soil Burn Severity**	**Grand Total**
Almeda Drive	ASHLAND BURGER KING	1				1
	BEAR CREEK MOBILE HOME PARK	1	2			3
	COMFORT INN - ASHLAND	1				1
	ECONO LODGE	1				1
	ODOT HD SUNCREST REST AREA		1			1
	RISING SUN FARMS INC	1				1
	ROGUE VALLEY STATIONS	1				1
	WHISPERING PINES MH VILLAGE	1	1			2
Almeda Drive Total		**7**	**4**			**11**
Archie Creek	BLM LONE PINE CAMPGROUND			1		1
	BLM MILLPOND REC SITE			1		1
	BLM SUSAN CREEK DAY USE			1		1
	DOUGLAS CO PKS - BAKER			1		1
	STEAMBOAT INN			1		1
	USFS BOGUS CREEK CG				1	1
Archie Creek Total				**5**	**1**	**6**
Beachie Creek	BLM CANYON CREEK REC SITE			1		1
	BLM ELKHORN VALLEY REC SITE			1		1
	BLM FISHERMANS BEND REC SITE		1			1
	CAMP CASCADE			1		1
	ELKHORN VALLEY GOLF			1		1
	EVANS CREEK CAMP RETREAT			1		1
	MARION CO PKS-BEAR CREEK PARK			1		1
	MARION CO PKS-NIAGRA PARK			1		1
	ODF SANTIAM HORSE CAMP		1			1
	ODF SHELLBURG FALLS CG		1			1
	OPRD MAPLES REST AREA		1			1
	OPRD NORTH SANTIAM STATE PARK		1			1
	TAYLOR PARK			1		1
	USFS DETROIT RANGER STATION		2			2
Beachie Creek Total			**7**	**8**		**15**
Echo Mountain Complex	ECHO MOUNTAIN PARK		1	1		2
	PANTHER CREEK WATER DISTRICT		1			1
	RIVERBEND PARK WATER SYSTEM	1				1
	SALMON RIVER MOBILE VILLAGE		1			1
Echo Mountain Complex Total		**1**	**3**	**1**		**5**
Holiday Farm	BLUE RIVER WATER DISTRICT			1		1
	FINN ROCK GRILL			1		1
	HOLIDAY FARM RESORT		1			1
	HOLIDAY FARM RV PARK		1			1
	LANE CO PARKS DORRIS PARK			1		1
	LAZY DAYS MOBILE HOME PARK		1			1
	MCKENZIE RIVER CHRISTIAN SCHOOL	1				1
	MOMS PIES INC		1			1
	ODF/WL LEABURG FISH HATCHERY		1			1
	RIVERSIDE INN			1		1
	USFS DELTA CG-HP #1			1		1
	USFS DELTA CG-HP #2			1		1
	USFS DELTA CG-HP #3			1		1
	VIDA CAFE			1		1
	VIDA COMMUNITY MARKET		1			1
	WAYFARER RESORT			1		1
	WESTLAKE RESORT			1		1
Holiday Farm Total		**1**	**6**	**10**		**17**
Lionshead	STAHLMAN SUMMER HOMES ASSOC	1				1
Lionshead Total		**1**				**1**

Riverside	CLACKAMAS RIVER RV PARK			1		1
	PGE FARADAY DAM		1			1
	PGE THREE LYNX (OAK GROVE)		1			1
	USFS ARMSTRONG CAMPGROUND		1			1
	USFS FISH CREEK CG HP			1		1
	USFS INDIAN HENRY CG		1			1
	USFS LAZY BEND CG			1		1
	USFS LOCKABY CG HP		1			1
	USFS RIVERSIDE CAMPGRND (HP3)		1			1
	USFS ROARING RIVER CAMPGROUND			1		1
	USFS SUNSTRIP CAMPGROUND HP			1		1
	USFS TIMBER LAKE JCC		2			2
Riverside Total			**8**	**5**		**13**
Grand Total		**10**	**28**	**29**	**1**	**68**

Table B.2: Public Water Systems with No Alternate Water Sources Available

Percent of DWSA and Upstream Within Fire Area	Subbasin	WildfireName	County	PWS ID	PWS Name	PWS Type	Population	Overall Watershed Rank	Source Type	GW Available?
100.0%	Santiam Subbasin	Lionshead	Marion	OR4193461	BREITENBUSH HOT SPRINGS	C	200	H	SW	No
80.0%	Santiam Subbasin	Beachie Creek,Lionshead	Marion	OR4100257	DETROIT WATER SYSTEM (Breitenbush R.)	C	205	H	SW	No
80.0%	Santiam Subbasin	Lionshead	Marion	OR4100257	DETROIT WATER SYSTEM (Mackey)	C	205	H	SW	No
56.0%	Molalla-Pudding Subbasin	Beachie Creek,Riverside	Clackamas	OR4100534	MOLALLA, CITY OF	C	9139	H	SW	No
52.0%	Santiam Subbasin	Beachie Creek	Linn	OR4100493	LYONS MEHAMA WATER DISTRICT	C	1300	H	SW	No
51.0%	Santiam Subbasin	Beachie Creek	Marion	OR4100843	STAYTON WATER SUPPLY	C	7830	H	SW	No
45.0%	Santiam Subbasin	Beachie Creek,Lionshead	Marion	OR4100317	GATES, CITY OF	C	490	H	SW	No
24.0%	Clackamas Subbasin	Riverside (relatively minor inputs from Beachie Creek,Lionshead)	Clackamas	OR4100279	ESTACADA, CITY OF	C	3725	H	SW	No
18.0%	Umpqua Subbasin	Archie Creek	Douglas	OR4100326	GLIDE WATER ASSOCIATION	C	1200	H	SW	No
	McKenzie Subbasin	Holiday Farm	Lane	OR4100287	EUGENE WATER & ELECTRIC BOARD	C	168000	H	SW	No
35.0%	Umpqua Subbasin	Archie Creek	Douglas	OR4100847	SUTHERLIN, CITY OF (Calapooya)	C	8060	M	SW	No
15.0%	Umpqua Subbasin	Archie Creek	Douglas	OR4100720	ROSEBURG, CITY OF	C	28800	M	SW	No
11.0%	Molalla-Pudding Subbasin	Beachie Creek	Marion	OR4100823	SILVERTON, CITY OF (abiqua)	C	10325	M	SW	No
3.0%	Umpqua Subbasin	Archie Creek	Douglas	OR4101095	USFS WOLF CREEK JOB CORPS	C	291	M	SW	No
	Umpqua Subbasin	Archie Creek (dwnstrm of Sutherlin)	Douglas	OR4100581	OAKLAND, CITY OF	C	954	M	SW	No
	Santiam Subbasin	Beachie Creek	Linn	OR4100012	ALBANY, CITY OF (Santiam R.)	C	56100	M	SW	No
	Umpqua Subbasin	Archie Creek (dwnstrm of Glide)	Douglas	OR4100719	UMPQUA BASIN WATER ASSOC	C	8900	M	SW	No
	Santiam Subbasin	Lionshead	Linn	OR4100394	IDANHA CITY WATER (Rainbow, only one in OHA dataset)	C		M	SW	No

Table B.3: Statewide Public Water Systems Concern Rankings

Total Score	PWS ID	Water System Name	PWS Type	Ownership Type	Subbasin	Wildfire Name	Watershed	Available Sources	Raw Water TOC Increase	Drinking Water Treatment	Dist. DBPs TTHM	Dist. DBPs HAA5	Water Plant Operator	Population Served
61	OR4100257	DETROIT WATER SYSTEM - Breitenbush River	C	Local Government	Santiam Subbasin	Beachie Creek,Lionshead	15	15	8	8	1	1	12	1
61	OR4100257	DETROIT WATER SYSTEM - Mackey Cr.	C	Local Government	Santiam Subbasin	Beachie Creek,Lionshead	15	15	8	8	1	1	12	1
61	OR4100317	GATES, CITY OF	C	Local Government	Santiam Subbasin	Beachie Creek,Lionshead	15	15	4	8	5	5	8	1
60	OR4100603	PANTHER CREEK WD	C	Local Government	Other Subbasin	Echo Mountain Complex	15	10	8	12	1	1	12	1
59	OR4100493	LYONS MEHAMA WATER DISTRICT	C	Local Government	Santiam Subbasin	Beachie Creek	15	15	1	12	1	1	12	2
57	OR4193461	BREITENBUSH HOT SPRINGS	C	Private	Santiam Subbasin	Lionshead	15	15	8	4	1	1	12	1
51	OR4100843	STAYTON WATER SUPPLY	C	Local Government	Santiam Subbasin	Beachie Creek	15	15	1	8	1	1	8	2
51	OR4100279	ESTACADA, CITY OF	C	Local Government	Clackamas Subbasin	Riverside (relatively minor inputs from Beachie Creek,Lionshead)	15	15	1	8	1	1	8	2
46	OR4100534	MOLALLA, CITY OF	C	Local Government	Molalla-PuddingSubbasin	Beachie Creek,Riverside	15	15	4	4	1	1	4	2
44	OR4101095	USFS WOLF CREEK JOB CORPS	C	Federal Agency	Umpqua Subbasin	Archie Creek	10	15	4	4	3	3	4	1
44	OR4100719	UMPQUA BASIN WATER ASSOC	C	Private	Umpqua Subbasin	Archie Creek (dwnstrm of Glide)	10	15	1	4	1	3	8	2
44	OR4100287	EUGENE WATER & ELECTRIC BOARD	C	Local Government	McKenzie Subbasin	Holiday Farm	15	15	1	4	1	1	4	3
43	OR4100326	GLIDE WATER ASSOCIATION	C	Private	Umpqua Subbasin	Archie Creek	15	15	1	4	1	1	4	2
43	OR4100720	ROSEBURG, CITY OF	C	Local Government	Umpqua Subbasin	Archie Creek	10	15	1	8	1	1	4	3
41	OR4100847	SUTHERLIN, CITY OF - Calapooya Cr	C	Local Government	Umpqua Subbasin	Archie Creek	10	15	4	4	1	1	4	2
41	OR4100847	SUTHERLIN, CITY OF - Cooper Cr	C	Local Government	Umpqua Subbasin	Archie Creek	10	15	4	4	1	1	4	2
41	OR4100012	ALBANY, CITY OF - CF - S. Santiam/Leb-Albany Canal	C	Local Government	Santiam Subbasin	Beachie Creek	10	15	1	4	3	1	4	3
41	OR4100012	ALBANY, CITY OF - MF - Santiam R.	C	Local Government	Santiam Subbasin	Beachie Creek	10	15	1	4	3	1	4	3
41	OR4100333	GOLD HILL, CITY OF	C	Local Government	Rogue Subbasin	South Obenchain, Almeda	1	15	1	8	1	1	12	2
40	OR4100971	CAVE JUNCTION, CITY OF	C	Local Government	Other Subbasin	Slater	10	10	8	4	1	1	4	2
39	OR4100823	SILVERTON, CITY OF - Abiqua	C	Local Government	Molalla-PuddingSubbasin	Beachie Creek	10	15	1	4	1	1	4	3
39	OR4100823	SILVERTON, CITY OF - Silver	C	Local Government	Molalla-PuddingSubbasin	Beachie Creek	10	15	1	4	1	1	4	3
38	OR4100731	SALEM PUBLIC WORKS	C	Local Government	Santiam Subbasin	Beachie Creek	15	1	1	8	3	3	4	3
38	OR4101520	HILAND WC - SHADY COVE	C	Private	Rogue Subbasin	South Obenchain	1	10	4	8	3	3	8	1
38	OR4192152	CASCADE PACIFIC PULP LLC - Willamette River	NTNC	Private	Umpqua Subbasin	Archie Creek (dwnstrm of Glide)	1	15	1	8	3	1	8	1
37	OR4100581	OAKLAND, CITY OF	C	Local Government	Umpqua Subbasin	Archie Creek (dwnstrm of Sutherlin)	10	15	1	4	1	1	4	1
37	OR4100408	JEFFERSON, CITY OF	C	Local Government	Santiam Subbasin	Beachie Creek	10	10	1	4	1	1	8	2
36	OR4100839	RAINBOW WATER DISTRICT - 5 wells , but only 1 is GU	C	Local Government	McKenzie Subbasin	Holiday Farm	10	1	1	12	1	1	8	2
35	OR4100202	COLTON WATER DISTRICT	C	Local Government	Molalla-PuddingSubbasin	Riverside	1	15	1	4	1	3	8	2
35	OR4100835	SHANGRI LA WATER DISTRICT - GU	C	Local Government	McKenzie Subbasin	Holiday Farm	10	1	1	12	1	1	8	1
34	OR4100580	NORTH CLACKAMAS COUNTY WC - MF	C	Local Government	Clackamas Subbasin	Riverside (relatively minor inputs from Beachie Creek,Lionshead)	1	15	1	8	1	1	4	3
34	OR4100580	NORTH CLACKAMAS COUNTY WC - SSF	C	Local Government	Clackamas Subbasin	Riverside (relatively minor inputs from Beachie Creek,Lionshead)	1	15	1	8	1	1	4	3
34	OR4100342	GRANTS PASS, CITY OF	C	Local Government	Rogue Subbasin	Steinmetz Creek, South Obenchain, Almeda	1	15	1	4	3	3	4	3
34	OR4100157	CANBY UTILITY - IG - Springs Gallery	C	Local Government	Molalla-PuddingSubbasin	Riverside	10	10	1	4	1	1	4	3
34	OR4100157	CANBY UTILITY - Molalla R.	C	Local Government	Molalla-PuddingSubbasin	Riverside	10	10	1	4	1	1	4	3
33	OR4100808	COUNTRY VIEW MH ESTATES	C	Private	Rogue Subbasin	South Obenchain	1	10	1	8	3	1	8	1

Total Score	PWS ID	Water System Name	PWS Type	Ownership Type	Subbasin	Wildfire Name	Watershed	Available Sources	Raw Water TOC Increase	Drinking Water Treatment	Dist. DBPs TTHM	Dist. DBPs HAA5	Water Plant Operator	Population Served
32	OR4100473	LEBANON, CITY OF	C	Local Government	Santiam Subbasin	Holiday Farm	1	15	1	4	3	1	4	3
32	OR4100394	IDANHA CITY WATER - Mud Puppy	C	Local Government	Santiam Subbasin	Lionshead	1	15	1	4	1	1	8	1
32	OR4100394	IDANHA CITY WATER - Rainbow	C	Local Government	Santiam Subbasin	Lionshead	1	15	1	4	1	1	8	1
32	OR4100187	CLACKAMAS RIVER WATER - CLACKAMAS	C	Local Government	Clackamas Subbasin	Riverside (relatively minor inputs from Beachie Creek,Lionshead)	1	15	1	4	1	3	4	3
32	OR4100276	ELKTON, CITY OF	C	Local Government	Umpqua Subbasin	Archie Creek (dwnstrm of Glide)	1	15	1	4	3	3	4	1
32	OR4101012	PP&L-TOKETEE VILLAGE	C	Private	Umpqua Subbasin	Thielsen	1	15	1	8	1	1	4	1
30	OR4101542	LAKE OSWEGO - TIGARD WATER SUPPLY	C	Local Government	Clackamas Subbasin	Riverside (relatively minor inputs from Beachie Creek,Lionshead)	1	15	1	4	1	1	4	3
29	OR4100613	PENDLETON, CITY OF	C	Local Government	Other Subbasin	Hager Ridge,Horse	1	10	1	4	1	1	8	3
29	OR4100591	SOUTH FORK WATER BOARD	C	Local Government	Clackamas Subbasin	Riverside (relatively minor inputs from Beachie Creek,Lionshead)	1	15	1	4	1	1	4	2
27	OR4101483	ANGLERS COVE/SCHWC	C	Private	Rogue Subbasin	South Obenchain	1	10	1	8	1	1	4	1
25	OR4100513	MEDFORD WATER COMMISSION	C	Local Government	Rogue Subbasin	South Obenchain	1	10	1	4	1	1	4	3
25	OR4100954	WILSONVILLE, CITY OF	C	Local Government	Santiam Subbasin	Beachie Creek	1	10	1	4	1	1	4	3
24	OR4100712	ROGUE RIVER, CITY OF	C	Local Government	Rogue Subbasin	South Obenchain, Almeda (dwnstrm of Gold Hill)	1	10	1	4	1	1	4	2
23	OR4100152	BROWNSVILLE, CITY OF	C	Local Government	McKenzie Subbasin	Holiday Farm	1	1	1	4	1	1	12	2
22	OR4100837	SPRINGFIELD UTILITY BOARD - GU	C	Local Government	McKenzie Subbasin	Holiday Farm	1	1	1	8	1	3	4	3
15	OR4101091	USFS STEAMBOAT WORK CENTER	NC	Federal Agency	Umpqua Subbasin	Archie Creek	10	1	1	8	1	1	4	1
15	OR4106169	OPAL CREEK ANCIENT FOREST CTR	NC	Private	Santiam Subbasin	Beachie Creek	15	15	12	12	1	1	8	1
15	OR4193438	TIMBER RIVER RV PARK	NC	Private	Umpqua Subbasin	Archie Creek	1	1	1	4	1	1	8	1

Table B.4: Public Water Systems Concern Rankings by Subbasin

Average Score	Total Score	Subbasin	Wildfire Name	PWS ID	Water System Name	PWS Type	Ownership Type	Watershed	Available Sources	Raw Water TOC Increase	Drinking Water Treatment	Dist. DBPs TTHM	Dist. DBPs HAA5	Water Plant Operator	Population Served
43.0	60	Other Subbasin	Echo Mountain Complex	OR4100603	PANTHER CREEK WD	C	Local Government	15	10	8	12	1	1	12	1
	40	Other Subbasin	Slater	OR4100971	CAVE JUNCTION, CITY OF	C	Local Government	10	10	8	4	1	1	4	2
	29	Other Subbasin	Hager Ridge,Horse	OR4100613	PENDLETON, CITY OF	C	Local Government	1	10	1	4	1	1	8	3
42.9	61	Santiam Subbasin	Beachie Creek,Lionshead	OR4100317	GATES, CITY OF	C	Local Government	15	15	4	8	5	5	8	1
	61	Santiam Subbasin	Beachie Creek,Lionshead	OR4100257	DETROIT WATER SYSTEM - Breitenbush River	C	Local Government	15	15	8	8	1	1	12	1
	61	Santiam Subbasin	Beachie Creek,Lionshead	OR4100257	DETROIT WATER SYSTEM - Mackey Cr.	C	Local Government	15	15	8	8	1	1	12	1
	59	Santiam Subbasin	Beachie Creek	OR4100493	LYONS MEHAMA WATER DISTRICT	C	Local Government	15	15	1	12	1	1	12	2
	57	Santiam Subbasin	Lionshead	OR4193461	BREITENBUSH HOT SPRINGS	C	Private	15	15	8	4	1	1	12	1
	51	Santiam Subbasin	Beachie Creek	OR4100843	STAYTON WATER SUPPLY	C	Local Government	15	15	1	8	1	1	8	2
	41	Santiam Subbasin	Beachie Creek	OR4100012	ALBANY, CITY OF - CF - S. Santiam/Leb-Albany Canal	C	Local Government	10	15	1	4	3	1	4	3
	41	Santiam Subbasin	Beachie Creek	OR4100012	ALBANY, CITY OF - MF - Santiam R.	C	Local Government	10	15	1	4	3	1	4	3
	38	Santiam Subbasin	Beachie Creek	OR4100731	SALEM PUBLIC WORKS	C	Local Government	15	1	1	8	3	3	4	3
	37	Santiam Subbasin	Beachie Creek	OR4100408	JEFFERSON, CITY OF	C	Local Government	10	10	1	4	1	1	8	2
	32	Santiam Subbasin	Holiday Farm	OR4100473	LEBANON, CITY OF	C	Local Government	1	15	1	4	3	1	4	3
	32	Santiam Subbasin	Lionshead	OR4100394	IDANHA CITY WATER - Mud Puppy	C	Local Government	1	15	1	4	1	1	8	1
	32	Santiam Subbasin	Lionshead	OR4100394	IDANHA CITY WATER - Rainbow	C	Local Government	1	15	1	4	1	1	8	1
	25	Santiam Subbasin	Beachie Creek	OR4100954	WILSONVILLE, CITY OF	C	Local Government	1	10	1	4	1	1	4	3
	15	Santiam Subbasin	Beachie Creek	OR4106169	OPAL CREEK ANCIENT FOREST CTR	NC	Private	15	15	12	12	1	1	8	1
37.8	46	Molalla-Pudding Subbasin	Beachie Creek,Riverside	OR4100534	MOLALLA, CITY OF	C	Local Government	15	15	4	4	1	1	4	2
	39	Molalla-Pudding Subbasin	Beachie Creek	OR4100823	SILVERTON, CITY OF - Abiqua	C	Local Government	10	15	1	4	1	1	4	3
	39	Molalla-Pudding Subbasin	Beachie Creek	OR4100823	SILVERTON, CITY OF - Silver	C	Local Government	10	15	1	4	1	1	4	3
	35	Molalla-Pudding Subbasin	Riverside	OR4100202	COLTON WATER DISTRICT	C	Local Government	1	15	1	4	1	3	8	2
	34	Molalla-Pudding Subbasin	Riverside	OR4100157	CANBY UTILITY - IG - Springs Gallery	C	Local Government	10	10	1	4	1	1	4	3
	34	Molalla-Pudding Subbasin	Riverside	OR4100157	CANBY UTILITY - Molalla R.	C	Local Government	10	10	1	4	1	1	4	3
35.4	44	Umpqua Subbasin	Archie Creek	OR4101095	USFS WOLF CREEK JOB CORPS	C	Federal Agency	10	15	4	4	3	3	4	1
	44	Umpqua Subbasin	Archie Creek (dwnstrm of Glide)	OR4100719	UMPQUA BASIN WATER ASSOC	C	Private	10	15	1	4	1	3	8	2
	43	Umpqua Subbasin	Archie Creek	OR4100326	GLIDE WATER ASSOCIATION	C	Private	15	15	1	4	1	1	4	2
	43	Umpqua Subbasin	Archie Creek	OR4100720	ROSEBURG, CITY OF	C	Local Government	10	15	1	8	1	1	4	3
	41	Umpqua Subbasin	Archie Creek	OR4100847	SUTHERLIN, CITY OF - Calapooya Cr	C	Local Government	10	15	4	4	1	1	4	2
	41	Umpqua Subbasin	Archie Creek	OR4100847	SUTHERLIN, CITY OF - Cooper Cr	C	Local Government	10	15	4	4	1	1	4	2
	38	Umpqua Subbasin	Archie Creek (dwnstrm of Glide)	OR4192152	CASCADE PACIFIC PULP LLC - Willamette River	NTNC	Private	1	15	1	8	3	1	8	1
	37	Umpqua Subbasin	Archie Creek (dwnstrm of Sutherlin)	OR4100581	OAKLAND, CITY OF	C	Local Government	10	15	1	4	1	1	4	1
	32	Umpqua Subbasin	Archie Creek (dwnstrm of Glide)	OR4100276	ELKTON, CITY OF	C	Local Government	1	15	1	4	3	3	4	1
	32	Umpqua Subbasin	Thielsen	OR4101012	PP&L-TOKETEE VILLAGE	C	Private	1	15	1	8	1	1	4	1
	15	Umpqua Subbasin	Archie Creek	OR4101091	USFS STEAMBOAT WORK CENTER	NC	Federal Agency	10	1	1	8	1	1	4	1
	15	Umpqua Subbasin	Archie Creek	OR4193438	TIMBER RIVER RV PARK	NC	Private	1	1	1	4	1	1	8	1
35.0	51	Clackamas Subbasin	Riverside (relatively minor inputs from Beachie Creek,Lionshead)	OR4100279	ESTACADA, CITY OF	C	Local Government	15	15	1	8	1	1	8	2
	34	Clackamas Subbasin	Riverside (relatively minor inputs from Beachie Creek,Lionshead)	OR4100580	NORTH CLACKAMAS COUNTY WC - MF	C	Local Government	1	15	1	8	1	1	4	3
	34	Clackamas Subbasin	Riverside (relatively minor inputs from Beachie Creek,Lionshead)	OR4100580	NORTH CLACKAMAS COUNTY WC - SSF	C	Local Government	1	15	1	8	1	1	4	3
	32	Clackamas Subbasin	Riverside (relatively minor inputs from Beachie Creek,Lionshead)	OR4100187	CLACKAMAS RIVER WATER - CLACKAMAS	C	Local Government	1	15	1	4	1	3	4	3
	30	Clackamas Subbasin	Riverside (relatively minor inputs from Beachie Creek,Lionshead)	OR4101542	LAKE OSWEGO - TIGARD WATER SUPPLY	C	Local Government	1	15	1	4	1	1	4	3
	29	Clackamas Subbasin	Riverside (relatively minor inputs from Beachie Creek,Lionshead)	OR4100591	SOUTH FORK WATER BOARD	C	Local Government	1	15	1	4	1	1	4	2

Average Score	Total Score	Subbasin	Wildfire Name	PWS ID	Water System Name	PWS Type	Ownership Type	Watershed	Available Sources	Raw Water TOC Increase	Drinking Water Treatment	Dist. DBPs TTHM	Dist. DBPs HAA5	Water Plant Operator	Population Served
	44	McKenzie Subbasin	Holiday Farm	OR4100287	EUGENE WATER & ELECTRIC BOARD	C	Local Government	15	15	1	4	1	1	4	3
	36	McKenzie Subbasin	Holiday Farm	OR4100839	RAINBOW WATER DISTRICT - 5 wells , but only 1 is GU	C	Local Government	10	1	1	12	1	1	8	2
32.0	35	McKenzie Subbasin	Holiday Farm	OR4100835	SHANGRI LA WATER DISTRICT - GU	C	Local Government	10	1	1	12	1	1	8	1
	23	McKenzie Subbasin	Holiday Farm	OR4100152	BROWNSVILLE, CITY OF	C	Local Government	1	1	1	4	1	1	12	2
	22	McKenzie Subbasin	Holiday Farm	OR4100837	SPRINGFIELD UTILITY BOARD - GU	C	Local Government	1	1	1	8	1	3	4	3
	41	Rogue Subbasin	South Obenchain, Almeda	OR4100333	GOLD HILL, CITY OF	C	Local Government	1	15	1	8	1	1	12	2
	38	Rogue Subbasin	South Obenchain	OR4101520	HILAND WC - SHADY COVE	C	Private	1	10	4	8	3	3	8	1
	34	Rogue Subbasin	Steinmetz Creek, South Obenchain, Almeda	OR4100342	GRANTS PASS, CITY OF	C	Local Government	1	15	1	4	3	3	4	3
31.7	33	Rogue Subbasin	South Obenchain	OR4100808	COUNTRY VIEW MH ESTATES	C	Private	1	10	1	8	3	1	8	1
	27	Rogue Subbasin	South Obenchain	OR4101483	ANGLERS COVE/SCHWC	C	Private	1	10	1	8	1	1	4	1
	25	Rogue Subbasin	South Obenchain	OR4100513	MEDFORD WATER COMMISSION	C	Local Government	1	10	1	4	1	1	4	3
	24	Rogue Subbasin	South Obenchain, Almeda (dwnstrm of Gold Hill)	OR4100712	ROGUE RIVER, CITY OF	C	Local Government	1	10	1	4	1	1	4	2

Table B.5: Public Water Systems Concern Rankings by Wildfire

Average Score	Total Score	Wildfire Name	Subbasin	PWS ID	Water System Name	PWS Type	Ownership Type	Watershed	Available Sources	Raw Water TOC Increase	Drinking Water Treatment	Dist. DBPs TTHM	Dist. DBPs HAA5	Water Plant Operator	Population Served
60.0	60	Echo Mountain Complex	Other Subbasin	OR4100603	PANTHER CREEK WD	C	Local Government	15	10	8	12	1	1	12	1
47.4	61	Beachie Creek,Lionshead	Santiam Subbasin	OR4100257	DETROIT WATER SYSTEM - Breitenbush River	C	Local Government	15	15	8	8	1	1	12	1
	61	Beachie Creek,Lionshead	Santiam Subbasin	OR4100257	DETROIT WATER SYSTEM - Mackey Cr.	C	Local Government	15	15	8	8	1	1	12	1
	61	Beachie Creek,Lionshead	Santiam Subbasin	OR4100317	GATES, CITY OF	C	Local Government	15	15	4	8	5	5	8	1
	59	Beachie Creek	Santiam Subbasin	OR4100493	LYONS MEHAMA WATER DISTRICT	C	Local Government	15	15	1	12	1	1	12	2
	51	Beachie Creek	Santiam Subbasin	OR4100843	STAYTON WATER SUPPLY	C	Local Government	15	15	1	8	1	1	8	2
	46	Beachie Creek,Riverside	Molalla-PuddingSubbasin	OR4100534	MOLALLA, CITY OF	C	Local Government	15	15	4	4	1	1	4	2
	41	Beachie Creek	Santiam Subbasin	OR4100012	ALBANY, CITY OF - CF - S. Santiam/Leb-Albany Canal	C	Local Government	10	15	1	4	3	1	4	3
	41	Beachie Creek	Santiam Subbasin	OR4100012	ALBANY, CITY OF - MF - Santiam R.	C	Local Government	10	15	1	4	3	1	4	3
	39	Beachie Creek	Molalla-PuddingSubbasin	OR4100823	SILVERTON, CITY OF - Abiqua	C	Local Government	10	15	1	4	1	1	4	3
	39	Beachie Creek	Molalla-PuddingSubbasin	OR4100823	SILVERTON, CITY OF - Silver	C	Local Government	10	15	1	4	1	1	4	3
	38	Beachie Creek	Santiam Subbasin	OR4100731	SALEM PUBLIC WORKS	C	Local Government	15	1	1	8	3	3	4	3
	37	Beachie Creek	Santiam Subbasin	OR4100408	JEFFERSON, CITY OF	C	Local Government	10	10	1	4	1	1	8	2
	25	Beachie Creek	Santiam Subbasin	OR4100954	WILSONVILLE, CITY OF	C	Local Government	1	10	1	4	1	1	4	3
	65	Beachie Creek	Santiam Subbasin	OR4106169	OPAL CREEK ANCIENT FOREST CTR	NC	Private	15	15	12	12	1	1	8	1
40.3	57	Lionshead	Santiam Subbasin	OR4193461	BREITENBUSH HOT SPRINGS	C	Private	15	15	8	4	1	1	12	1
	32	Lionshead	Santiam Subbasin	OR4100394	IDANHA CITY WATER - Mud Puppy	C	Local Government	1	15	1	4	1	1	8	1
	32	Lionshead	Santiam Subbasin	OR4100394	IDANHA CITY WATER - Rainbow	C	Local Government	1	15	1	4	1	1	8	1
40.0	40	Slater	Other Subbasin	OR4100971	CAVE JUNCTION, CITY OF	C	Local Government	10	10	8	4	1	1	4	2
37.1	44	Archie Creek	Umpqua Subbasin	OR4101095	USFS WOLF CREEK JOB CORPS	C	Federal Agency	10	15	4	4	3	3	4	1
	44	Archie Creek (dwnstrm of Glide)	Umpqua Subbasin	OR4100719	UMPQUA BASIN WATER ASSOC	C	Private	10	15	1	4	1	3	8	2
	43	Archie Creek	Umpqua Subbasin	OR4100326	GLIDE WATER ASSOCIATION	C	Private	15	15	1	4	1	1	4	2
	43	Archie Creek	Umpqua Subbasin	OR4100720	ROSEBURG, CITY OF	C	Local Government	10	15	1	8	1	1	4	3
	41	Archie Creek	Umpqua Subbasin	OR4100847	SUTHERLIN, CITY OF - Calapooya Cr	C	Local Government	10	15	4	4	1	1	4	2
	41	Archie Creek	Umpqua Subbasin	OR4100847	SUTHERLIN, CITY OF - Cooper Cr	C	Local Government	10	15	4	4	1	1	4	2
	38	Archie Creek (dwnstrm of Glide)	Umpqua Subbasin	OR4192152	CASCADE PACIFIC PULP LLC - Willamette River	NTNC	Private	1	15	1	8	3	1	8	1
	37	Archie Creek (dwnstrm of Sutherlin)	Umpqua Subbasin	OR4100581	OAKLAND, CITY OF	C	Local Government	10	15	1	4	1	1	4	1
	32	Archie Creek (dwnstrm of Glide)	Umpqua Subbasin	OR4100276	ELKTON, CITY OF	C	Local Government	1	15	1	4	3	3	4	1
	27	Archie Creek	Umpqua Subbasin	OR4101091	USFS STEAMBOAT WORK CENTER	NC	Federal Agency	10	1	1	8	1	1	4	1
	18	Archie Creek	Umpqua Subbasin	OR4193438	TIMBER RIVER RV PARK	NC	Private	1	1	1	4	1	1	8	1

Average Score	Total Score	Wildfire Name	Subbasin	PWS ID	Water System Name	PWS Type	Ownership Type	Watershed	Available Sources	Raw Water TOC Increase	Drinking Water Treatment	Dist. DBPs TTHM	Dist. DBPs HAA5	Water Plant Operator	Population Served
34.8	51	Riverside (relatively minor inputs from Beachie Creek,Lionshead)	Clackamas Subbasin	OR4100279	ESTACADA, CITY OF	C	Local Government	15	15	1	8	1	1	8	2
	35	Riverside	Molalla-PuddingSubbasin	OR4100202	COLTON WATER DISTRICT	C	Local Government	1	15	1	4	1	3	8	2
	34	Riverside (relatively minor inputs from Beachie Creek,Lionshead)	Clackamas Subbasin	OR4100580	NORTH CLACKAMAS COUNTY WC - MF	C	Local Government	1	15	1	8	1	1	4	3
	34	Riverside (relatively minor inputs from Beachie Creek,Lionshead)	Clackamas Subbasin	OR4100580	NORTH CLACKAMAS COUNTY WC - SSF	C	Local Government	1	15	1	8	1	1	4	3
	34	Riverside	Molalla-PuddingSubbasin	OR4100157	CANBY UTILITY - IG - Springs Gallery	C	Local Government	10	10	1	4	1	1	4	3
	34	Riverside	Molalla-PuddingSubbasin	OR4100157	CANBY UTILITY - Molalla R.	C	Local Government	10	10	1	4	1	1	4	3
	32	Riverside (relatively minor inputs from Beachie Creek,Lionshead)	Clackamas Subbasin	OR4100187	CLACKAMAS RIVER WATER - CLACKAMAS	C	Local Government	1	15	1	4	1	3	4	3
	30	Riverside (relatively minor inputs from Beachie Creek,Lionshead)	Clackamas Subbasin	OR4101542	LAKE OSWEGO - TIGARD WATER SUPPLY	C	Local Government	1	15	1	4	1	1	4	3
	29	Riverside (relatively minor inputs from Beachie Creek,Lionshead)	Clackamas Subbasin	OR4100591	SOUTH FORK WATER BOARD	C	Local Government	1	15	1	4	1	1	4	2
34.0	34	Steinmetz Creek, South Obenchain, Almeda	Rogue Subbasin	OR4100342	GRANTS PASS, CITY OF	C	Local Government	1	15	1	4	3	3	4	3
32.0	44	Holiday Farm	McKenzie Subbasin	OR4100287	EUGENE WATER & ELECTRIC BOARD	C	Local Government	15	15	1	4	1	1	4	3
	36	Holiday Farm	McKenzie Subbasin	OR4100839	RAINBOW WATER DISTRICT - 5 wells , but only 1 is GU	C	Local Government	10	1	1	12	1	1	8	2
	35	Holiday Farm	McKenzie Subbasin	OR4100835	SHANGRI LA WATER DISTRICT - GU	C	Local Government	10	1	1	12	1	1	8	1
	32	Holiday Farm	Santiam Subbasin	OR4100473	LEBANON, CITY OF	C	Local Government	1	15	1	4	3	1	4	3
	23	Holiday Farm	McKenzie Subbasin	OR4100152	BROWNSVILLE, CITY OF	C	Local Government	1	1	1	4	1	1	12	2
	22	Holiday Farm	McKenzie Subbasin	OR4100837	SPRINGFIELD UTILITY BOARD - GU	C	Local Government	1	1	1	8	1	3	4	3
32.0	32	Thielsen	Umpqua Subbasin	OR4101012	PP&L-TOKETEE VILLAGE	C	Private	1	15	1	8	1	1	4	1
31.3	41	South Obenchain, Almeda	Rogue Subbasin	OR4100333	GOLD HILL, CITY OF	C	Local Government	1	15	1	8	1	1	12	2
	38	South Obenchain	Rogue Subbasin	OR4101520	HILAND WC - SHADY COVE	C	Private	1	10	4	8	3	3	8	1
	33	South Obenchain	Rogue Subbasin	OR4100808	COUNTRY VIEW MH ESTATES	C	Private	1	10	1	8	3	1	8	1
	27	South Obenchain	Rogue Subbasin	OR4101483	ANGLERS COVE/SCHWC	C	Private	1	10	1	8	1	1	4	1
	25	South Obenchain	Rogue Subbasin	OR4100513	MEDFORD WATER COMMISSION	C	Local Government	1	10	1	4	1	1	4	3
	24	South Obenchain, Almeda (dwnstrm of Gold Hill)	Rogue Subbasin	OR4100712	ROGUE RIVER, CITY OF	C	Local Government	1	10	1	4	1	1	4	2
29.0	29	Hager Ridge,Horse	Other Subbasin	OR4100613	PENDLETON, CITY OF	C	Local Government	1	10	1	4	1	1	8	3

Appendix B.6: WEPP Modeling - Sediment Loads to PWS Intakes (Modeled Systems Only)

Subbasin	Wildfire Name	PWS ID	Water System Name	Modeled	Burn Area	Contribution Area (acre)	Pre-Fire Basin: 2-yr Runoff Event (cfs)	Pre-Fire Basin: Total Sediment Discharge (ton/yr)	Pre-Fire Basin: Fractional Proportion: Sand	Silt	Clay	Organic Matter*	Post-Fire Basin: 2-yr Runoff Event (cfs)	Post-Fire Basin: Total Sediment Discharge (ton/yr)	Post-Fire Basin: Fractional Proportion: Sand	Silt	Clay	Organic Matter*	Total Organic Matter: Unburned Organic Matter Loading (ton/yr)	Burned Organic Matter Loading (ton/yr)	Percent Increase (ton/yr)	Organic Matter (<0.030 mm)**: Unburned Organic Matter Loading (ton/yr)	Burned Organic Matter Loading (ton/yr)	Percent Increase (ton/yr)	Total Organic Matter Basin: Unburned Organic Matter Loading (ton/yr)	Burned Organic Matter Loading (ton/yr)	Percent Increase (ton/yr)
Molalla-Pudding Subbasin	Beachie Creek, Riverside	OR4100534	MOLALLA, CITY OF	Yes	Yes	130000	1100	160000	0.51	0.368	0.122	0.052	12000	180000	0.487	0.386	0.127	0.055	8320	9900	18.99%	8374.08	9806.94	17.11%	8385.6	9965.6	18.84%
Molalla-Pudding Subbasin	Riverside	OR4100202	COLTON WATER DISTRICT	Yes	Yes	2100	260	1600	0.595	0.31	0.095	0.041	250	1600	0.594	0.311	0.095	0.041	65.6	65.6	0.00%	65.208	65.208	0.00%			
Other Subbasin	Echo Mountain Complex	OR4100603	PANTHER CREEK WD	Yes	Yes	1000	98	140	0.554	0.354	0.092	0.04	100	180	0.514	0.386	0.1	0.043	5.6	7.74	38.21%	5.52552	7.722	39.75%	40125.6	51837.74	29.19%
Other Subbasin	Slater	OR4100971	CAVE JUNCTION, CITY OF	Yes	Yes	150000	28000	590000	0.472	0.37	0.158	0.068	30000	730000	0.444	0.39	0.165	0.071	40120	51830	29.19%	39991.38	51673.05	29.21%			
Rogue Subbasin	South Obenchain	OR4101520	HILAND WC - SHADY COVE	Yes	Yes	7500	420	520	0.481	0.378	0.141	0.06	420	580	0.475	0.377	0.147	0.063	31.2	36.54	17.12%	31.45428	36.57654	16.28%	31.2	36.54	17.12%
Santiam Subbasin	Lionshead	OR4193461	BREITENBUSH HOT SPRINGS	Yes	Yes	34000	1900	12000	0.493	0.408	0.099	0.042	2100	17000	0.479	0.414	0.107	0.046	504	782	55.16%	509.652	780.351	53.11%	7101.928	9228.608	29.95%
Santiam Subbasin	Beachie Creek	OR4106169	OPAL CREEK ANCIENT FOREST CTR	Yes	Yes	360	49	730	0.575	0.331	0.094	0.04	58	2300	0.558	0.344	0.098	0.042	29.2	96.6	230.82%	29.43798	96.6966	228.48%			
Santiam Subbasin	Beachie Creek, Lionshead	OR4100317	GATES, CITY OF	Yes	Yes	290000	8800	120000	0.533	0.36	0.107	0.046	8900	140000	0.521	0.365	0.114	0.049	5520	6860	24.28%	5508.36	6846.84	24.30%			
Santiam Subbasin	Beachie Creek, Lionshead	OR4100257	DETROIT WATER SYSTEM - Breitenbush River	Yes	Yes	66000	3200	27000	0.575	0.34	0.085	0.037	3700	34000	0.537	0.367	0.096	0.041	999	1394	39.54%	984.555	1400.256	42.22%			
Santiam Subbasin	Lionshead	OR4100257	DETROIT WATER SYSTEM - Mackey Cr.	Yes	Yes	170	25	180	0.513	0.362	0.125	0.054	28	770	0.479	0.384	0.137	0.059	9.72	45.43	367.39%	9.6525	45.25521	368.84%			
Santiam Subbasin	Lionshead	OR4100394	IDANHA CITY WATER - Mud Puppy	Yes	Yes	63	8	66	0.543	0.323	0.134	0.058	8	66	0.543	0.323	0.134	0.058	3.828	3.828	0.00%	3.794076	3.794076	0.00%			
Santiam Subbasin	Lionshead	OR4100394	IDANHA CITY WATER - Rainbow	Yes	Yes	460	76	670	0.43	0.444	0.126	0.054	83	850	0.415	0.457	0.128	0.055	36.18	46.75	29.22%	36.21618	46.6752	28.88%			
Umpqua Subbasin	Archie Creek	OR4101095	USFS WOLF CREEK JOB CORPS	Yes	Yes	56000	2100	11000	0.28	0.559	0.161	0.069	2100	12000	0.278	0.557	0.165	0.071	759	852	12.25%	759.759	849.42	11.80%	9999	12402	24.03%
Umpqua Subbasin	Archie Creek	OR4100847	SUTHERLIN, CITY OF - Calapooya Cr	Yes	Yes	53000	12000	120000	0.405	0.414	0.181	0.077	13000	150000	0.404	0.415	0.18	0.077	9240	11550	25.00%	9317.88	11583	24.31%			

*Note: Organic Matter is the percentage of the entire sediment loading.

**Note: Settable Organic Matter was determined from the model's settings for the clay fraction containing 42.9% organic matter.

Appendix B.7: WEPP Modeling - Sediment Loads to PWS Intakes

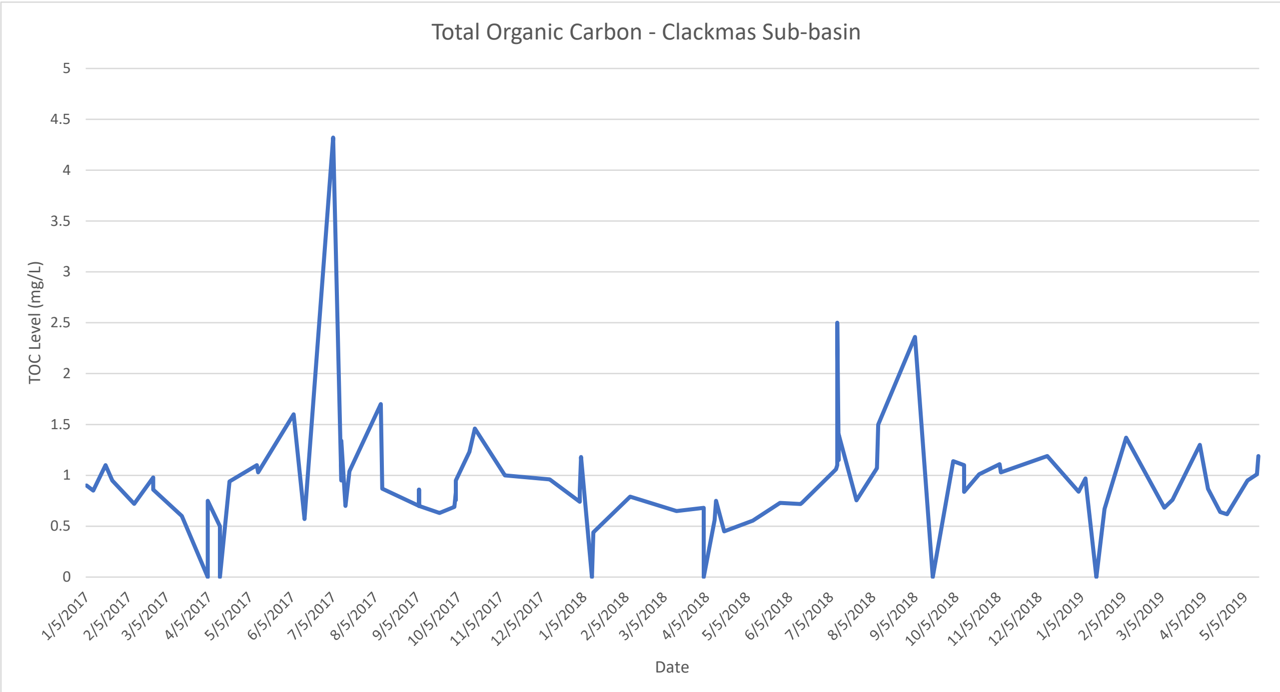
										Pre-Fire Basin						Post-Fire Basin						Total Organic Matter			Organic Matter (<0.030 mm)**			
												Fractional Proportion						Fractional Proportion				Unburned	Burned		Unburned	Burned		
Subbasin	Wildfire Name	PWS ID	Water System Name	Ownership Type	Source Type	Modeled	Burn Area	Notes	Contribution Area (acre)	2-yr Runoff Event (cfs)	Total Sediment Discharge (ton/yr)	Sand	Silt	Clay	Organic Matter*	2-yr Runoff Event (cfs)	Total Sediment Discharge (ton/yr)	Sand	Silt	Clay	Organic Matter*	Organic Matter Loading (ton/yr)	Organic Matter Loading (ton/yr)	Percent Increase (ton/yr)	Organic Matter Loading (ton/yr)	Organic Matter Loading (ton/yr)	Percent Increase (ton/yr)	Organic Loading Concern
Clackamas Subbasin	Riverside (relatively minor inputs from Beachie Creek, Lionshead)	OR4100279	ESTACADA, CITY OF	Local Government	Surface Intake	No	No	too far from headwaters. Most of the burn is above dams on the clackamas river. There is spot fire right upstream of the intake (below Faraday Lake) but no actual tribs to model. Low soil burn severity near the intake																				L
Clackamas Subbasin	Riverside (relatively minor inputs from Beachie Creek, Lionshead)	OR4101542	LAKE OSWEGO - TIGARD WATER SUPPLY	Local Government	Surface Intake	No	No	too far from headwaters and fire boundary. Multiple dams on the Clackamas river though downstream of the fire.																				L
Clackamas Subbasin	Riverside (relatively minor inputs from Beachie Creek, Lionshead)	OR4100591	SOUTH FORK WATER BOARD	Local Government	Surface Intake	No	No	too far from headwaters and fire boundary. Multiple dams on the Clackamas river though downstream of the fire.																				L
Clackamas Subbasin	Riverside (relatively minor inputs from Beachie Creek, Lionshead)	OR4100580	NORTH CLACKAMAS COUNTY WC - MF	Local Government	Surface Intake	No	No	too far from headwaters and fire boundary. Multiple dams on the Clackamas river though downstream of the fire. I wouldn't be too concerned. A small spot fire near Bonnie Lure State Park - I don't see a SBS map for that but I think it must have been a part of Riverside.																				L
Clackamas Subbasin	Riverside (relatively minor inputs from Beachie Creek, Lionshead)	OR4100580	NORTH CLACKAMAS COUNTY WC - SSF	Local Government	Surface Intake	No	No	too far from headwaters and fire boundary. Multiple dams on the Clackamas river though downstream of the fire.																				L
Clackamas Subbasin	Riverside (relatively minor inputs from Beachie Creek, Lionshead)	OR4100187	CLACKAMAS RIVER WATER - CLACKAMAS	Local Government	Surface Intake	No	No	too far from headwaters and fire boundary																				L
McKenzie Subbasin	Holiday Farm	OR4100287	EUGENE WATER & ELECTRIC BOARD	Local Government	Surface Intake	No	No	too far from headwaters and fire boundary																				L
McKenzie Subbasin	Holiday Farm	OR4100152	BROWNSVILLE, CITY OF	Local Government	Surface Intake	No	No	too far from headwaters and fire boundary																				L
McKenzie Subbasin	Holiday Farm	OR4100839	RAINBOW WATER DISTRICT - 5 wells , but only 1 is GU	Local Government	Surface Intake	No	No	too far from headwaters and fire boundary																				L
McKenzie Subbasin	Holiday Farm	OR4100837	SPRINGFIELD UTILITY BOARD - GU	Local Government	Surface Intake	No	No	too far from headwaters and fire boundary																				L
McKenzie Subbasin	Holiday Farm	OR4100835	SHANGRI LA WATER DISTRICT - GU	Local Government	Surface Intake	No	No	too far from headwaters and fire boundary																				L
Molalla-Pudding Subbasin	Beachie Creek, Riverside	OR4100534	MOLALLA, CITY OF	Local Government	Surface Intake	Yes	Yes	Additionally, each of the NF Molalla drainages were modeled too. Soils Folder under wepp/Riverside	130000	1100	160000	0.51	0.368	0.122	0.052	12000	180000	0.487	0.386	0.127	0.055	8320	9900	18.99%	8374.08	9806.94	17.11%	M
Molalla-Pudding Subbasin	Beachie Creek	OR4100823	SILVERTON, CITY OF - Abiqua	Local Government	Surface Intake	No	No	too far from headwaters and fire boundary.																				L
Molalla-Pudding Subbasin	Beachie Creek	OR4100823	SILVERTON, CITY OF - Silver	Local Government	Surface Intake	No	No	too far from headwaters and fire boundary																				L
Molalla-Pudding Subbasin	Riverside	OR4100202	COLTON WATER DISTRICT	Local Government	Surface Intake	Yes	Yes		2100	260	1600	0.595	0.31	0.095	0.041	250	1600	0.594	0.311	0.095	0.041	65.6	65.6	0.00%	65.208	65.208	0.00%	L
Molalla-Pudding Subbasin	Riverside	OR4100157	CANBY UTILITY - IG - Springs Gallery	Local Government	Surface Intake	No	No	Very far from any fire. There shouldn't be much concern here																				L
Molalla-Pudding Subbasin	Riverside	OR4100157	CANBY UTILITY - Molalla R.	Local Government	Surface Intake	No	No	Very far from any fire. There shouldn't be much concern here																				L
Other Subbasin	Echo Mountain Complex	OR4100603	PANTHER CREEK WD	Local Government	Surface Intake	Yes	Yes		1000	98	140	0.554	0.354	0.092	0.04	100	180	0.514	0.386	0.1	0.043	5.6	7.74	38.21%	5.52552	7.722	39.75%	H
Other Subbasin	Slater	OR4100971	CAVE JUNCTION, CITY OF	Local Government	Surface Intake	Yes	Yes		150000	28000	590000	0.472	0.37	0.158	0.068	30000	730000	0.444	0.39	0.165	0.071	40120	51830	29.19%	39991.38	51673.05	29.21%	H
Other Subbasin	Hager Ridge,Horse	OR4100613	PENDLETON, CITY OF	Local Government	Surface Intake	No	No	Very far from any fire and these fires were very tiny it would be unlikely they'd see any change. There shouldn't be much concern here																				L
Rogue Subbasin	South Obenchain	OR4101520	HILAND WC - SHADY COVE	Private	Surface Intake	Yes	Yes	Modeled a trib directly above this intake - it is the only trib that is an area of influence with any fire.	7500	420	520	0.481	0.378	0.141	0.06	420	580	0.475	0.377	0.147	0.063	31.2	36.54	17.12%	31.45428	36.57654	16.28%	M
Rogue Subbasin	South Obenchain	OR4101483	ANGLERS COVE/SCHWC	Private	Surface Intake	No	No	too far from headwaters and fire boundary																				L
Rogue Subbasin	South Obenchain	OR4100808	COUNTRY VIEW MH ESTATES	Private	Surface Intake	No	No	No fire upstream to influence this intake																				L
Rogue Subbasin	South Obenchain, Almeda (downstream of Gold Hill)	OR4100712	ROGUE RIVER, CITY OF	Local Government	Surface Intake	No	No	too far from headwaters and fire boundary																				L
Rogue Subbasin	South Obenchain	OR4100513	MEDFORD WATER COMMISSION	Local Government	Surface Intake	No	No	too far from headwaters and fire boundary																				L
Rogue Subbasin	Steinmetz Creek, South Obenchain, Almeda	OR4100342	GRANTS PASS, CITY OF	Local Government	Surface Intake	No	No	too far from headwaters and fire boundary																				L
Rogue Subbasin	South Obenchain, Almeda	OR4100333	GOLD HILL, CITY OF	Local Government	Surface Intake	No	No	too far from headwaters and fire boundary																				L
Santiam Subbasin	Lionshead	OR4193461	BREITENBUSH HOT SPRINGS	Private	Surface Intake	Yes	Yes		34000	1900	12000	0.493	0.408	0.099	0.042	2100	17000	0.479	0.414	0.107	0.046	504	782	55.16%	509.652	780.351	53.11%	H
Santiam Subbasin	Beachie Creek	OR4106169	OPAL CREEK ANCIENT FOREST CTR	Private	Surface Intake	Yes	Yes		360	49	730	0.575	0.331	0.094	0.04	58	2300	0.558	0.344	0.098	0.042	29.2	96.6	230.82%	29.43798	96.6966	228.48%	VH

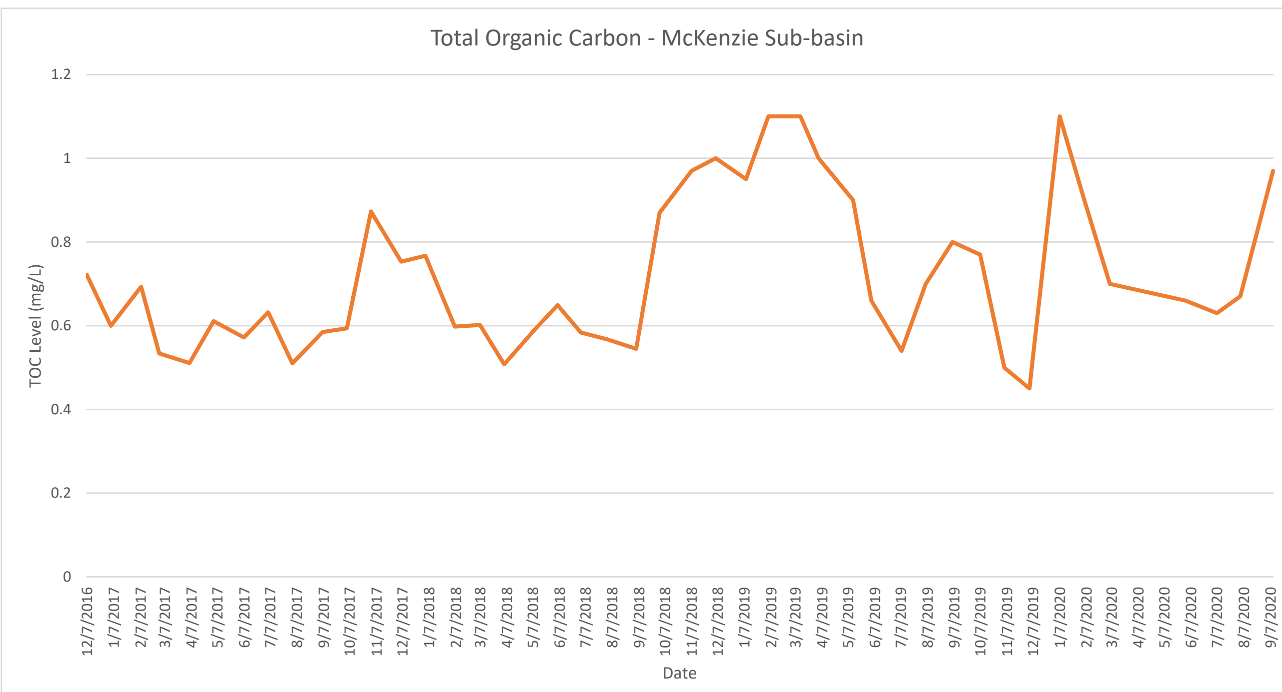
										Pre-Fire Basin						Post-Fire Basin						Total Organic Matter			Organic Matter (<0.030 mm)**			
												Fractional Proportion						Fractional Proportion				Unburned	Burned		Unburned	Burned		
Subbasin	Wildfire Name	PWS ID	Water System Name	Ownership Type	Source Type	Modeled	Burn Area	Notes	Contribution Area (acre)	2-yr Runoff Event (cfs)	Total Sediment Discharge (ton/yr)	Sand	Silt	Clay	Organic Matter*	2-yr Runoff Event (cfs)	Total Sediment Discharge (ton/yr)	Sand	Silt	Clay	Organic Matter*	Organic Matter Loading (ton/yr)	Organic Matter Loading (ton/yr)	Percent Increase (ton/yr)	Organic Matter Loading (ton/yr)	Organic Matter Loading (ton/yr)	Percent Increase (ton/yr)	Organic Loading Concern
Santiam Subbasin	Beachie Creek	OR4100843	STAYTON WATER SUPPLY	Local Government	Surface Intake	No	No	Too far from headwaters and fire. Many tribs along the mainstem were modeled though for ETART																				L
Santiam Subbasin	Beachie Creek	OR4100731	SALEM PUBLIC WORKS	Local Government	Surface Intake	No	No	Too far from headwaters and fire. Many tribs along the mainstem were modeled though for ETART																				L
Santiam Subbasin	Beachie Creek	OR4100493	LYONS MEHAMA WATER DISTRICT	Local Government	Surface Intake	No	No	Too far from headwaters. Streams upriver of intake - Polly Creek, Jeeter Creek, Kiel Creek, Canyon Creek, a trib, and other tribs upstream were modeled for ETART.																				L
Santiam Subbasin	Beachie Creek, Lionshead	OR4100317	GATES, CITY OF	Local Government	Surface Intake	Yes	Yes		290000	8800	120000	0.533	0.36	0.107	0.046	8900	140000	0.521	0.365	0.114	0.049	5520	6860	24.28%	5508.36	6846.84	24.30%	M
Santiam Subbasin	Beachie Creek, Lionshead	OR4100257	DETROIT WATER SYSTEM - Breitenbush River	Local Government	Surface Intake	Yes	Yes		66000	3200	27000	0.575	0.34	0.085	0.037	3700	34000	0.537	0.367	0.096	0.041	999	1394	39.54%	984.555	1400.256	42.22%	H
Santiam Subbasin	Lionshead	OR4100257	DETROIT WATER SYSTEM - Mackey Cr.	Local Government	Surface Intake	Yes	Yes		170	25	180	0.513	0.362	0.125	0.054	28	770	0.479	0.384	0.137	0.059	9.72	45.43	367.39%	9.6525	45.25521	368.84%	VH
Santiam Subbasin	Beachie Creek	OR4100954	WILSONVILLE, CITY OF	Local Government	Surface Intake	No	No	Reasonably would not be impacted by fire																				L
Santiam Subbasin	Holiday Farm	OR4100473	LEBANON, CITY OF	Local Government	Surface Intake	No	No	too far from headwaters and fire boundary																				L
Santiam Subbasin	Beachie Creek, Lionshead	OR4100408	JEFFERSON, CITY OF	Local Government	Surface Intake	No	No	too far from headwaters and fire boundary																				L
Santiam Subbasin	Lionshead	OR4100394	IDANHA CITY WATER - Mud Puppy	Local Government	Surface Intake	Yes	Yes		63	8	66	0.543	0.323	0.134	0.058	8	66	0.543	0.323	0.134	0.058	3.828	3.828	0.00%	3.794076	3.794076	0.00%	L
Santiam Subbasin	Lionshead	OR4100394	IDANHA CITY WATER - Rainbow	Local Government	Surface Intake	Yes	Yes		460	76	670	0.43	0.444	0.126	0.054	83	850	0.415	0.457	0.128	0.055	36.18	46.75	29.22%	36.21618	46.6752	28.88%	H
Santiam Subbasin	Beachie Creek	OR4100012	ALBANY, CITY OF - CF - S. Santiam/Leb-Albany Canal	Local Government	Surface Intake	No	No	too far from headwaters and fire boundary																				L
Santiam Subbasin	Beachie Creek	OR4100012	ALBANY, CITY OF - MF - Santiam R.	Local Government	Surface Intake	No	No	too far from headwaters and fire boundary																				L
Umpqua Subbasin	Archie Creek	OR4101095	USFS WOLF CREEK JOB CORPS	Federal Agency	Surface Intake	Yes	Yes		56000	2100	11000	0.28	0.559	0.161	0.069	2100	12000	0.278	0.557	0.165	0.071	759	852	12.25%	759.759	849.42	11.80%	M
Umpqua Subbasin	Archie Creek	OR4101091	USFS STEAMBOAT WORK CENTER	Federal Agency	Surface Intake	No	Yes	North Umpqua river is too large.																				L
Umpqua Subbasin	Archie Creek	OR4100847	SUTHERLIN, CITY OF - Calapooya Cr	Local Government	Surface Intake	Yes	Yes		53000	12000	120000	0.405	0.414	0.181	0.077	13000	150000	0.404	0.415	0.18	0.077	9240	11550	25.00%	9317.88	11583	24.31%	M
Umpqua Subbasin	Archie Creek (downstream of Sutherlin)	OR4100581	OAKLAND, CITY OF	Local Government	Surface Intake	No	No	too far from headwaters and fire boundary																				L
Umpqua Subbasin	Archie Creek	OR4100326	GLIDE WATER ASSOCIATION	Private	Surface Intake	No	Unknown	Too large of a watershed to model. You may be able to pull trib data from other Archie modeling... Rock creek is the closest drainage to this location																				L
Umpqua Subbasin	Archie Creek	OR4193438	TIMBER RIVER RV PARK	Private	Surface Intake	No	Unknown	Along N. Umpqua river too large of a watershed to model the mainstem - You could look at smaller tribs closer to the intake where the fire burned though?																				L
Umpqua Subbasin	Archie Creek (downstream of Glide)	OR4192152	CASCADE PACIFIC PULP LLC - Willamette River	Private	Surface Intake	No	No	too far from headwaters and fire boundary																				L
Umpqua Subbasin	Thielsen	OR4101012	PP&L-TOKETEE VILLAGE	Private	Surface Intake	No	No	too far from headwaters and fire boundary																				L
Umpqua Subbasin	Archie Creek	OR4100847	SUTHERLIN, CITY OF - Cooper Cr	Local Government	Surface Intake	No	Yes	This is the Calapooya river not cooper																				L
Umpqua Subbasin	Archie Creek	OR4100720	ROSEBURG, CITY OF	Local Government	Surface Intake	No	Unknown	this is in a cooper creek subwatershed of the North Umpqua river. Too large of a headwater.																				L
Umpqua Subbasin	Archie Creek (downstream of Glide)	OR4100719	UMPQUA BASIN WATER ASSOC	Private	Surface Intake	No	No	too far from headwaters and fire boundary																				L
Umpqua Subbasin	Archie Creek (downstream of Glide)	OR4100276	ELKTON, CITY OF	Local Government	Surface Intake	No	No	too far from headwaters and fire boundary																				L

*Note: Organic Matter is the percentage of the entire sediment loading.

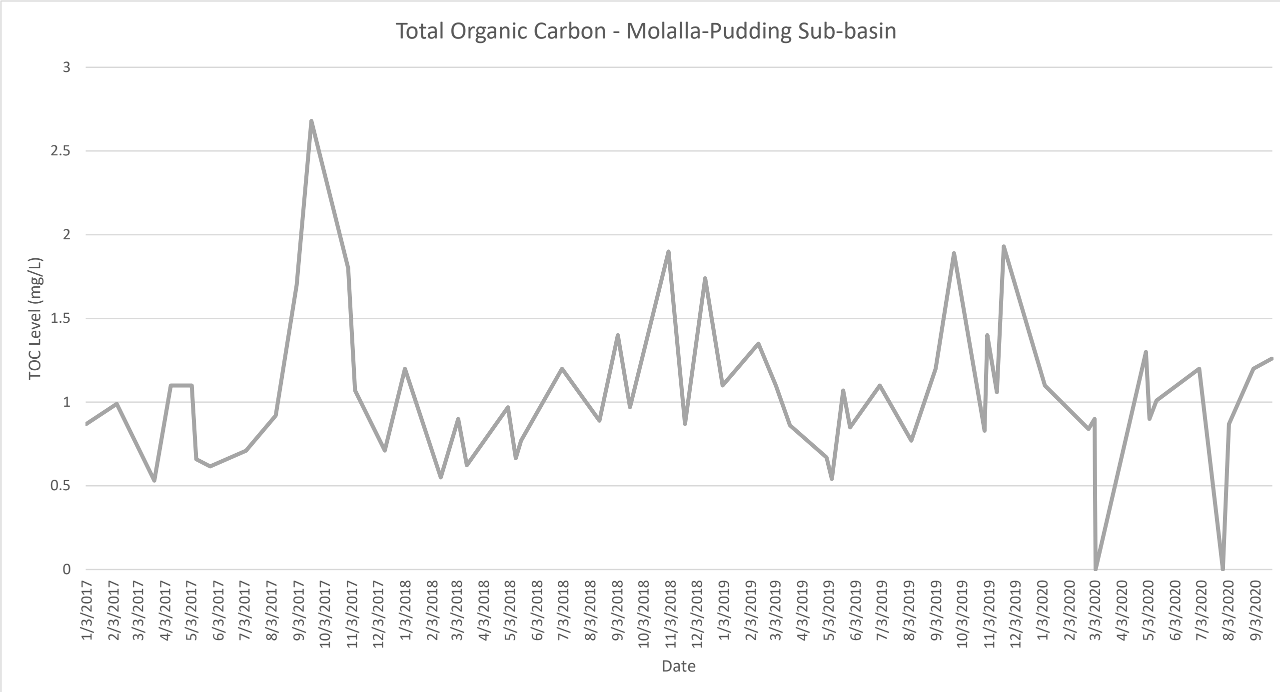
**Note: Settable Organic Matter was determined from the model's settings for the clay fraction containing 42.9% organic matter.

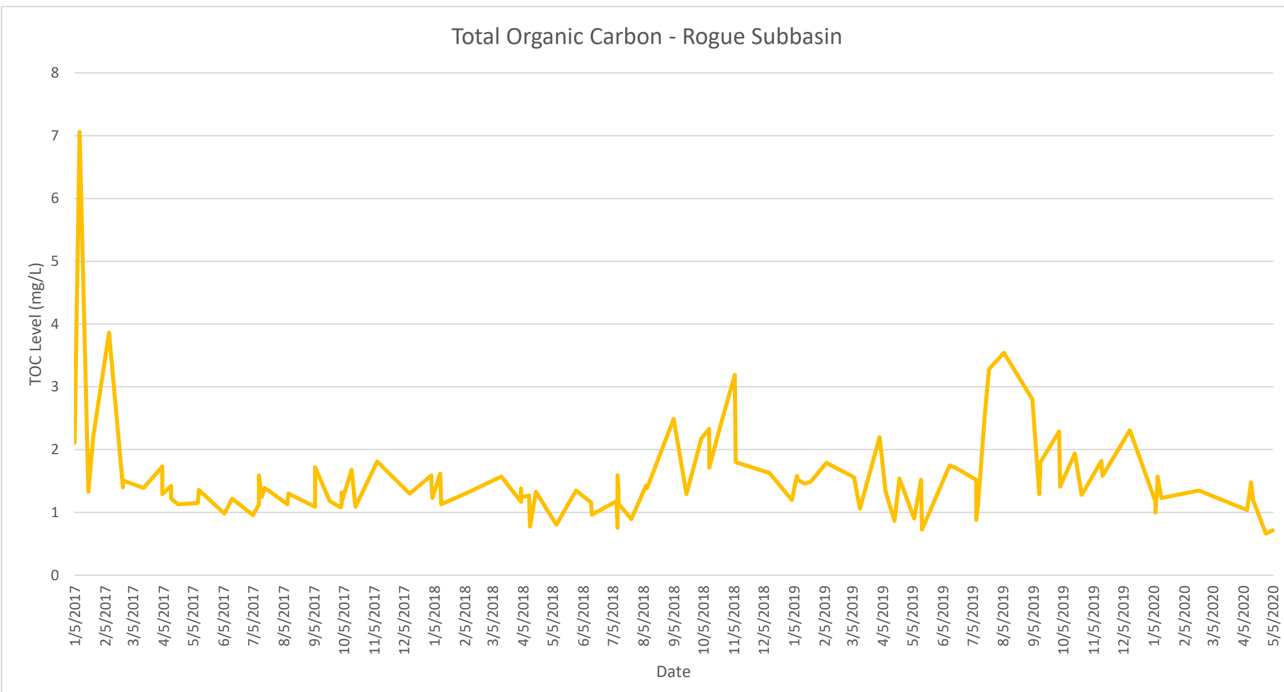
Raw Water at Surface Water Intake
Average Total Organic Carbon
(Conventional Treatment Plants)



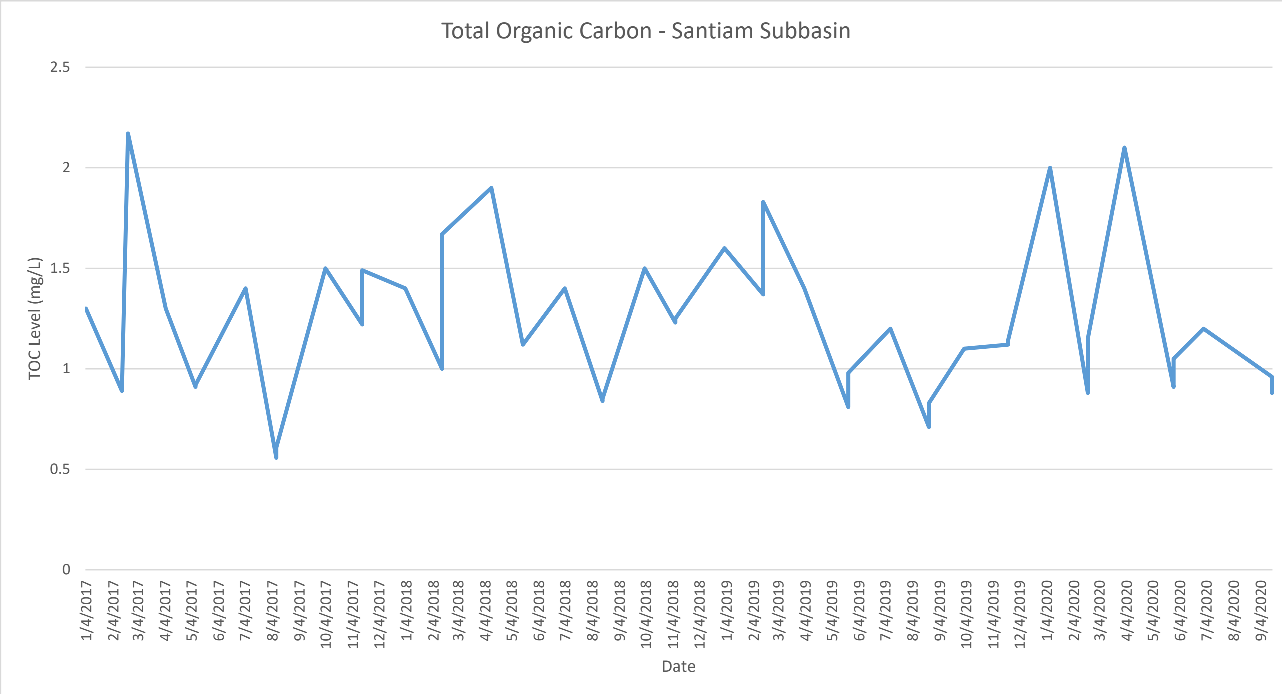


Raw Water at Surface Water Intake
Average Total Organic Carbon
(Conventional Treatment Plants)





Raw Water at Surface Water Intake
Average Total Organic Carbon
(Conventional Treatment Plants)



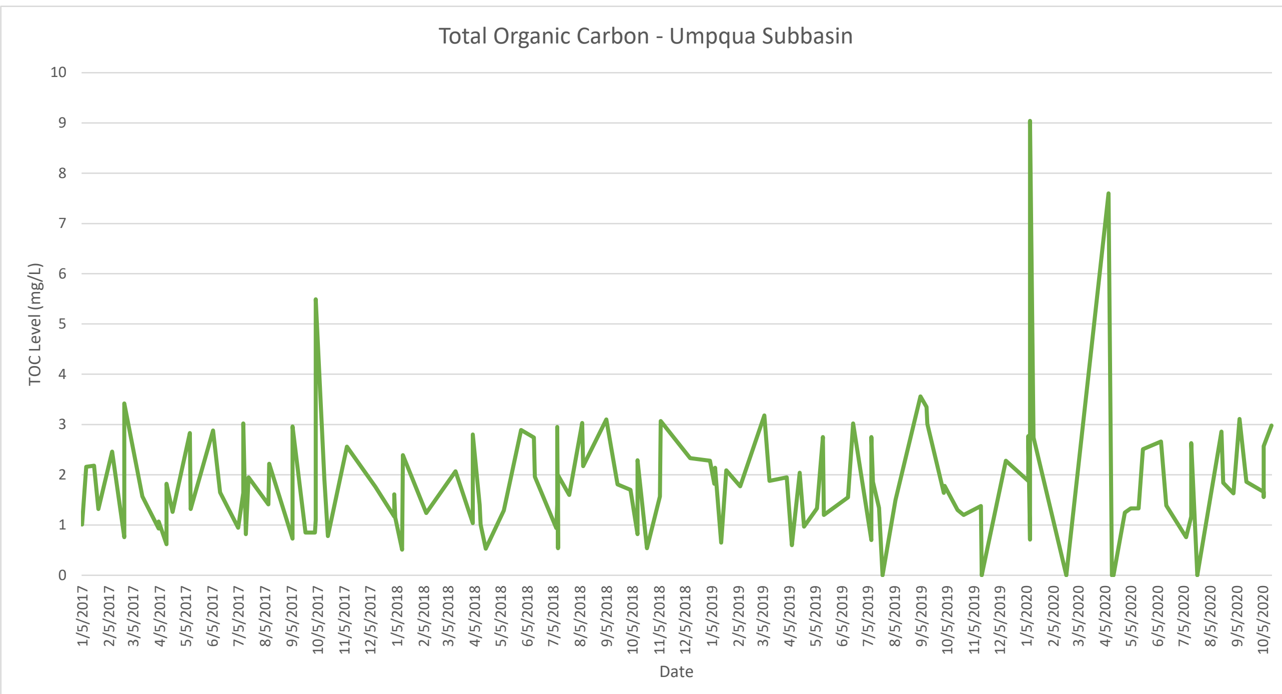


Table B.9: Total Trihalomethanes (TTHMs) and Haloacetic Acids (HAA5s) Summary

Max TTHM Last 2 YRS	Max HAA5 Last 2 YRS	TTHM Concern	HAA5 Concern	Subbasin	PWSID	PWS Name	Filter Type	Pre-Treatment
0.0784	0.0567	H	H	Santiam Subbasin	OR00317	GATES, CITY OF	Membrane	None (MF, CL2, and Soda Ash)
0.0731	0.0394	M	M	Rogue Subbasin	OR01520	HILAND WC - SHADY COVE	Membrane	None
0.061	0.044	M	M	Rogue Subbasin	OR00342	GRANTS PASS, CITY OF	Conventional	ACH and KMnO4
0.06	0.011	M	L	Umpqua Subbasin	OR92152	CASCADE PACIFIC PULP LLC	Direct	Polyamines and Cl2
0.0599	0.0386	M	M	Umpqua Subbasin	OR01095	USFS WOLF CREEK JOB CORPS	Membrane	None
0.052	0.025	M	L	Santiam Subbasin	OR00012	ALBANY, CITY OF (S Santiam/Leb-Albany Canal)	Conventional	ACH
0.052	0.025	M	L	Santiam Subbasin	OR00012	ALBANY, CITY OF (Santiam R.)	Membrane	ACH
0.0501	0.0273	M	L	Rogue Subbasin	OR00808	COUNTRY VIEW MH ESTATES	Conventional	unknown
0.046	0.026	M	L	Santiam Subbasin	OR00473	LEBANON, CITY OF	Membrane	ACH and Chlorine
0.0433	0.0318	M	M	Umpqua Subbasin	OR00276	ELKTON, CITY OF	Conventional	Alum sulfide
0.042	0.042	M	M	Santiam Subbasin	OR00731	SALEM PUBLIC WORKS	Slow Sand	PAC
0.039	0.034	L	M	Clackamas Subbasin	OR00187	CLACKAMAS RIVER WATER - CLACKAMAS	Direct	Cl2, alum, ACH, floc w PAC seasonal for
0.0382	0.0258	L	L	Santiam Subbasin	OR93461	BREITENBUSH HOT SPRINGS	Cartridge	None (CT and CL2 Only)
0.033	0.0439	L	M	Umpqua Subbasin	OR00719	UMPQUA BASIN WATER ASSOC	Membrane	ACH and Miox
0.031	0.044	L	M	McKenzie Subbasin	OR00837	SPRINGFIELD UTILITY BOARD	Slow Sand	Bank filtration
0.031	0.024	L	L	Other Subbasin	OR00613	PENDLETON, CITY OF	Membrane	Coag/rapid mix/floc (MF)
0.03	0.024	L	L	Other Subbasin	OR00603	PANTHER CREEK WD	Slow Sand	None
0.029	0.024	L	L	Umpqua Subbasin	OR00581	OAKLAND, CITY OF	Conventional	ACH
0.0283	0.0211	L	L	Santiam Subbasin	OR00843	STAYTON WATER SUPPLY	Slow Sand	Pre CL2 (SSF, soda ash and post CL2)
0.0272	0.00434	L	L	Santiam Subbasin	OR00493	LYONS MEHAMA WATER DISTRICT	Slow Sand	None
0.027	0.039	L	M	Molalla-PuddingSubbasin	OR00202	COLTON WATER DISTRICT	Conventional	chlorine & PACL, then floc and tubes
0.027	0.0266	L	L	Rogue Subbasin	OR00333	GOLD HILL, CITY OF	Conventional	Alum
0.0252	0.0144	L	L	Clackamas Subbasin	OR00591	SOUTH FORK WATER BOARD	Conventional	polymer & alum then, hyraulic floc & se
0.0252	0.0115	L	L	Rogue Subbasin	OR00712	ROGUE RIVER, CITY OF	Conventional	Alum
0.024	0.017	L	L	Molalla-PuddingSubbasin	OR00157	CANBY UTILITY (Molalla)	Conventional	Cationic coagulant, then either CAC or
0.024	0.017	L	L	Molalla-PuddingSubbasin	OR00157	CANBY UTILITY (I.G.-Springs Gallery)	Conventional	Cationic coagulant, then either CAC or
0.0237	0.0117	L	L	Santiam Subbasin	OR00394	IDANHA CITY WATER (mud Puppy, only one in OHA dataset)	Membrane	Ability to feed PACL, but not used
0.0234	0.0282	L	L	Umpqua Subbasin	OR00847	SUTHERLIN, CITY OF (Calapooya)	Conventional	PACL, KMnO4, Miox
0.0234	0.0282	L	L	Umpqua Subbasin	OR00847	SUTHERLIN, CITY OF (Cooper Cr)	Direct	PACL, KMnO4, Miox
0.023	0.023	L	L	Umpqua Subbasin	OR00720	ROSEBURG, CITY OF	Conventional	Miox and ACH
0.021	0.006	L	L	Santiam Subbasin	OR00954	WILSONVILLE, CITY OF	Conventional	Alum, cationic polymer, & caustic some
0.0207	0.00742	L	L	McKenzie Subbasin	OR00152	BROWNSVILLE, CITY OF	Slow Sand	None
0.019	0.021	L	L	Rogue Subbasin	OR00513	MEDFORD WATER COMMISSION	Conventional	CO2, Ozone, Cl2, PAC and PACl
0.0187	0.0153	L	L	Santiam Subbasin	OR00257	DETROIT WATER SYSTEM (Breitenbush R.)	Slow Sand	None (SSF and CL2 only)
0.0187	0.0153	L	L	Santiam Subbasin	OR00257	DETROIT WATER SYSTEM (Mackey)	Slow Sand	None (SSF and CL2 only)
0.018	0.02	L	L	Other Subbasin	OR00971	CAVE JUNCTION, CITY OF	Direct	Alum
0.017	0.0098	L	L	McKenzie Subbasin	OR00287	EUGENE WATER & ELECTRIC BOARD	Conventional	None
0.016	0.018	L	L	Clackamas Subbasin	OR00279	ESTACADA, CITY OF	Conventional	soda ash & alum, then floc, then tubes
0.015	0.013	L	L	Molalla-PuddingSubbasin	OR00534	MOLALLA, CITY OF	Conventional	ACH, non-ionic polymer, then CAC
0.0141	0.0102	L	L	Molalla-PuddingSubbasin	OR00823	SILVERTON, CITY OF (abiqua)	Conventional	Coag/rapid mix/floc (CF plant)
0.0141	0.0102	L	L	Molalla-PuddingSubbasin	OR00823	SILVERTON, CITY OF (silver)	Conventional	Coag/rapid mix/floc (CF plant)
0.0137	0.0062	L	L	Umpqua Subbasin	OR00326	GLIDE WATER ASSOCIATION	Direct	PACL and Soda Ash
0.012	0.0123	L	L	Rogue Subbasin	OR01483	ANGLERS COVE/SCHWC	Direct	ACH
0.0107	0.0073	L	L	Clackamas Subbasin	OR00580	NORTH CLACKAMAS COUNTY WC	Slow Sand	None
0.0107	0.0073	L	L	Clackamas Subbasin	OR00580	NORTH CLACKAMAS COUNTY WC	Membrane	Microscreens then PAC, ACH, & someti
0.009	0.0089	L	L	Umpqua Subbasin	OR01012	PP&L-TOKETEE VILLAGE	Conventional	PACL and Soda Ash
0.0062	ND	L	L	McKenzie Subbasin	OR00835	SHANGRI LA WATER DISTRICT	Conventional	Bank filtration
0.0022	ND	L	L	McKenzie Subbasin	OR00839	RAINBOW WATER DISTRICT	Cartridge	Bank filtration

Table B.10: Total Trihalomethanes (TTHMs) and Haloacetic Acids (HAA5s) Summary by Basin

Subbasin	Max TTHM Last 2 YRS	Max HAA5 Last 2 YRS	TTHM Concern	HAA5 Concern	PWSID	PWS Name	Filter Type	Pre-Treatment	Average of the Max TTHM (mg/L)	Average of the Max HAA5 (mg/L)
Clackamas Subbasin	0.039	0.034	L	M	OR00187	CLACKAMAS RIVER WATER - CLACKAMAS	Direct	Cl2, alum, ACH, floc w PAC seasonal for HABS, sed basins, then filter aid pre filters	0.020	0.016
Clackamas Subbasin	0.0252	0.0144	L	L	OR00591	SOUTH FORK WATER BOARD	Conventional	polymer & alum then, hyraulic floc & sed basins w/ filter aid		
Clackamas Subbasin	0.016	0.018	L	L	OR00279	ESTACADA, CITY OF	Conventional	soda ash & alum, then floc, then tubes & plates		
Clackamas Subbasin	0.0107	0.0073	L	L	OR00580	NORTH CLACKAMAS COUNTY WC	Slow Sand	None		
Clackamas Subbasin	0.0107	0.0073	L	L	OR00580	NORTH CLACKAMAS COUNTY WC	Membrane	Microscreens then PAC, ACH, & sometimes chlorine, w/ floc basins		
McKenzie Subbasin	0.031	0.044	L	M	OR00837	SPRINGFIELD UTILITY BOARD	Slow Sand	Bank filtration	0.015	0.020
McKenzie Subbasin	0.0207	0.00742	L	L	OR00152	BROWNSVILLE, CITY OF	Slow Sand	None		
McKenzie Subbasin	0.017	0.0098	L	L	OR00287	EUGENE WATER & ELECTRIC BOARD	Conventional	None		
McKenzie Subbasin	0.0062	ND	L	L	OR00835	SHANGRI LA WATER DISTRICT	Conventional	Bank filtration		
McKenzie Subbasin	0.0022	ND	L	L	OR00839	RAINBOW WATER DISTRICT	Cartridge	Bank filtration		
Molalla-PuddingSubbasin	0.027	0.039	L	M	OR00202	COLTON WATER DISTRICT	Conventional	chlorine & PACL, then floc and tubes	0.020	0.018
Molalla-PuddingSubbasin	0.024	0.017	L	L	OR00157	CANBY UTILITY (Molalla)	Conventional	Cationic coagulant, then either CAC or hydr floc & sed		
Molalla-PuddingSubbasin	0.024	0.017	L	L	OR00157	CANBY UTILITY (I.G.-Springs Gallery)	Conventional	Cationic coagulant, then either CAC or hydr floc & sed		
Molalla-PuddingSubbasin	0.015	0.013	L	L	OR00534	MOLALLA, CITY OF	Conventional	ACH, non-ionic polymer, then CAC		
Molalla-PuddingSubbasin	0.0141	0.0102	L	L	OR00823	SILVERTON, CITY OF (abiqua)	Conventional	Coag/rapid mix/floc (CF plant)		
Molalla-PuddingSubbasin	0.0141	0.0102	L	L	OR00823	SILVERTON, CITY OF (silver)	Conventional	Coag/rapid mix/floc (CF plant)		
Other Subbasin	0.031	0.024	L	L	OR00613	PENDLETON, CITY OF	Membrane	Coag/rapid mix/floc (MF)	0.026	0.023
Other Subbasin	0.03	0.024	L	L	OR00603	PANTHER CREEK WD	Slow Sand	None		
Other Subbasin	0.018	0.02	L	L	OR00971	CAVE JUNCTION, CITY OF	Direct	Alum		
Rogue Subbasin	0.0731	0.0394	M	M	OR01520	HILAND WC - SHADY COVE	Membrane	None	0.038	0.026
Rogue Subbasin	0.061	0.044	M	M	OR00342	GRANTS PASS, CITY OF	Conventional	ACH and KMnO4		
Rogue Subbasin	0.0501	0.0273	M	L	OR00808	COUNTRY VIEW MH ESTATES	Conventional	unknown		
Rogue Subbasin	0.027	0.0266	L	L	OR00333	GOLD HILL, CITY OF	Conventional	Alum		
Rogue Subbasin	0.0252	0.0115	L	L	OR00712	ROGUE RIVER, CITY OF	Conventional	Alum		
Rogue Subbasin	0.019	0.021	L	L	OR00513	MEDFORD WATER COMMISSION	Conventional	CO2, Ozone, Cl2, PAC and PACl		
Rogue Subbasin	0.012	0.0123	L	L	OR01483	ANGLERS COVE/SCHWC	Direct	ACH		
Santiam Subbasin	0.0784	0.0567	H	H	OR00317	GATES, CITY OF	Membrane	None (MF, CL2, and Soda Ash)	0.037	0.023
Santiam Subbasin	0.052	0.025	M	L	OR00012	ALBANY, CITY OF (S Santiam/Leb-Albany Canal)	Conventional	ACH		
Santiam Subbasin	0.052	0.025	M	L	OR00012	ALBANY, CITY OF (Santiam R.)	Membrane	ACH		
Santiam Subbasin	0.046	0.026	M	L	OR00473	LEBANON, CITY OF	Membrane	ACH and Chlorine		
Santiam Subbasin	0.042	0.042	M	M	OR00731	SALEM PUBLIC WORKS	Slow Sand	PAC		
Santiam Subbasin	0.0382	0.0258	L	L	OR93461	BREITENBUSH HOT SPRINGS	Cartridge	None (CT and CL2 Only)		
Santiam Subbasin	0.0283	0.0211	L	L	OR00843	STAYTON WATER SUPPLY	Slow Sand	Pre CL2 (SSF, soda ash and post CL2)		
Santiam Subbasin	0.0272	0.00434	L	L	OR00493	LYONS MEHAMA WATER DISTRICT	Slow Sand	None		
Santiam Subbasin	0.0237	0.0117	L	L	OR00394	IDANHA CITY WATER (mud Puppy, only one in OHA dataset)	Membrane	Ability to feed PACL, but not used		

Table B.10: Total Trihalomethanes (TTHMs) and Haloacetic Acids (HAA5s) Summary by Basin

Subbasin	Max TTHM Last 2 YRS	Max HAA5 Last 2 YRS	TTHM Concern	HAA5 Concern	PWSID	PWS Name	Filter Type	Pre-Treatment	Average of the Max TTHM (mg/L)	Average of the Max HAA5 (mg/L)
Santiam Subbasin	0.021	0.006	L	L	OR00954	WILSONVILLE, CITY OF	Conventional	Alum, cationic polymer, & caustic sometimes, then ballasted floc w/ lamella plates, ozone		
Santiam Subbasin	0.0187	0.0153	L	L	OR00257	DETROIT WATER SYSTEM (Breitenbush R.)	Slow Sand	None (SSF and CL2 only)		
Santiam Subbasin	0.0187	0.0153	L	L	OR00257	DETROIT WATER SYSTEM (Mackey)	Slow Sand	None (SSF and CL2 only)		
Umpqua Subbasin	0.06	0.011	M	L	OR92152	CASCADE PACIFIC PULP LLC	Direct	Polyamines and Cl2	0.032	0.024
Umpqua Subbasin	0.0599	0.0386	M	M	OR01095	USFS WOLF CREEK JOB CORPS	Membrane	None		
Umpqua Subbasin	0.0433	0.0318	M	M	OR00276	ELKTON, CITY OF	Conventional	Alum sulfide		
Umpqua Subbasin	0.033	0.0439	L	M	OR00719	UMPQUA BASIN WATER ASSOC	Membrane	ACH and Miox		
Umpqua Subbasin	0.029	0.024	L	L	OR00581	OAKLAND, CITY OF	Conventional	ACH		
Umpqua Subbasin	0.0234	0.0282	L	L	OR00847	SUTHERLIN, CITY OF (Calapooya)	Conventional	PACL, KMnO4, Miox		
Umpqua Subbasin	0.0234	0.0282	L	L	OR00847	SUTHERLIN, CITY OF (Cooper Cr)	Direct	PACL, KMnO4, Miox		
Umpqua Subbasin	0.023	0.023	L	L	OR00720	ROSEBURG, CITY OF	Conventional	Miox and ACH		
Umpqua Subbasin	0.0137	0.0062	L	L	OR00326	GLIDE WATER ASSOCIATION	Direct	PACL and Soda Ash		
Umpqua Subbasin	0.009	0.0089	L	L	OR01012	PP&L-TOKETEE VILLAGE	Conventional	PACL and Soda Ash		

Appendix C

Public and Private Drinking Water System Resources

(Oregon Health Authority Optimization Recommendations)
(Oregon Approved Laboratories)

Optimizing Water Treatment Plants After a Wildfire

OHA Drinking Water Services
October 2020

The purpose of this document is to alert operators of things to consider following a wildfire and provide options to surface water treatment plants to optimize existing treatment to address potential impacts to water quality. Impacts to water quality can include changes in:

- The amount and timing of snowmelt and runoff from storms. Storm events can lead to flash flooding, higher floodwaters, and shorter times to peak flows,
- Raw water quality from build-up of ash, soil erosion, and fire debris, taste, color and smell of drinking water;
- Phosphate, nitrate, and nitrite runoff (firefighting agents may lead to short-lived run-off of phosphates, ammonia,)
- Naturally occurring metals (iron, manganese, arsenic, asbestos, etc.)
- Algal blooms, some of which may produce algal toxins;
- pH and alkalinity. Deposition of ash after a fire can increase pH and alkalinity in soil and water
- Sediment and debris buildup around intake impoundments;
- Coagulation and disinfection required to address higher turbidity and TOC, which also often requires more frequent backwashing and solids/waste handling capabilities and alkalinity if using alum; Organic carbon resulting from fire is more humic and aromatic than pre-fire organic carbon and, therefore, more likely to produce DBPs.
- Risks to water bodies from landslides as well as risks to intakes, treatment plants, and other structures;
- Although the worst effects of fire occur in the first 1-2 years, watersheds may take from 4-8 years and streams can take 4-5 years to recover from a wildfire (Clark, 2010). Recovery varies based on underlying soils & bedrock, vegetation, slopes, stream chemistry, and severity of fire
- Operability of valves and other control systems that may have been damaged or affected by debris and sediment.

General strategies applicable to all surface water filtration systems:

The following strategies will help to prepare for and mitigate the impacts to source water and treatability from wildfires.

1. ***Employ a multiple barrier approach:***

   Water treatment plants employ the multiple barrier approach when they consider each unit process as providing a distinct barrier to contaminants. Water treatment plant optimization is the process of improving the performance of each process to achieve its maximum performance, often performing well beyond that required by regulation.

2. ***Practice:***

   Update operation and maintenance manuals and emergency response plans. Use table-top drills and exercises to practice optimization strategies so they can be implemented when needed – don't wait until the storms come!

3. ***Overall optimization strategies – source, treatment & distribution:***

   <u>Source:</u>

   a. Pay attention to storm events, flood warnings, and source water levels, flows, and/or turbidity levels as this can be an early warning of sudden rises in turbidity due to rain or landslides which can cause turbidity to increase to 1,000 – 10,000 NTU or more. Lowering raw water high turbidity alarms may also give you an earlier warning sign of rapid spikes in turbidity. Like a wave, plan to ride out these peak events by shutting off intake flows if you are able until raw water turbidity drops to more manageable levels and be ready to jar test frequently to ensure proper treatment.
   b. Ensure surface water intake impoundments are dredged or prepare to dredge at a higher frequency as these may be quickly silted in. Plan for emergency cleanout operations in preparation for landslides and debris flows. One storm after the Buffalo Creek Fire in Colorado produced 15 acres of debris, deposited 10 years' worth of sediment, and clogged the Denver Water delivery system and their raw water reservoir lost about 30 years of its planned life (Kennedy, 2011). Be mindful of the increased risk of falling trees and landslides following a wildfire and if possible, travel in pairs to the intake.

c. For water systems with intakes within multiple water layers, utilize the intake from the layer that may be least impacted by ash, sediment, algal blooms or cyanotoxins.

Treatment:

a. Evaluate/Increase ability to handle periods of high turbidity. Ash and clay-sized particles contribute to increases in total suspended solids. Anticipate operating at lower flows, shorter filter runs, increased backwashing, and having to override automation in order to meet demands.
b. If chemical contaminants or cyanotoxins are of concern, cease any recycling of process water, for example filter backwash water.
c. Do not apply algaecides during a cyanobacteria bloom as this risks cell lysis, or stressing the cells, potentially causing cyanotoxin release.
d. Treatment objectives may have to shift at times from turbidity removal to TOC removal which can be 5 times higher than normal levels, requiring higher coagulant doses or the use of activated carbon and more frequent jar testing.
e. Increase capability to add more coagulant (if applicable). Alkalinity may need to be increased if using Alum.
f. Ensure sedimentation basins, sludge detention basins and backwash handling facilities have been cleaned and are able to hand the excess wastewater and sludge. Discharge permits may need to be modified/approved to address higher wastewater and sludge disposal needs.
g. Leaching of ash washed into surface waters can release positively charged ions like calcium and magnesium, changing the electric potential of source waters, which may impact coagulation controlled by streaming current meters or zeta meters.
h. Anticipate the need to feed more chlorine due to oxidant demands. Additional oxidation may be needed to address TOC, taste, and odor concerns, however, be mindful of the potential impact to disinfection by-products. Organic carbon resulting from fire is more humic and aromatic than pre-fire organic carbon and, therefore, more likely to produce DBPs.

Distribution:

a. Anticipate/evaluate the ability to meet demands using available storage in case the plant needs to be taken off-line for extended periods of time. Also prepare for issuing notices for water conservation/curtailment.
b. Ensure distribution valves are operational as the frequency of line breaks may increase.
c. Replenish emergency supplies, fuel for back-up generators, treatment chemicals, waterline repair bands, valves, etc.
d. Evaluate operations staffing levels should treatment need to extend run times from having to backwash more often or slow production to handled high turbidity. Also consider higher demands placed upon distribution system operators.
e. Identify/exercise alternate sources or interties with other nearby water systems.

The following information and strategies are specific to filtration type.

4. *Membrane Filtration:*

a. Membranes can generally handle very high feed turbidity provided trans-membrane pressures (TMP) are kept within an acceptable range by lowering flows and increasing backwashing and cleaning frequency. Manual backwashing may be needed to increase backwash frequency to as much as once every 15 minutes in order minimize TMP and fouling.
b. Plan for increased cleanings and clean-in-place frequency and monitor changes permeability or resistance as an indicator of irreversible fouling.
c. Conduct direct integrity testing daily at the test pressures approved by DWS. Think of the direct integrity test as if you were to test a tire for a leak by pumping it up - the less air you pump into the tire, the more likely small leaks will go undetected. Ensure that any filter units that fail a direct integrity test are removed from service, repaired, and re-tested prior to being put back into use. Keeping membranes intact is key to contaminant removal
d. Establish a conservative individual filter unit effluent turbidity goal of 0.05 NTU to alert you to sudden integrity breaches between direct integrity tests. The direct integrity test is the only way to directly test the integrity

of the membranes, while the turbidity can indicate a problem between integrity tests.

e. The addition of coagulants can keep membranes from fouling and can assist with particulate and cyanobacterial cell removal. The membrane manufacturer should be consulted prior to adding any type of coagulant as some coagulants can quickly foul membranes. Polymers should never be applied to membranes without checking with the manufacturer due to material compatibility issues and irreversible fouling.
f. MF and UF systems are not generally capable of removing dissolved organics like TOC or extracellular toxins, however, the addition of a coagulant can greatly improve this capability.

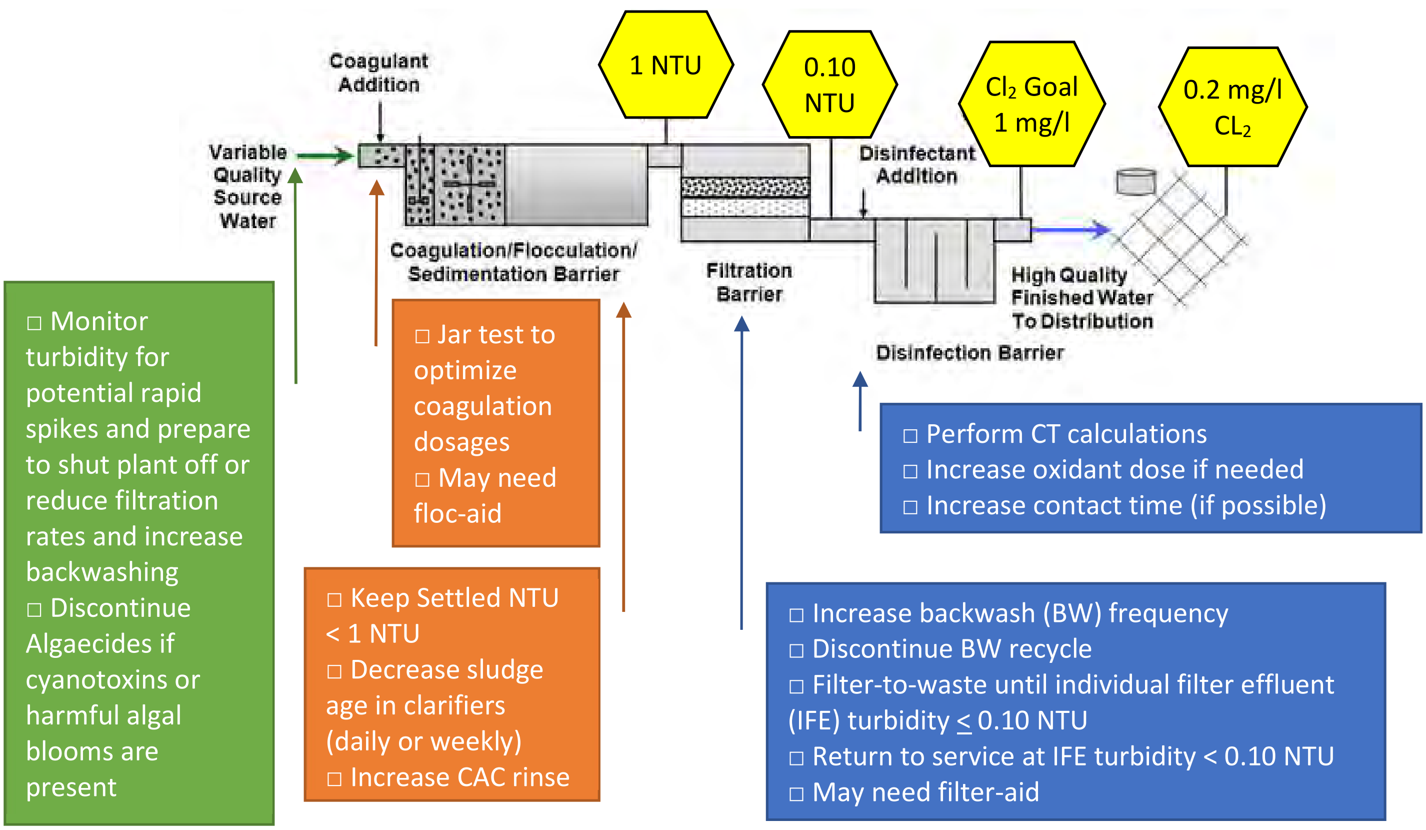
5. Conventional and Direct Filtration:

Conventional and direct filtration plants are encouraged to optimize their treatment processes and adopt water quality goals more stringent than the regulatory drinking water standards to allow a buffer should raw water conditions make treatment more challenging. Improved turbidity removal results in increased pathogen removal.

a. Coagulation and flocculation:
    i. Use jar tests to simulate varying coagulant dosages and plant mixing hydraulics to obtain desired floc formation and increased turbidity removal.
    ii. Compare coagulation feed rates or dosages to periods of historical high turbidity events to optimize the delivery of coagulants to increase the removal of turbidity.
    iii. If powdered activated carbon (PAC) is plumbed to the front of the plant, turn on the feed to aid in taste, odor, or cyanotoxin removal.
b. Sedimentation:
    i. Measure and record settled water turbidity daily and meet settled water turbidity optimization goals (settled water below 1 NTU when raw is less than 10 NTU and settled water below 2 NTU when raw is greater or equal to 10 NTU).
    ii. Conduct more frequent clarifier or sedimentation basin sludge removal, such as on a daily or weekly basis.
    iii. Conduct more frequent contact adsorption clarifier (CAC) rinses.

c. Filtration:
   i. When able, produce filtered water that meets the optimization goal of less than or equal to 0.10 NTU.
   ii. Establish your individual filter run and filter-to-waste durations based on meeting 0.10 NTU and quarterly post-backwash filter turbidity profiles.
   iii. Increase backwash frequency.
   iv. Reduce filter loading rates and filter run times.
   v. Ensure that the backwash sufficiently expands the filter bed media (sand and anthracite layers) to at least 20% to remove remnant particles.

The following graphic summarizes post-wildfire optimization goals and strategies for conventional and direct filtration plants.



6. Slow sand filtration:

a. If turbidity in source water rapidly increases and if there is enough finished water storage available or an alternate source to meet demands, shut off intakes to filters and let the bulk of the high turbidity water pass by the intake to avoid plugging the filters. As turbidity drops, steadily increase flows into the filter and overflow to waste. Not introducing fresh water above the filter bed for days at a time can starve the filter biota of nutrients and dissolved oxygen. Begin filtering when raw water turbidity drops to 10 NTU or less.
b. If cyanotoxins are a concern, lower the filtration rate to improve contaminant removal and allow cyanotoxins to be metabolized. Lowering filtration rates to less than 0.02 gpm/ft^2 should be avoided to keep biota viable.
c. Consider controls that allow a constant higher water level (supernatant or "headwater") above the filter at all times, (i.e., throttle the intake valve to maintain a constant headwater throughout the filter run). This requires the use of piezometers or other pressure sensor to determine head loss. Maintaining deeper headwater keeps increases available storage while minimizing algal blooms in the filter.
d. Monitor head loss so that the filter can be cleaned during the time of year less likely to have algal blooms and high run-off. Graphing head loss development versus time can reveal how fast the filter plugs as the filter approaches the time when cleaning is needed.
e. Staggering cleanings may allow longer filter-to-waste times without the risk of the other filters plugging in the interim.
f. Filter-to-waste for a minimum of 24 hours to ensure filters are ripe after each cleaning.
g. Just prior to cleaning, sample influent and effluent coliform counts in units of MPN/100 ml and determine the percent removal. Clean the filter and repeat the sampling after the first 24 hours of filtering to waste to determine the post-cleaning percent removal. Use the pre- and post-cleaning coliform removals as an indicator of the filter recovery following a cleaning. Avoid returning a filter to service when filter effluent coliform counts are more than 5 MPN/100 ml, turbidity is above 1 NTU, or % coliform removal is less than 90% (2-log).
h. Blending with a source that has lower turbidity and/or cyanobacteria cells may help, however, use caution when blending with groundwater as this can "starve" the slow sand filter of nutrients. Keep blended groundwater

to a minimum and monitor coliform removal twice a week to watch for elevated coliforms in the effluent or declining coliform removals. If possible, investigate this option prior to needing it for an emergency and consider nutrient amendments such as acetic acid to provide a food source for filter biota.

7. Cartridge filtration:

a. Expect to change the filters more frequently and at a lower pressure differential (difference between filter inlet and outlet pressure) than under standard operating conditions as filters may quickly clog
b. Lower flows may be needed to keep differential pressures in check.
c. Ensure gaskets and seals used in cartridge cannisters are in good working order and replace according to manufacturer's recommendation and if they appear worn or damaged.
d. Ensure a sizable supply of spare filters are on-site.
e. Closely monitor raw water turbidity as this can allow you to shut the plant off to avoid turbidity from extreme rain/runoff events.
f. Investigate adding backwashable sand filters, re-usable bag filters, or other type of roughing filter to reduce the turbidity load on the finish filter.

8. Adding treatment:

If optimizing existing water treatment facilities is not enough to handle higher turbidity, TOC, and other contaminants, adding new treatment, such as a roughing filter, granular or powdered activated carbon, may be useful. DWS plan review approval is required prior to adding new water treatment facilities. See www.healthoregon.org/pwsplanreview for further information or contact DWS. Caution should be exercised, and manufacturer consulted when considering PAC as it may damage polymeric membranes and plug slow sand and cartridge/bag filters.

Additional Resources:

- Wildfire Information for Water Systems - OHA – Drinking Water Services

- Refer for the Oregon Post-Wildfire Flood Playbook for more information on identify and mitigating flood risks and other fire-related information.

- Oregon Department of Environmental Quality - Wildfire response Information, debris removal, and fact sheets. This site also contains links to funding and additional state and federal FEMA resources.

- After the Fire fact sheet for homeowners includes resources and advice on how to proceed with recovery in both English and Spanish.

- For more detailed information on potential source water changes, see USGS' Wildfires and Water or US EPA's Wildfires: How Do they Affect our Water Supplies

On-site technical assistance and resources for water systems:

- State Revolving Loan Fund - Technical Assistance Circuit Riders
- Oregon Association of Water Utilities (OAWU)
- Oregon Water/Wastewater Agency Response Network (ORWARN)
- Rural Community Assistance Corporation (RCAC) - non-profit
- Oregon Department of Environmental Quality (DEQ) Wildfire Response

The following general optimization resources may be found on DWS' surface water treatment web page at www.healthoregon.org/swt:

  - Optimization goals for conventional and direct filtration plants
  - Optimization goals for slow sand filter plants
  - Filter turbidity profile example
  - Filter bed expansion measurement

Since wildfires may contribute to algal blooms, learn how to prepare/mitigate harmful algal blooms and optimize treatment of cyanotoxins on-line at:

- https://www.oregon.gov/oha/PH/HealthyEnvironments/DrinkingWater/Operations/Treatment/Pages/algae.aspx
- US EPA's Water Treatment Optimization for Cyanotoxins

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ORELAP Accredited OREGON Laboratories that Test Drinking Water and Accept Public Samples

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Analytical Laboratory Group	541-485-8404	361 West Fifth Ave. Eugene, OR 97401	✓	✓	✓	✓		kimr@alglabsinc.com
Apex Laboratories, LLC	503-718-2323	6700 SW Sandburg St. Tigard, OR 97223			✓			kpatton@apex-labs.com
Box R Water Analysis Laboratory, L.L.C.	541-416-1401	567 NW 2nd Street. Prineville, OR 97754	✓	✓				boxrwaterlab@qwestoffice.net
City of Bend Water Quality Laboratory	541-317-3017	62975 Boyd Acres Rd. Bend, OR 97701		✓				dbarnes@bendoregon.gov
City of The Dalles Water Quality Lab	541-298-2248	6780 Reservoir Rd. The Dalles, OR 97058	✓	✓				dramos@ci.the-dalles.or.us
Columbia Laboratories Inc.	503-254-1794	12423 NE Whitaker Way. Portland, OR 97230	✓	✓	✓	✓	✓	derrick.tanner@tentamus.com
Edge Analytical, Inc - Corvallis	541-753-4946	1100 NE Blvd. Suite 130. Corvallis, OR 97330	✓	✓				smiller@edgeanalytical.com
Edge Analytical, Inc - Portland	503-682-7802	9150 SW Pioneer Ct Ste W. Wilsonville, OR 97070	✓	✓				tphan@edgeanalytical.com
Edge Analytical, Inc. - Bend	541-639-8425	20332 Empire Avenue, Suite F4. Bend, OR 97703		✓				bend.lab@edgeanalytical.com
Grants Pass Water Laboratory, Inc./The Water Lab	541-476-0733	964 SE M Street. Grants Pass, OR 97526	✓	✓	✓	✓		doree@gpwaterlab.com
LabCor Portland	503-224-5055	4321 SW Corbett Ave, Suite A. Portland, OR 97239			✓			staff@labcorpdx.net

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Neilson Research Corporation	541-770-5678	245 South Grape St. Medford, OR 97501	✓	✓	✓	✓	✓	TKreutzer@nrclabs.com
OMIC USA Inc.	503-223-1497	3344 NW Industrial St. Portland, OR 97210						h.flynn@omicusa.com
Spring Street Analytical Laboratory	541-882-6286	350 Spring Street. Klamath Falls, OR 97601	✓	✓				waterlab@springstreetanalytical.com
Umpqua Research Company	541-863-5201	626 NE Division St. Myrtle Creek, OR 97457	✓	✓	✓	✓	✓	twilliams@urcmail.net
Umpqua Research Company - Table Rock	541-276-0385	419 SW 5th St. Pendleton, OR 97801	✓	✓				trlab@urcmail.net
Umpqua Research Company (Bend)	541-312-9454	738 SE Glenwood Drive. Bend, OR 97702	✓	✓				bendlab@urcmail.net
Waterlab Corp.	503-363-0473	2603 12th St. SE. Salem, OR 97302	✓	✓	✓	✓		waterlab@comcast.net