BIOLOGICAL ASSESSMENT
MISSION RESTORATION

PROJECT LOCATION BY HUC WATERSHEDS:

HUC8:	Methow River	17020008
HUC10:	Twisp River	1702000805
HUC12:	Lower Twisp River	170200080509
	Buttermilk Creek	170200080506
HUC10:	Lower Methow River	1702000807
HUC12:	Libby Creek	170200080701

WATERSHED ANALYSES:

Twisp River (USDA 1995a) Libby Creek (USDA 1995b)

EFFECTS DETERMINATION FOR NON-ARBO II ACTIONS ANALYZED IN THIS BA:

May Affect, Not Likely to Adversely Affect:

Columbia River Bull Trout
Upper Columbia River steelhead DPS
Upper Columbia River Spring-Run Chinook ESU
Columbia River Bull Trout Designed Critical Habitat
Upper Columbia River Spring-Run Chinook and Upper Columbia River Steelhead Designated Critical Habitat

Essential Fish Habitat: Not Adversely Affected

May Affect, Not Likely to Adversely Affect:

Gray Wolf
Grizzly Bear
Northern Spotted Owl
Canada Lynx
Canada Lynx Designated Critical Habitat

No Affect:

Wolverine

FISHERIES BIOLOGISTS: Gene Shull

WILDLIFE BIOLOGIST: John Rohrer

DATE: February 22, 2018

LEVEL 1 TEAM REVIEW:
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Introduction

The Methow Valley Ranger District (MVRD) is proposing vegetation and aquatic/watershed restoration activities in the Buttermilk Creek and Libby Creek sub-watersheds (Figure 1). Past logging, road construction, fire suppression, livestock grazing, and beaver trapping resulted in overstocked stands, low complexity aquatic habitat, and resilient riparian habitat conditions. Under the Okanogan-Wenatchee Forest Restoration Strategy (2012) and draft Whole Watershed Restoration Procedure approach, management of vegetation and forest roads are paired with restoring aquatic/riparian resources.

The primary goal for the Mission Restoration Project is to improve vegetation and aquatic/riparian resource conditions and increase resiliency to current and future natural disturbances. Key vegetation and road objectives for the Mission project are to maintain and restore forest vegetation conditions, increase resiliency to natural disturbances, and develop a safe, stable road network that minimizes impacts to natural resources. Key objectives for the aquatic/watershed restoration projects are to improve habitat conditions for ESA listed fish species. Treatments include a suite of restoration actions such as; decommissioning and closing roads, replacing barrier culverts and undersized stream culverts, adding coarse wood to streams, rock armoring, removing intermittent stream culverts and replacing with hardened fords, and beaver habitat restoration. These actions would reduce artificial sediment, increase habitat complexity in spawning and rearing habitat, restore fish passage, and increase wetland habitat. All of the proposed aquatic/watershed actions are restorative and consistent with activities covered in 2013 Re-initiation of Aquatic Restoration Activities in States of Oregon and Washington programmatic Biological Opinions (ARBO II) (USDC-NMFS 2013). The vegetation and hazard fuels treatments are restorative as well, but these treatments are not covered under ARBO II.

We are using a different approach to completing fisheries ESA consultation for this project for the fisheries resource only. This includes creating two groups of activities: an ARBO II consistent activity group and a non-ARBO II activity group. The aquatic/watershed restorative actions are consistent with the following ARBO II project categories: **Road and Trail Erosion Control and Decommissioning, LW Placement, Fish Passage Restoration, Riparian Vegetation Treatment (controlled burning),** and **Beaver Habitat Restoration**. Design and implementation would be consistent with design criteria in ARBO II and therefore, the effects to fisheries would be the same (May Affect, Likely to Adversely Affect) as described in ARBO II and would not be re-analyzed in this BA. The second group consists of activities not consistent with ARBO II. This includes proposed commercial harvest, non-commercial harvest, hazard fuels reduction, road work associated with timber harvest access, and soil restoration. Together, these two groups of activities comprise the Mission Restoration Project proposed action.

The purpose of this assessment is to determine the effects of the proposed Mission Forest Restoration project on fish and wildlife species that are federally protected under the Endangered Species Act of 1973 (as amended). This evaluation is intended to fulfill section 7 (c) of the Endangered Species Act (ESA) and meet the requirements of Forest Service Manual direction (FSM 2670). It is intended to ensure that proposed management activities would not likely jeopardize the continued existence of the Federally listed species, nor result in the destruction or adverse modification of designated critical habitat (CH) or essential fish habitat, as defined in the Endangered Species Consultation Handbook (USDI and USDC 1998).

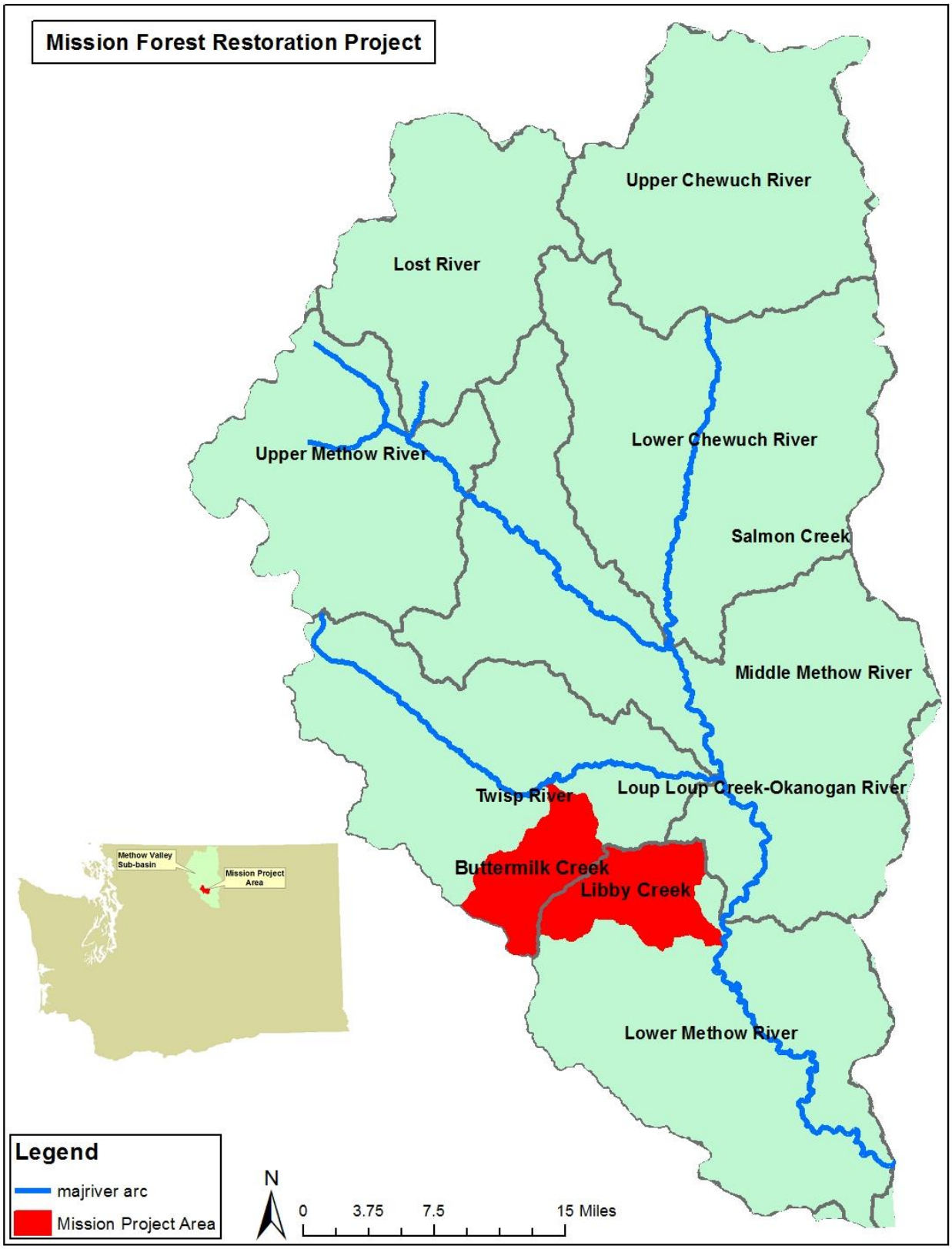


Figure 1. Mission Project area vicinity map.

Purpose and Need

This project uses information from photo interpretation, field reconnaissance, and analysis results of the Ecosystem Management Decision Support (EMDS) tools to identify vegetation, wildlife, and aquatic restoration and wildfire hazard reduction needs at the stand and landscape levels in the project area. The interdisciplinary team (IDT) compared the existing condition to desired conditions that are consistent with the amended Okanogan National Forest Land and Resource Management Plan (LRMP), Northwest Forest Plan (NWFP 1994), and other guidance. The IDT also considered changing climates by emphasizing the restoration of natural processes, functions, and patterns across the landscape to build more resilient ecosystems. These efforts determined the following needs for this project:

1. **Hydrologic Function and Aquatic/Riparian Habitat**
   Several roads add sediment, increase the drainage network, block fish migration, and reduce woody debris recruitment. Large wood and pool habitat are currently below desired conditions for ESA listed fish species (USDA, USDC, and USDI 2004). Past fire suppression has altered riparian plant species composition and structure that would have occurred under the natural fire regime in dry forest conditions. Some drier drainages have stands of conifers that shade out hardwoods and reduce the amount of water available for stream flow. These conditions also make riparian areas more susceptible to uncharacteristic harmful effects caused by wildfire. Road construction, conifer encroachment, and past vegetation management practices have reduced water flow and wetland habitat in the project area. A purpose of this project is to restore and maintain aquatic, riparian, and hydrologic processes impacted by past management, improve habitat for Threatened and Endangered aquatic species, and increase watershed resiliency to existing and anticipated disturbances.

2. **Soil Productivity**
   Soil compaction in the project area limits native plant growth, reduces soil biological activity and water infiltration, limits soil productivity, and reduces the resiliency of plant communities to climactic and biological changes over time. A purpose of this project is to restore soil-related processes and functions where past management practices have created detrimental effects.

3. **Vegetation Composition and Structure**
   Past management practices, including fire suppression, changed forest vegetation structure, overstory and understory species composition, and spatial patterns in comparison to historical conditions. These changes include a large increase of densely stocked stands with multiple canopy layers or closed canopies with a high proportion of young shade-tolerant tree species (including Douglas-fir and subalpine fir in the dry forest type and subalpine fir in the moist forest type). These densely stocked stands tend to be arranged in a more continuous or unbroken pattern across the project area compared to historical conditions. Dry and moist forest stands with lower tree stocking levels and open canopy closure have decreased in total area and patch (stand) size compared to historic levels. Dry and moist forest stands comprised primarily of large trees also have decreased in total area and patch size compared to historic levels. Portions of the project area are highly susceptible to dwarf mistletoe infection, defoliating insects and bark beetle attacks due to vegetation composition and structure changes from historical conditions. The risk of crown fire initiation and spread and associated fire effects are greater than historical conditions due to increased tree density and development of forest stands with multiple and closed canopy layers across the

landscape. Dry and moist forest vegetation in the project area is susceptible to increased frequency and severity of natural disturbances (including insects, disease, and fire) associated with a warmer, drier climate. A purpose of this project is to maintain and restore forest vegetation characteristics to within estimated historical and future ranges of variability to improve forest resiliency to insect, disease, and wildfire events.

4. **Wildlife Habitat**
   Northern spotted owl habitat is limited and scattered in the project area compared to historical conditions, and habitat connectivity to suitable habitat outside of the project area is fragmented from past management actions. Meadow habitat around Mission Pond and Blackpine Meadows is shrinking due to conifer encroachment. The amount of large-tree habitat that provides nesting and foraging opportunities for northern goshawk, white-headed woodpeckers, western gray squirrels, and other species in the project area is below desirable levels. Existing early-successional conifer and deciduous stands is under-represented based on historical conditions, providing less quality habitat for lynx and their prey. A purpose of this project is to develop, maintain, and/or enhance habitat for federally listed and other wildlife species and reduce the risk of large-scale habitat loss to fires by increasing resilience of habitats to wildfire.

5. **Sensitive Plants and Unique Habitats**
   Conifer encroachment in the project area has decreased nutrient, water, and sunlight availability to moonworts, bladderwort, and aspen. A purpose of this project is to maintain and enhance existing and potential R6 Sensitive Survey and Manage plant populations and Unique habitats within meadows and aspen stands.

6. **Wildfire Hazard in the Wildland Urban Interface**
   Current fuel conditions near and adjacent to private lands support flame lengths that increase the likelihood of crown fire initiation, placing life and property at risk and limiting direct suppression opportunities. Current fuel loading and stand structure along Forest Roads 4300 and 4340 may create high-intensity fire conditions that limit the usefulness of these routes during wildfire evacuation or access for suppression resources. A purpose of this project is to modify the structure, composition, and patterns of forest stands within and adjacent to the wildland/urban interface (WUI) as defined by the 2013 Okanogan Community Wildfire Protection Plan[1], enabling the use of more direct firefighting strategies to protect life and personal property.

   The project area landscape fits in the frequent, low-severity fire regime that, historically, was characterized by stands with low tree density and more open forests (Spies et al. 2016). Decades of timber harvest, grazing, removal of beavers, and fire suppression have resulted in overstocked, heavy fuel loading across the landscape including the Riparian Reserves. Fire suppression caused increased fuel loading and reduced species diversity that led to high susceptibility to insects, disease, and wildfires. Modern wildfires sweep through streamside

[1] Okanogan County Community Wildfire Protection Plan (CWPP) (Bloch et al. 2013a, 2013b): This plan was collaboratively developed by local and state government representatives in consultation with federal agencies and other interested parties, and was last updated in 2012. The CWPP incorporates and supersedes the Methow Community Wildfire Protection Plan, using local interagency and public input to create a specific definition of Wildland urban Interface (WUI) that considers risks to developments within fire-prone environments in Okanogan County.

forests in a high intensity burn, often leaving little vegetation to protect streambanks and reducing water quality. Riparian function and resiliency are central to maintain and improve aquatic habitat. Riparian fuels treatments are proposed to improve diversity and build resiliency in streamside forests to maintain the health of aquatic systems.

7. **Transportation System**
   Existing undersized culverts present risk for road failure and sediment delivery to streams. Road surfaces have poor drainage and have lost durable road surface, which contributes to the potential for road failure and increased maintenance needs. Several roads do not meet current safety or design standards or are now surplus to management needs because of changes in logging system practices or management objectives. The existing road network costs more to maintain than is available in road maintenance funding. A purpose of this project is to provide the road system needed for safe and efficient travel, administration, public use, and protection of natural resources on National Forest System lands.

To set focus for watershed and aquatic restoration goals in the Mission Project area, the hydrologist and fish biologist identified limiting factors for watershed condition and aquatic habitat. Several sources provided information on limiting factors for the project area: A Biological Strategy To Protect And Restore Salmonid Habitat In The Upper Columbia Region (RTT 2014), the Upper Columbia Salmon and Steelhead Recovery Plan (NMFS 2007 [referred to as UCRSSRP]), and the Salmon, Steelhead, and Bull Trout Habitat Limiting Factors report for the Methow Valley (Andonaegui 2000). Additionally, the Okanogan-Wenatchee Watershed Condition Framework update (USDA 2011a), Level II streams surveys (USDA 2010 & 2011c), Trout Unlimited's aquatic assessment report (Crandall 2016), and field observations within the project area helped identify key project area limiting factors. The limiting factors include:

- Water Quality - riparian roads and livestock grazing are chronic sources of erosion and sediment delivery. Episodic road failures contribute large volumes of sediment during storm events
- Water Quantity – summer and fall base flows are reduced from water withdrawals from private irrigation ditches and water transmission lines
- Stream Channel Complexity – past riparian harvest has reduced natural wood recruitment. Instream coarse woody debris levels are low in multiple fish streams.
- Fish Access – full or partial barrier culverts limit fish passage and prevent access to suitable habitat
- Riparian Area Function – riparian roads, past timber harvest, and livestock grazing have removed riparian forest and limit current riparian function and resiliency to disturbances
- Introduced Exotic Aquatic Species – brook trout presence negatively interact with bull trout and increase competition for food and cover.

Water quality and quantity, aquatic habitat diversity, fish access and riparian function (resiliency) were the limiting factors prioritized to improve.

Species Considered

Listed fish species in the project area include Upper Columbia River steelhead Distinct Population Segment (DPS) (threatened), the Upper Columbia River Spring-run Chinook Evolutionarily Significant Unit (ESU; endangered), and Columbia River Bull Trout (threatened). Spring Chinook, steelhead, and bull trout have designated critical habitat within the proposed project area.

Magnuson-Stevens Fishery Conservation and Management Act (MSA) species include Chinook and coho salmon.

Listed wildlife species known or suspected to occur in or near the project area include gray wolf (endangered), Canada lynx (threatened), grizzly bear (threatened), and northern spotted owl (threatened). There is designated critical habitat for Canada lynx within the project area. There is no designated critical habitat for the northern spotted owl within the project area. Wolverine are proposed for listing as a threatened species, and may use the Wilderness portion of the analysis area. The remainder of the analysis area is too low in elevation to provide habitat. No treatments are planned in wolverine habitat.

Summary of Determinations:
The Mission Project includes commercial and non-commercial vegetation treatments, prescribed fire, road treatments and a suite of aquatic/watershed restoration treatments. After review and agreement with the Okanogan-Wenatchee Level 1 Team, we approached consultation by splitting treatments into ARBO II bin activities and non-ARBO II bin activities, for fisheries. This BA will focus on the effects from proposed actions that are not consistent with the ARBO II for fisheries. For wildlife species, the ARBO II consistent activities are considered in this BA.

Our effect determinations for non-ARBO II project activities are may affect, not likely to adversely affect bull trout, steelhead, and spring chinook, and their designated CH. Effect determinations for wildlife species, for all project activities are may affect, not likely to adversely affect" for wolf, grizzly bear, lynx, spotted owl and Critical Habitat for lynx, and no effect for wolverine (if listed).

There would be no effect to any ESA-listed plant species found on the Okanogan-Wenatchee National Forest since none occurs in the project area.

Management Direction

Principal regulatory direction applicable to the management of fisheries resources on the Okanogan-Wenatchee National Forest include:

- National Forest Management Act of 1976 (NFMA)
- Endangered Species Act of 1973 (ESA)
- Clean Water Act of 1972
- Okanogan National Forest, Forest Plan (USDA 1989), as amended
- Northwest Forest Plan (USDA and USDI 1994)

The National Forest Management Act (NFMA) (1976) requires that the Forest Service manage for a diversity of fish habitat to support viable fish populations (36 CFR 219.19). Regulations further state the effects on these species and the reason for their choice as management indicator Species be documented (36 CFR 219.19 (a) (1)).

Regulations of NFMA (219.12g) state, "Fish and wildlife habitats will be managed... to maintain and improve habitat of management indicator species." Executive Orders 11988 and 11990 (May 24, 1977) contain as part of their objectives minimizing the destruction, loss, and degradation of wetlands, and to give preferential consideration to riparian dependent resources when conflicts among land use activities occur.

A range of standards are included in the Okanogan National Forest (OWNF) Forest Plan (USDA Forest Service 1989) are applicable to the management of riparian and aquatic resources. Forest Plan standards and guidelines require maintenance or enhancement of riparian and aquatic habitat parameters that affect fish and other aquatic life. These parameters include fine sediment, pool habitat, large woody debris, riparian vegetation, and provision of fish passage at road crossings. The Northwest Forest Plan (USDA and USDI 1994) (NWFP henceforth) amended the Forest Plan and provides additional direction for the project area. See the Northwest Forest Plan pages C-31 to C-35 for applicable Standard and Guidelines.

Current forest management guidelines provide considerably more protection for aquatic and riparian resources than was granted in the past. For example, under the Northwest Forest Plan direction, all management activities occurring within Riparian Reserves must maintain functional ecological conditions or lead to improved conditions to be consistent with the management guidance.

Okanogan Forest Plan land allocations within the project area include Management Area 5 (roaded recreation and scenic emphasis), Management Area 14 (wildlife habitat emphasis), Management Area 15B (Chelan-Sawtooth Wilderness), Management Area 17 (developed recreation emphasis), Management Area 25 (timber and range emphasis), and Management Area 26 (deer winter range emphasis). Northwest Forest Plan allocations include Congressionally Reserved (Chelan-Sawtooth Wilderness), Late-Successional Reserve, Matrix, Key Watersheds, and Riparian Reserves. The project area contains portions of the Sawtooth Inventoried Roadless Area.

The Northwest Forest Plan provides management direction from the Mission Restoration project area. Riparian management in NWFP areas follows four components of the Aquatic Conservation Strategy (ACS). The four components include Riparian Reserves (RRs), Key Watersheds, Watershed Analyses, and Watershed Restoration. These components are combined to restore and maintain ecological health of watershed and aquatic ecosystems contained within public lands. Activities associated with the proposed Mission project are designed to be consistent with the ACS at site, sub-watershed (project), and watershed scales (See ACS consistency summary on page 208). Watershed analyses reviewed for the Mission project area were the Twisp River and Libby Creek Watershed Analyses (USDA Forest Service 1995a and 1995b). RR widths are the default widths outlined in the ACS.

The Endangered Species Act and Magnuson-Stevens Fishery Conservation and Management Act require that consultation be completed with respect to effects of proposed activities on Endangered, Threatened, Sensitive, and Management Indicator Species, Critical Habitat, and Essential Fish Habitat. The species and habitat of concern in the Mission Restoration Project are described later in this section. Consultation on effects to ESA listed species will be completed with the required regulatory agencies (U.S. Fish and Wildlife Service [USFWS] and National Marine Fisheries Service [NMFS]) prior to issuance of the Environmental Assessment and Decision Notice for this project.

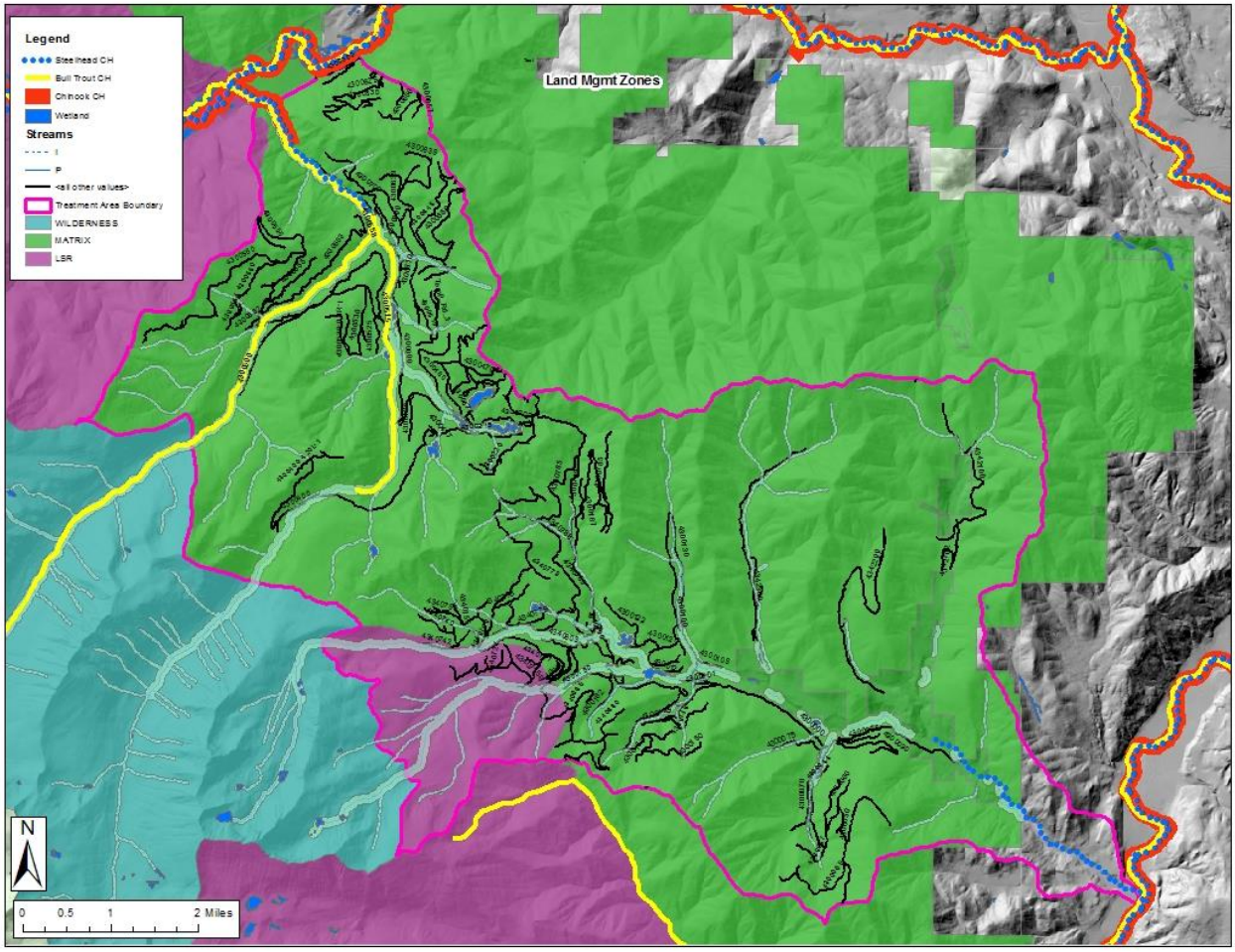


Figure 2. Northwest Forest Plan land allocations in the Mission Project area.

Project Area Description

The Mission Project area encompasses approximately 31,700 acres within the Twisp River 10th (1702000805) and Lower Methow River (1702000807) watersheds (Figure 2). The project area includes the lower portions of the Buttermilk Creek 12th (170200080506) and Libby Creek 12th (170200080701) sub-watersheds, which are approximately 23,500 and 25,500 acres in size, respectively (Table 1). The project boundaries correspond to watershed boundaries except for a small piece near the bottom of Buttermilk Creek that lies within the Mainstem Lower Twisp River sub-watershed. Activities in this area are minor with no effects to hydrologic or aquatic resources and will not be discussed further. There are 43 miles of perennial streams and 85 miles of intermittent streams within the project area boundary.

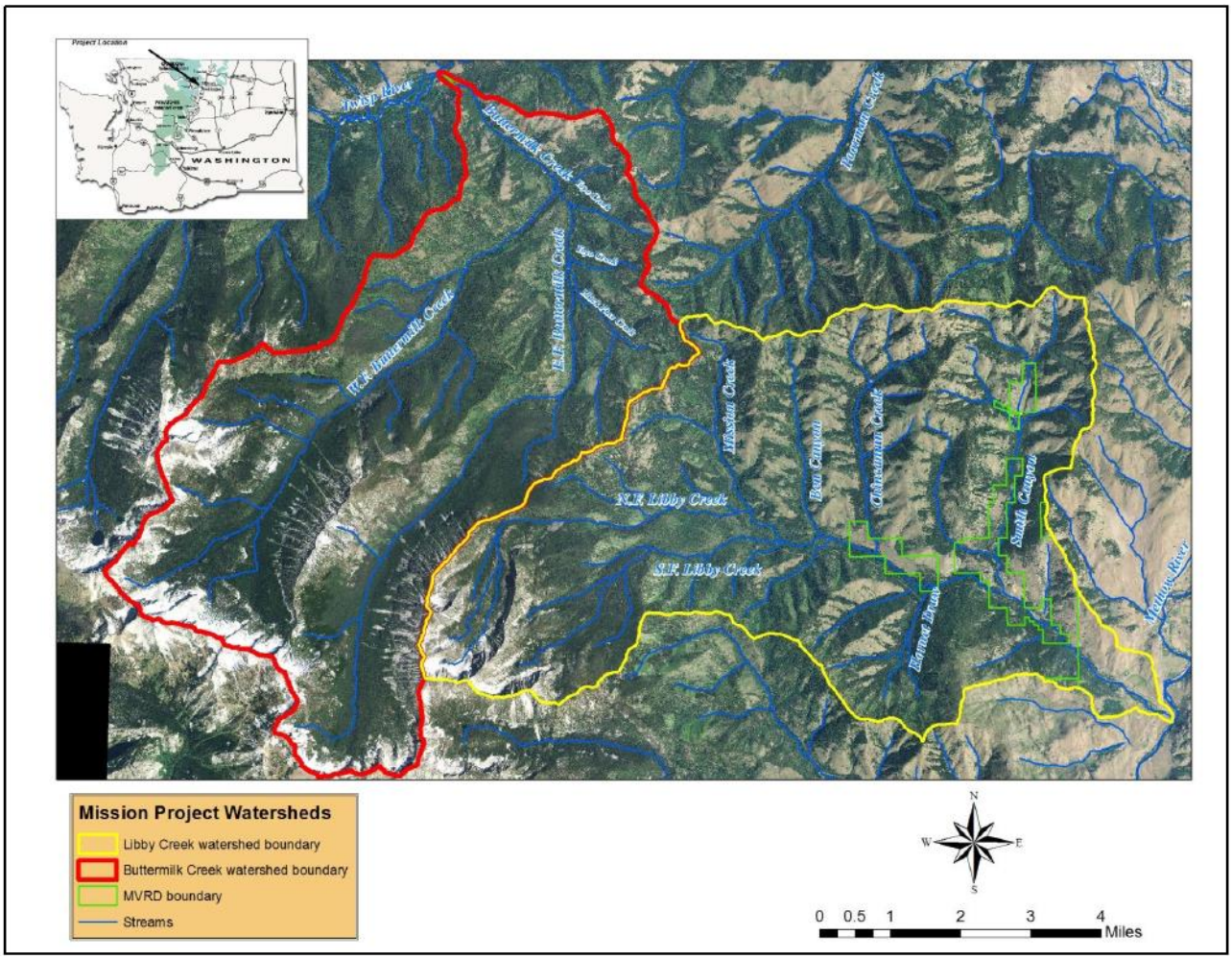


Figure 2. Mission Project area sub-watersheds.

Table 1. Watershed and Treatment Areas (USFS GIS data)

HUC	HUC name	Acres	Project planning area acres	% of HUC 12 area
170200080507	Buttermilk Creek	23,500	10,900	~46
170200080701	Libby Creek	25,500	22,670	~89

Buttermilk Creek Sub-watershed Description

The Buttermilk Creek sub-watershed is within the larger Twisp River Watershed. The headwaters originates at the confluence of the West and East Forks of Buttermilk Creek, which both originate within alpine cirques in the Chelan-Sawtooth Wilderness at elevations of 7,000'-8,600'. Both forks flow for approximately nine miles before joining at RM 2.6 and provide the majority of stream flow in the watershed. Downstream from this confluence, Buttermilk Creek flows through a steep canyon to join the Twisp River at RM 12. Perennial tributaries in the watershed include Black Pine Creek, which flows into the East Fork approximately 0.5 miles upstream of the forks confluence. Several other intermittent streams enter into the West and East Forks and mainstem.

Buttermilk Creek covers ~23,500 acres and most of the land (99%) is managed by the Okanogan-Wenatchee National Forest. Much of the Twisp Watershed, including all of Buttermilk, is a Tier 1 key watershed, identified under the NWFP as important in contributing to the conservation of anadromous salmonids, bull trout, and other resident fish species. About 12,200 acres of Buttermilk (about 52%) is within the Lake Chelan-Sawtooth Wilderness. The remaining ~11,300acres consist of multiple use management. A watershed analysis was completed in 1995 (USFS 1995).

Annual precipitation in the area ranges from 90 inches along the Cascade crest to 20 inches near the mouth. The elevation ranges from 8,500 feet at the upper ridges to 1,300 feet at the confluence with the Methow. Most precipitation comes during the winter as snow.

In the Buttermilk Creek drainage, bull trout are documented from the drainage mouth to a natural barrier in EF Buttermilk Creek at RM 3.0 and to ~RM 9.0 in WF Buttermilk Creek. Spawning occurs in both EF and WF Buttermilk Creeks. Steelhead are documented up to the top of the mainstem of Buttermilk Creek. Rainbow/steelhead are documented up to RM 3.1 in WF Buttermilk Creek, to the falls at RM 3.0 in EF Buttermilk Creek, and the culvert on the 43 road on Black Pine Creek (RM 0.62). Juvenile spring chinook are documented in the mainstem Buttermilk Creek up to RM 1.4 Figure 3 shows distribution along with critical habitat. Where tables show proximities to critical habitat (CH) or steelhead (STHD), it means the combined or max distribution.

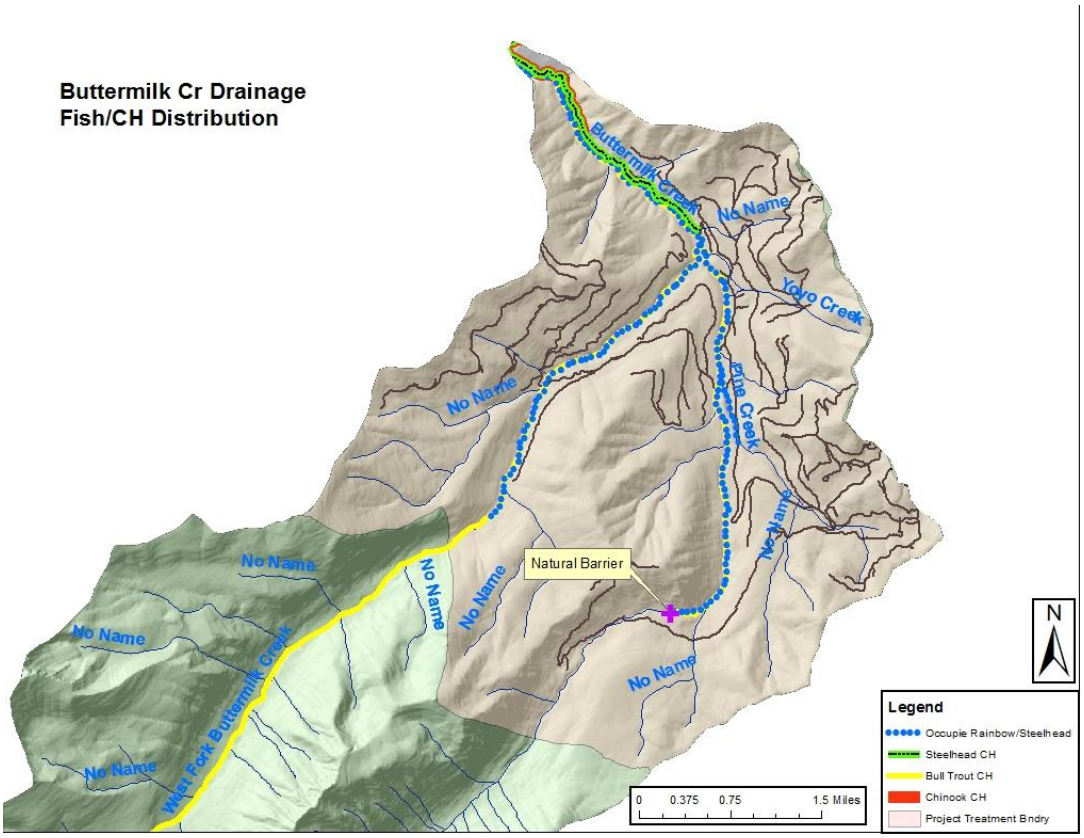


Figure 3. Listed fish distribution in the Buttermilk Creek drainage, including designated critical habitat. Bull trout and chinook distributions are nearly identical to the CH distribution.

Libby Creek Sub-watershed Description

The Libby Creek sub-watershed is within the Lower Methow River Watershed. The headwaters of Libby Creek originate in alpine cirques and several lakes within the Chelan-Sawtooth Wilderness at elevations of 6,800'-8,400'. Libby Creek proper is formed by the confluence of its two primary forks, the North Fork and South Fork, at river mile (RM) 7.2, and these two tributaries contribute approximately 60% of stream flow to the mainstem (USFS 1998). From its headwaters, Libby Creek flows in an easterly direction for approximately 14 miles to its confluence with the Methow River at RM 26, just downstream from the town of Carlton, at an elevation of 1,360'. Other tributaries to Libby Creek include Smith Canyon, Chicamun Canyon, Ben Canyon, Mission Creek, and Hornet Draw. These streams are mostly perennial, but may flow intermittently in low water years. Several other intermittent creeks and draws also contribute to the instream flow, especially during spring runoff.

Libby Creek sub-watershed covers 25,500 acres and most of the land (92%) is managed by the Okanogan-Wenatchee National Forest. About 3,000 acres of Libby (about 11%) is within the Lake Chelan-Sawtooth Wilderness. The remaining acres are Matrix lands. A watershed analysis was completed in 1995 (USFS 1995).

Annual precipitation varies from about 10 inches at the mouth of Libby Creek to over 40 inches at the highest elevations in the watershed. At the lower elevations 35-40% of the precipitation falls as snow while at the higher elevations 55-65% of the precipitation falls as snow.

Both the Buttermilk and Libby Creek sub-watersheds experienced decades of timber harvest, fire suppression, livestock grazing, illegal firewood cutting, dispersed recreation impacts, and road construction with varying effects to aquatic and riparian resources. Implementation of the NWFP and ESA listing of fish species has provided greater protection for RRs, but at risk conditions remain.

Within the Libby Creek drainage, limited bull trout use (1 documented fish) is documented in Libby Creek up to RM 6.7, just above the 4300100 road (USGS 2007). Habitat use in Libby Creek includes foraging, migration, and over wintering habitat. Steelhead are documented up to the top of the mainstem of Libby Creek. Rainbow/steelhead are documented up to RM 1.6 in NF Libby Creek and 1.3 in SF Libby Creek. Juvenile spring chinook are documented in the mainstem Libby Creek up to RM 2.5; however, there is no designated critical habitat for chinook salmon. Figure 4 shows distribution along with steelhead critical habitat.

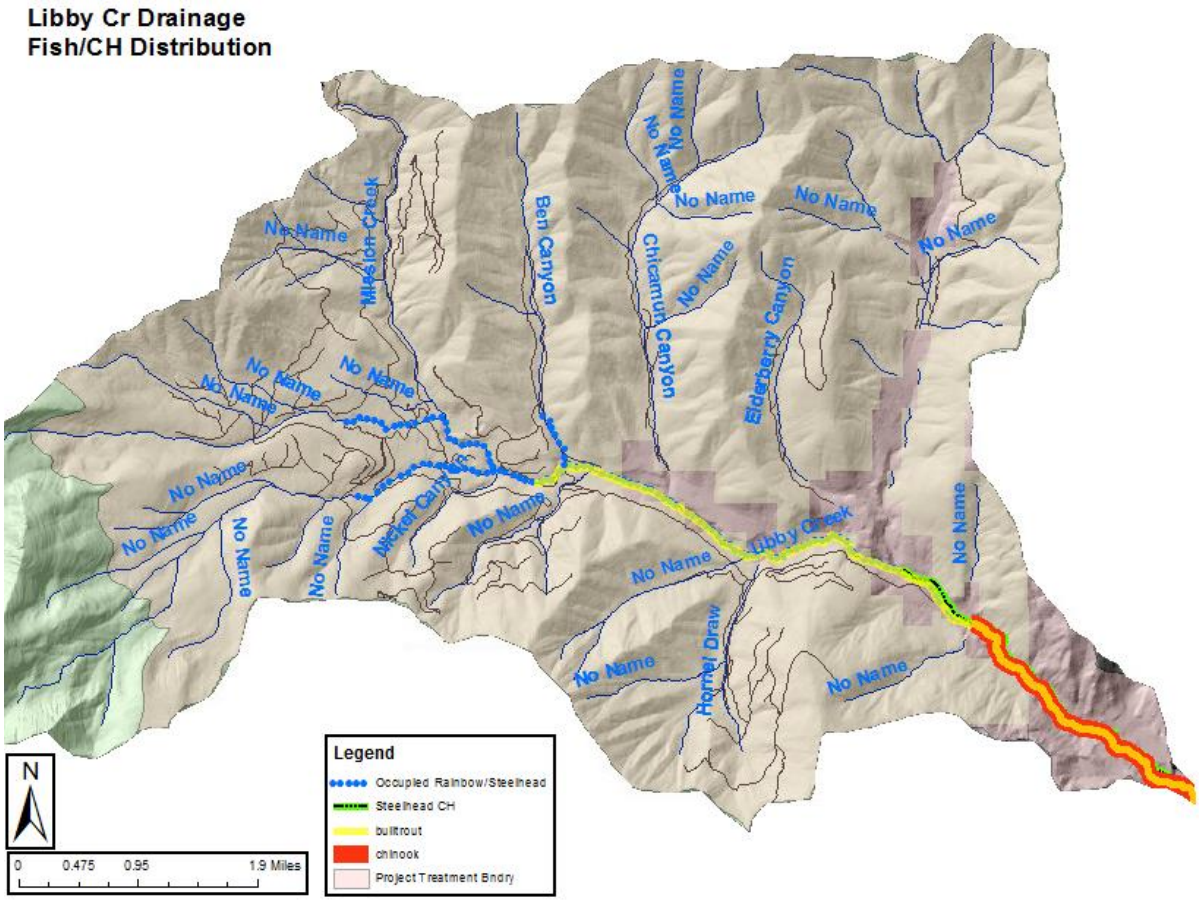


Figure 4. Libby Creek fish distribution with designated critical habitat.

ESA Action Area

The proposed project is located within the Twisp 10th field watershed and Lower Methow River 10th field watershed. Sub-watersheds include the Buttermilk Creek and Libby 12th fields.

The Action Area for this project, is defined under the ESA as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action" (50 CFR § 402). The ESA Action Area for this project includes the harvest and vegetation treatments, tree planting, roadwork associated with the harvest, and prescribed fire not covered under ARBO II. Our analysis indicates that the proposed Mission Project has the potential to generate direct and indirect affects to aquatic species and aquatic habitats in the Buttermilk and Libby Creek drainages from the upper project area boundary areas downstream to the mouth. The Twisp River is over 4 miles downstream from the nearest road crossing (non-paved) and the Methow River is 3 miles below the nearest road crossing. Using BMPs and design criteria, no downstream project effects are expected these rivers. The Buttermilk Creek and Libby Creek drainage areas encompass the Action Area.

Proposed Action

The Mission Project was developed to re-establish ecological processes, patterns, and functions to restore the Libby and Buttermilk Creek landscapes to be more resilient to disturbances such as wildfire and changing climates, reduce wildfire hazards in the Wildland Urban Interface (WUI), restore aquatic/riparian habitat, and manage the existing transportation system. Additionally, the

project is intended to provide commercially valuable timber/other forest products that are economically viable and sustainable. The proposed action includes commercial timber harvest, non-commercial thinning, various fuels/prescribed fire treatments, decommissioning un-needed roads and some high aquatic-risk roads, hydrologically closing roads needed for long-term vegetation management, replacing fish barrier culverts, rocking road-stream crossings, adding coarse wood to fish habitat, and enhancing beaver release sites.

The intent of the aquatic/watershed treatments are to improve stream function, restore plant species composition developed under natural fire regimes, and watershed process by removing or hydrologically closing riparian roads, storm-proofing existing roads, increasing fish habitat complexity, restoring fish passage, increasing natural water storage, reducing artificial sediment delivery to streams, and improving habitat in beaver release sites. After review of the aquatic/watershed treatments, the Level 1 Team agreed these actions are consistent and fit under the ARBO II project activities.

Tables 2a and 2b describe all the proposed treatments associated with the Mission Project. Table 2a summarizes the non-ARBO II treatment bin treatments and Table 2b are the ARBO II bin treatments. Each of the proposed treatments is described in greater details below. Where the project proposes to cover an action under the programmatic, it will be identified as (ARBO II).

Table 2a. Mission Restoration Project Summary Table – **Non-ARBO II Treatments**.

Treatment Type	Description	Amount
Non-Commercial Thinning	TSI	1,737 acres
	Wetland Thin	22 acres
	Ladder Fuel Reduction Thin (outside of commercial thinning units)	6,501 acres
	Post and Pole Thin	36 acres
	Conifer Girdling & Thin for Aspen Restoration	72 acres
	Subtotal Non-Commercial Thinning	**8,367 acres**
Commercial Thinning	Aspen Release Thin	160 acres
	Moist Forest Thin	69 acres
	Dry Forest Restoration Thin	1,280 acres
	Dry Forest Restoration – Dwarf Mistletoe Thin	285 acres
	Variable Retention Regeneration (VRR) and post-harvest tree planting	59 acres
	Subtotal Commercial Thinning	**1,853 acres**
Tree Planting	In the VRR units	59 acres
Prescribed Fire	Hand-piling and pile burning	2,901 acres
	Machine-piling and pile burning	701 acres
	Underburning (upland burning)*	7,086 acres
	Landing pile burning	179 landing piles
	Subtotal Prescribed Fire	**10,220 ac + 179 L Piles**
Road Maintenance/Reconstruction	Surface blading, ditch cleaning, road surface reconstruction	51.1/15 miles
Log Hauling	Summer/Winter Hauling	55.7 miles
Opening Closed Roads	System/Non-System Rds	20.4 miles
New Temporary Roads	New Construction	1.2 miles
Adjust Rd Maintenance Levels	Upgrades and downgrades	22.7 miles
Adding Unauthorized Roads	Open/Closed roads	3.5 miles
Road Closure/Decommissioning	Roads used for log hauling and done by purchaser	12.0/7.1 miles
Road to Stock Trail	Roads decommissioned, converted to non-motorized cow trail	0.7 miles
Road to ML2 Admin Closed	Roads used for log hauling and done by purchaser	12.54 miles

*These acres are just for upland areas outside of RRs. An additional 273.6 acres would occur in RRs that is consistent with ARBO II Treatment #15-Riparian Vegetation Treatment (controlled burning).

Table 2b. Mission Restoration Project Summary Table –**ARBO II Treatments**.

Treatment Type	Description	Amount
Prescribed Fire	**Riparian Vegetation Treatment (Controlled Burning)**: Riparian Underburning	273.6 acres
Soil Restoration	**Road and Trail Erosion Control and Decommissioning**: Tilling compacted surfaces to reestablish native vegetation in RRs	468 acres
Culvert Replacement	**Fish Passage Restoration**: Replace culverts where fish barriers exist on fish-bearing streams	8 culverts
	Road and Trail Erosion Control and Decommissioning: Replace undersized culverts on non-fish-bearing streams	15 culverts
Beaver Habitat Enhancement	**Beaver Habitat Restoration**: Enhance and protect areas for future beaver utilization.	8 sites
West Fork Buttermilk Bridge Replacement	**Fish Passage Restoration (Replacing culverts or bridges with properly sized culverts and bridges)**: Replace bridge across West Fork Buttermilk Creek to restore motorized access	1 bridge
Coarse Woody Debris (CWD)	**Large Wood (LW):** Restore deficient levels of CWD in fish-bearing streams	10 miles
Rock Armoring	**Road and Trail Erosion Control and Decommissioning**: Apply rock to road surface at stream crossings.	33 stream crossings
Road Closure/Decommissioning	**Road and Trail Erosion Control and Decommissioning**: Hydrologic storage/Decommissioning	22.8/24.6 miles
Road to ML2 Admin Closed	**Road and Trail Erosion Control and Decommissioning**: Open roads closed to public use, storm-proofing	2.9 miles
Road to stock trail	**Road and Trail Erosion Control and Decommissioning**: Road decommissioned with small, non-motorized cattle trail 3ft—wide constructed.	1.3 miles
Drivable Ford Conversion	**Road and Trail Erosion Control and Decommissioning**: Intermittent, fishless streams	4 stream crossings

Project treatments would occur in different phases; the first phase would include rock armoring of road crossings over six perennial stream crossings prior to summer log hauling, if summer log haul occurs (Table 3). Note - rock armoring was chosen over up-front decommissioning because it would result in immediate, tangible watershed improvements by reducing sediment delivery to streams compared to upland road decommissioning. Following this, harvest-related actions would occur that include pre-haul road maintenance, temporary road construction (in the uplands), timber harvest and thinning, timber haul, and post-harvest-related road treatments including road closures, road decommissioning, and etc. Some aquatic restoration treatments could start during the first phase such as fish passage, course wood placement, beaver enhancement, and possibly some road decommissioning and closure. These treatments are funding dependent. Next (or partly overlapping) would be standalone fuels treatments that are treatments done just to address fuel loading and harvest-unit fuels reduction treatments. The remaining project actions that include road closures, ML downgrading, road decommissioning, rock armoring, culvert replacement, bridge replacement, and hardened fords would occur, some of which would be ready at the time of the decision is signed. Most would benefit aquatic and wildlife resources. In some cases, no on-the-ground action may be needed (e.g. decommissioning some roads may be best done by abandonment. Actual implementation would be considered on a road-by-road basis subject to field verification). The project could start as early as summer 2018 . The dark grey boxes are years when these activities are expected to occur. The light grey boxes indicate uncertainty on which year they would occur because they are yet to be funded, but presumed to occur in these time periods. All project activities described above are expected to be completed within 10 years.

Table 3. Estimated project timeline. Dark boxes are definite treatment years and grey boxes are ranges when treatment is likely to occur.

Treatments		Implementation Year									
		1	2	3	4	5	6	7	8	9	10
Non-ARBO II Treatments	Road Maintenance/Reconstruction										
	Rock Armoring (Mitigation)										
	Opening Closed Roads										
	New Temporary Roads										
	Commercial Thinning/Log Haul										
	Prescribed Fire										
	Non-commercial Thinning										
	Wetland Thin										
ARBO II Treatments	Controlled Burning (Riparian Underburning)										
	Culvert Replacement										
	Beaver Site Enhancement										
	Drivable Ford Conversion										
	Rock Armoring										
	Soil Restoration										
	Coarse Woody Debris (CWD)										
	Road Closure/Decom/Road to Stock Trail										
	WF Buttermilk Creek Bridge										

VEGETATION TREATMENTS

The Mission Project proposes vegetation treatments on 10,220 acres across the project area. Treatments involve a mix of non-commercial thinning and commercial harvest treatments. Commercial harvest would occur on ~1,853 acres and small diameter, non-commercial treatments would occur on the total 10,220 acres (Table 4).

Table 4. Vegetation treatment summary.

Vegetation Treatment Type	Prescription Summary*	Prescribed Fire				Total Acres (RR Ac/Ac by CH)	Treatment Objective	Riparian Objective
		UB (ac)	HP (ac)	MP (ac)	LNDGs (ct)			
Dry Forest Restoration (DFR)	Thin conifers up to 24" DBH with mechanized equipment. Thin remaining trees <8" DBH with chainsaws. Prune remaining conifers up to 6'.	817	0	463	126	1279 (44/2.7)	Restore structure, composition, and pattern of conifers in frequent fire interval forests. Accelerate growth of and protection of larger trees. Increase stream flow.	**13 Ac** - Slivers of upland units taken to existing road in outer edge of RR to avoid new temporary road. Restore forest health, maintain stream shade, wood recruitment. Retain trees ≥18" DBH. **31 Ac** - increase hardwoods/shrubs for beavers. Winter or other low impact method. 2.7 acres ≥250 ft from streams.
Dry Forest Restoration Thin with Dwarf Mistletoe Reduction (DFDMT)		199	0	87	29	286 (0/0)	Restore structure, composition, and pattern of conifers in frequent fire interval forests. Reduce Douglas-fir dwarf mistletoe infection. Accelerate growth of and protection of large trees.	N/A
Aspen Release		135	25	0	16	160 (6/0.8)	Release aspen from conifer encroachment. Stimulate & diversify development of aspen.	Same. Maintain stream shade, wood recruitment. Retain all trees ≥18" DBH. 0.8 acres are >250 ft from streams.
Moist Forest Thin (MFT)		3	0	67	7	69 (2/0.3)	Maintain large trees and structural diversity. Accelerate development of large trees in dense multi-story (NSO) habitat. Reduce risk of crown fire initiation in NSO habitat.	**0.3 Ac** - Slivers of upland units taken to existing road in outer edge of RR to avoid new temporary road. Restore forest health, maintain stream shade, wood recruitment. Retain trees ≥18" DBH. **1.7 Ac** - increase hardwoods/shrubs for beavers. All winter or other low impact method. 0.3 Ac is ≥250 ft from streams.

Vegetation Treatment Type	Prescription Summary*	Prescribed Fire				Total Acres (RR Ac/Ac by CH)	Treatment Objective	Riparian Objective
		UB (ac)	HP (ac)	MP (ac)	LNDGs (ct)			
Variable Retention Regeneration (VRR) [Includes WHIP]	Harvest conifers up to 24" DBH with mech equipment. Fell remaining undesirable trees up to 8" DBH with whip felling. Prune remaining conifers ≤6'. Replant, after.	59	0	0	0	59 (0/0)	Promote early seral species and regenerate a new cohort of trees in the majority of the unit while maintain components of structural diversity.	N/A
Total Commercial Harvest		**1154**	**25**	**617**	**178**	**1794 (52/3.8)**		
Conifer Girdling for Aspen Restoration (CGAR)	Thin conifers ≤10" DBH in 15 – 30' circles around aspen trees with chainsaw. Girdle conifers 10 – 21" DBH with chainsaws.	24	47	0	0	71 (26/0)	Release aspen from conifer encroachment .Stimulate & diversify development of aspen. All done by hand.	
Post and Pole Thin (PP)*	Thin conifers up to 13" DBH with chainsaws; remove trees by hand (no mechanized equipment – personal use). Thin conifers greater than 2' tall and ≤8" DBH with chainsaws. Thinning would occur in 15 – 30' circles around trees >8" DBH. Prune remaining conifers up to 6'.	36	0	0	0	36 (0/0)	Reduce densely stocked, mixed conifer stands and reduce fuel loading. All cut and removed by hand.	
Total Non-Commercial Overstory Thinning		**60**	**47**	**0**	**0**	**107 (26/0)**		
Young Plantation Thin (TSI)	Thin conifers up to 8" DBH with a chainsaw. Prune remaining conifers up to 6'	0	1652	85	0	1737 (86/24)	Reduce stand density. Accelerate growth of larger trees. (Promote early seral species while maintaining species diversity). Stream buffers described in Table 8.	
Wetland Thin (WT)	Thin conifers up to 8" DBH with chainsaws in Black Pine Meadows and Mission Pond*	0	22	0	0	22 (22/0)	Reduce conifer encroachment on wetland vegetation. No aspen or other broadleaf deciduous trees would be felled.	
Ladder Fuel Thinning (LFR8)	Thin conifers ≤ 8" DBH with chainsaws. Thinning would occur in 15 – 30' circles around trees >8" DBH. Prune remaining conifers up to 6'.	5345	1155	0	0	6501 (534/179)	Restore stand structure, composition, and pattern in frequent-fire return interval forests. Accelerate growth of and protect larger trees. Reduce risk of crown fire initiation. Increase public/firefighter safety and suppression options.	
Total Non-Commercial Thinning Understory		**5345**	**2829**	**85**	**0**	**8260 (1284/203)**		

*Note – these meadows are already excluded from cattle with fencing.

Commercial Harvest

The wood fiber proposed for harvest would amount to about 6.3 million board feet of saw logs (1,575 truckloads), a value that may decrease as unit boundaries are shrunk and/or units are dropped (there would be no added/grown units). Commercial harvest prescriptions generally involve thinning stands with some regeneration harvest acres. See Appendix A for all vegetation treatment prescriptions. See Appendix B for each vegetation unit description.

The commercial timber harvest would employ a couple different strategies to minimize soil impact: harvesting over frozen ground, using lower-impact harvest equipment like harvester-forwarders, and requiring slash mats on multi-pass skid trails during summer harvest. Approximately 577 acres (~30%) would be restricted to winter harvest operation, over frozen ground, or another method with similar low impacts that minimize compaction and displacement of detrimentally impacted soil conditions to no more than 1-2% ground disturbance. The other 1,276 acres would be optional summer or winter harvest. All summer harvest would be done with harvester-forwarder equipment (cut-to-length; CTL) or other lower impact equipment where sensitive soils occur. Conventional feller-buncher/grapple skidder (whole tree logging) equipment would be used where soils have higher resiliency. Slash mats would be required on all multi-pass skid trails and a minimum depth of six inches on trails used by rubber tired skidders. Figure 5 and Table 5 display winter and optional season harvest areas.

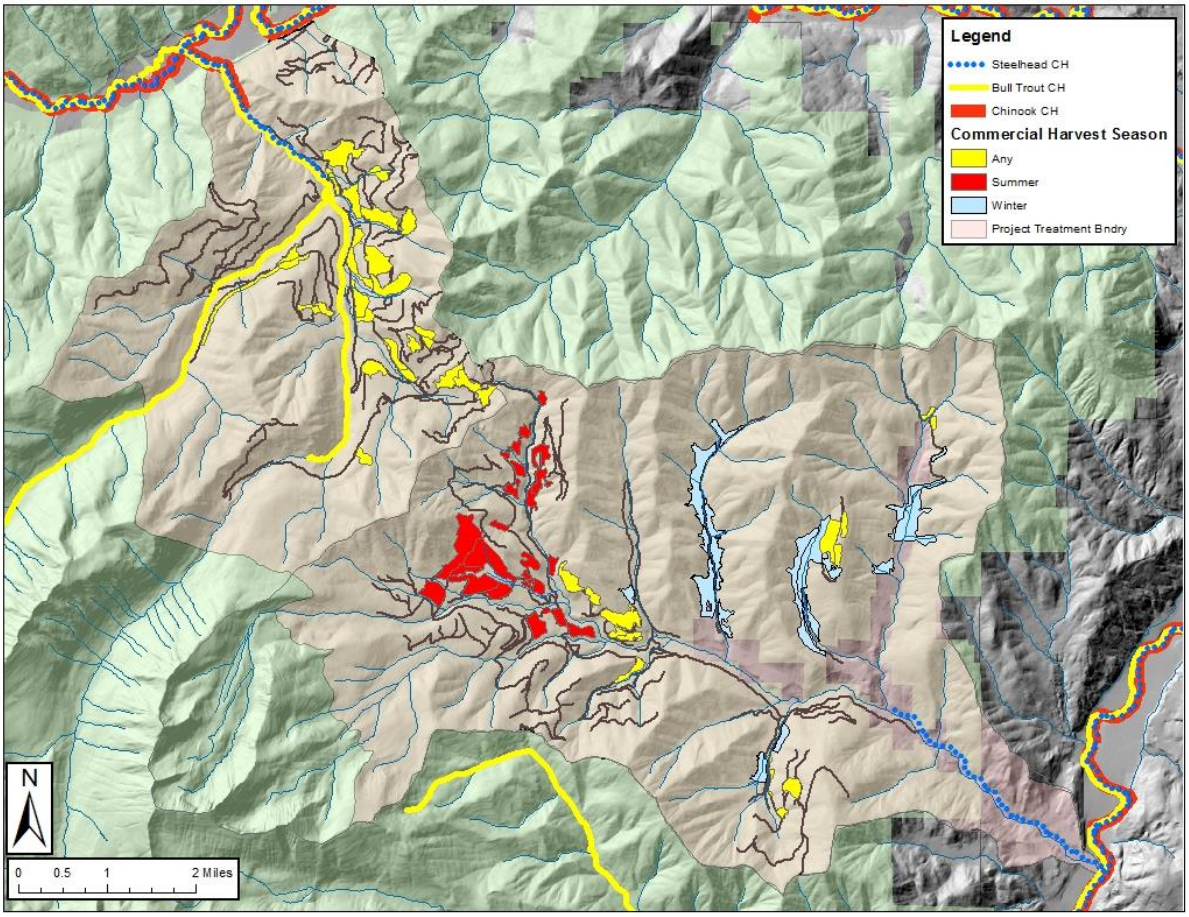


Figure 5. Proposed commercial harvest seasons.

Table 5. Displays seasonal and sub-watershed distribution commercial harvest operation.

Harvest Season	Buttermilk	Libby	Total
Winter	0	577	577
Optional (S/W)	545	229	774
Summer		502	502
Total	545	1308	1853

General Commercial Harvest Parameters:

1. Conifers 7 to 9 inches DBH up to 24 inches diameter at breast height (DBH) would be harvested with the following provisions:

    a. All trees greater than 24 inches DBH would be retained

    b. Trees 21 inches DBH and larger with an estimated age of 150 years or greater (based on criteria described in Van Pelt 2008) would be retained.

    c. Trees 21 to 24 inches DBH with an estimated age of less than 150 years would occasionally be harvested to release a larger (more preferred species) tree, reduce dwarf mistletoe infection, or reduce conifer encroachment in aspen stands (except in areas with field verified old forest multistory structure located in unit 21) when consistent with treatment objectives.

    d. Thin conifers from below retaining trees among the largest, most vigorous, and most preferred conifer species present to meet treatment objectives.

    e. Conifer species preference for retention, unless specified otherwise, is as follows in descending order: ponderosa pine, Douglas-fir, Engelmann spruce, lodge pole pine, and subalpine fir.

2. Conifers less than seven to nine inches DBH which exceed desired tree density levels and are not needed to meet resource management objectives also would be removed at the time of logging if favorable market conditions exist.

3. Conifers less than seven to nine inches DBH remaining following harvest which exceed desired tree density levels and are not needed to meet resource management objectives would be felled in a ladder fuel reduction treatment (see Ladder Fuel Reduction thin description below for specifications). Conifers felled post-harvest would be made available for firewood gathering where consistent with fuels management and stand treatment objectives and the current firewood policy. See below for more details on firewood gathering.

Commercial Harvest in Riparian Reserves

Fire exclusion, past timber harvest, grazing, and beaver population decline have altered the vegetation conditions and vulnerabilities to natural disturbances in RRs. Tree species composition, tree stocking levels, and size class distribution of many RR forest stands have changed, especially in the dry forest environmental zones. Large trees are now less common compared to historic levels. Current tree-stocking levels are sufficiently high that hinder the maintenance and development of large trees. Resiliency of RR vegetation to natural disturbances, like diseases and wildfire, has decreased compared to historical conditions in project area RRs. Aspen stands and other hardwood plant communities where they currently exist are in decline, primarily because of fire exclusion and conifer encroachment. The decline of beavers is believed to have caused a decline in wetland habitat and hardwoods along streams. Overall, many RRs are in undesirable condition.

Under historical conditions, RRs along larger fish bearing streams would have multi-aged canopies that provide adequate wood, stream shade, and nutrient input. Wood loading would be considerably

higher than current conditions. Fox and Bolton (2007) suggest the fish bearing streams Douglas-fir and ponderosa pine forests should have between 240 and 270 pieces per mile while current pieces range from 74 to 221 pieces per mile with an average of 134. Natural rates of bank erosion, stream sediment levels, and channel stability would exist. Riparian forests would have natural rates of disturbances and appropriate resilient vegetation conditions.

To move some RRs towards desired conditions, the USFS proposes to commercially thin 52 acres of previously managed stands. These acres involve 32 acres to improve beaver habitat, 14 acres of slivers of larger landscape units that opted to take units to existing roads instead of new temporary roads, and 6 acres for aspen stand improvement. About four acres of harvest would occur in the outer edge of RRs associated with critical habitat for bull trout and occupied steelhead streams above critical habitat. Table 6 defines the different treatments and the amount of harvest in proximity to ESA streams.

The shortest distance between harvest units and Critical Fish Habitat is within the Buttermilk Creek drainage where a few units are on the outer edge of the East Fork Buttermilk Creek RR. These units are at least 250 feet away from the creek and above an existing road. In the Libby Creek drainage, the closest RR harvest unit is 1.5 miles upstream from critical habitat.

The project prescribes a few different RR harvest design criteria to reduce potential short-term impacts to insignificant levels and to meet ACS objectives: winter harvest (or a similar low impact method), no-treatment equipment buffers along streams, and slash mats on multiple use (>1 pass) skid trails. Alternative harvest methods would be allowed in the winter harvest areas if the purchaser presented a method with in no more than 1-2% ground disturbance. Any new proposal would be vetted through the timber, hydrology, soils, and fisheries specialists and must be deemed effective in meeting this low impact design criteria before approved. The ~11 acres of harvest outside of winter would occur on gentle slopes (<10%) and over 100 feet from adjacent streams.

Table 6. Riparian Reserve Harvest Treatments.

Treatment Objective (prescription)	Approx. acres of treatment by season			Total RR Acres	Acres adjacent to CH
	Winter	Optional Summer/Winter	Summer		
Aspen Release		6		6	0.8***
Slivers in outer edge to treat stand for larger treatment and avoid new temporary road (DFR/MFT)*	9	4	2	14	3.0***
Beaver Site Enhancement (DFR/MFT)	32			32	0
All treatments	40**	10	2	52	3.8

* Note, the stands for these small pieces are slivers of forest that are similar to upland conditions and would benefit from thinning like the upland stands would. [To make clear there is ecological benefit as well]
**All RR harvest treatments in the Libby Creek drainage would be done in winter or some other harvest method, but only if it results in no more impacts than winter harvest does.
***These units are at least 250 feet away from the creek and above an existing road. In the Libby Creek drainage, the closest RR harvest unit is 1.5 miles upstream from critical habitat.

No-treatment buffer strips along streams is an effective way to decrease effects from adjacent timber harvest. Minimum buffer widths are suggested from various studies and management guidance to maintain important stream attributes like water temperature, wood recruitment, and

sediment levels (FEMAT 1993, Rashin et al. 2006, Sweeney et al. 2014). Factors that influence sediment transport distances include infiltration rates, hillslope gradient, and surface roughness. Table 7 displays the prescribed stream buffer widths that were developed for the project following multiple field trips with the ID Team, the project fish biologist, and project hydrologist, and are based on site conditions and literature review (Rashin et al. 2006; Liquori et al. 2008). Along perennial streams, the heavy equipment buffer width would be at least 100ft, consistent with FEMAT guidance (p. V-28, 29;1993) to maintain shade. Along intermittent channels, the project would employ a variable buffer width based on adjacent valley slopes and the presence of inner gorge features. Minimum equipment buffers widths would be >50 feet when slopes are 10% or less and 75 feet with slopes 16-25%. Slopes exceeding 25% would receive full 100-foot buffers. Treatment along Chicamun Canyon Creek and a portion of Hornet Draw (both intermittent) would allow equipment to reach in closure than 50 feet to remove trees from these buffers in order to maximize benefit for hardwood development. These areas would be winter harvest or other low impact method. One other harvest unit is along an intermittent stream that would be optional summer/winter harvest and the equipment and thinning buffers would be the same. This unit is upstream of a ~2 mile subsurface reach with no potential for downstream impacts. This is limited to units Equipment tracks would meet the following buffer widths. See below for rationale for this prescription. All proposed harvest along intermittent streams would be winter harvest or other low disturbance method. Where commercial harvest would occur in RRs outside of winter conditions, all units are located at least 100 feet from the adjacent stream and on ground less than 10% slope.

Natural features to protect adjacent channels include undisturbed ground cover, often with dense mats of grass and snowberry, along with downed wood. Sediment transport increases with increasing slope. Increasing the buffer widths as slopes increase is expected to provide greater protection in these areas.

Table 7. Minimum commercial harvest no-treatment buffer widths along streams.

Riparian Harvest Equipment Buffers			
Stream Type	**Equipment Buffer Width**	**Harvest Buffer***	**Adjacent Slopes**
Intermittent channels	≥ 50ft or inner gorge**	≥ 25ft	0-10%
	≥ 70ft or inner gorge	≥ 45ft	11-25%
	≥ 90ft or inner gorge	≥ 65ft	26-35%
Perennial Non-fish	≥ 100ft		< 35%
Perennial Fish	≥ 100ft		< 35%

*What equipment can reach from equipment buffer distances in select units to benefit hardwood species. This is limited to just units 53-57.
**Slopes breaks where gradient is >35%

Summer harvest in the outer edges of RRs would use slash mats to reduce soil disturbance. All summer skid trails with two passes or more would have 6-inch deep slash mats. The advantage of slash mats is they distribute the weight of the heavy equipment over a larger area on skid trails, thereby reducing direct contact between the machine tires and the soil surface. In addition, this can minimize soil rutting by using slash to reinforce skid trails and protect against soil compaction (Eliasson and Wasterlund 2007). Other protections include using designated skid trails, existing trails used whenever possible, and no crossing of streams except at one pre-identified location. Skid trails would be rehabilitated with features like water bars, slash, etc. See project design criteria for more details.

Specific design criteria included in Table.8 ensure that Forest Plan and Northwest Forest Plan standards and guidelines/ACS Objectives are met. Harvest in the RRs would only take place in the outer portions of the management areas and heavy equipment use and harvest would not occur in areas that are perennially wet or where mesic vegetation conditions are dominant. Prescriptions harvest within RRs would be designed to restore historic vegetation characteristics and disturbance intervals by managing for large trees, historic hardwood/aspen components, allow for more hardwood development, and increasing resiliency to disturbance by fire, insects, and disease. These objectives are the drivers for the treatments and protective measures to minimize short-term impacts like mostly winter harvest, no-treatment buffers, and falling trees into and towards streams would ensure that the ACS is met, according to the best available science. Commercial harvest would occur within the prescribed equipment buffers around two beaver enhancement sites. These RR areas (~32 acres total) were identified as suitable beaver release sites, but need more shrubs and hardwoods for beaver food. These sites are associated with intermittent streams and within drier RR sites in Libby Creek. Increasing sunlight and reducing competition for water and nutrients would allow more hardwoods and shrubs to grow. Opening up these drier sites would allow more hardwood generation, setting these areas up for future beaver release. Once beavers are established, we anticipate increased natural water storage and improved base flows. To minimize impacts to soils and surface erosion, commercial harvest within RRs would be done as winter harvest or another method that could be proposed that has the same level of detrimental soil disturbance (DSD) (~1-2%) and equipment buffers would be 50, 70, or 90 feet depending on slopes.

<u>General Commercial Harvest Parameters within RRs:</u>

1. Harvest treatments conducted in Riparian Reserves would occur to benefit and restore aquatic resources. Regeneration harvest would not occur in Riparian Reserves. All trees 18 inches DBH and larger would be retained in Riparian Reserves.

2. Harvest treatments in Riparian Reserves located in harvest units 53 - 57 are along small non-fish bearing intermittent streams and would be conducted as follows to meet aquatic resource management objectives:

    a. Twenty to 30 conifers per acre on average would be retained in accordance with the Dry Forest Restoration Thin treatment criteria (described above) to reduce conifer competition with existing deciduous vegetation and promote the establishment of additional deciduous trees and shrubs.

    b. Harvest would occur an additional 25 feet closer to intermittent stream channels than standard harvest buffer design features described for the project based on what heavy equipment can reach. Ground based harvest equipment tracks would be restricted to at least 50 feet. See buffers listed in Table 7 above.

    c. Riparian Reserve conifers located between intermittent streams and the boundaries of harvest units 53 - 57 would be hand-felled toward the stream to add coarse woody debris into the channel or girdled to retain an average live conifer stocking level of the largest 20 to 30 trees per acre to reduce conifer competition with existing deciduous vegetation and promote the establishment of additional deciduous trees and shrubs. No commercial harvest would occur in this zone.

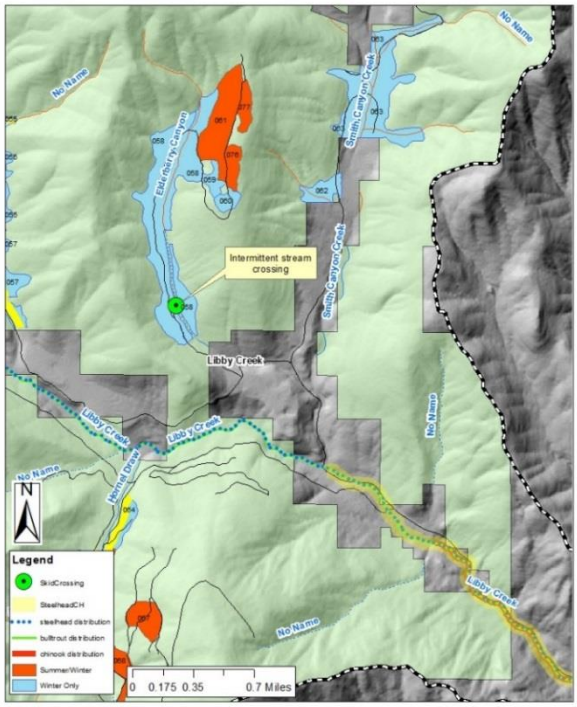
Table 8. Commercial Harvest Treatment Matrix – General Design Criteria for treatments in Riparian Reserves.

Stream flow regime	NWFP designated RR management zone. All treatments must maintain or help attain ACS OBJECTIVESs	Harvest Treatment Buffer	LFR8/NCT[2] Treatment	Landing Const., Pile Burning
Ephemeral Drainage Features	Ephemeral draws are defined as draws with no defined channel or signs of annual scour or deposition. NWFP does not designate RRs for ephemeral drainage features.	No buffer/do not skid up-down low point of draws, minimize/ mitigate crossings	No restrictions	Avoid new landings/ piles directly within low point of draws.
Intermittent Streams (defined by presence of defined channel, scour/deposition)	From intermittent stream channel and area to top of inner gorge, or outer edges of riparian vegetation, or to distance equal to height of one site-potential tree, or **100 feet slope distance (200 feet total, plus stream)**, whichever is greatest.	*Equipment Buffer* – 50ft for 0-10% slopes. Winter harvest or no equipment in RR. Trees within reach of equipment from buffer allowed for harvest in beaver units[3].	25-foot buffer or inner gorge (>35%), whichever is greater, LFR/NCT cutting of understory trees	Mitigated Landing locations and designated landing locations/ avoidance areas (Appendix C)
		Equipment Buffer – 70ft for 11-25% slopes. Winter harvest or no equipment in RR. Trees within reach of equipment from buffer allowed for harvest in beaver units [2].		
		Equipment Buffer – 90ft for 26-35% slopes. Winter harvest or no equipment in RR. Trees within reach of equipment from buffer allowed for harvest in beaver units [2].		
Perennial Streams non-fish-bearing streams and	From edges of active stream channel to top of inner gorge, or to outer edges of 100-year flood plain, or to outer edges of riparian vegetation, or to distance equal to height of one site-potential tree or **150 feet slope distance (300 feet total, plus stream),** whichever is greatest	Buffer - 100ft. Winter harvest or no equipment in RR.	50-foot buffer LFR/NCT cutting of understory trees. CGAR (girdling) will be at least 100 feet from streams.	
Fish-bearing streams	From edges of active stream channel to top of inner gorge, or to outer edges of 100-year floodplain, or to outer edges of riparian vegetation, or to a distance equal to height of two site-potential trees, or **300 feet slope distance (600 feet total, plus stream)**, whichever is greatest.			
Constructed ponds and reservoirs, and wetlands greater than 1 acre	From waterbody or wetland to outer edge of riparian veg., or to extent of seasonally saturated soil, or a distance equal to height of one site-potential tree, or 150 feet slope distance from edge of wetland/waterbody, whichever is greatest.			
Lakes or natural ponds	From lake or pond to outer edge of riparian vegetation, or to extent of seasonally saturated soil, or to distance equal to height of one site-potential tree, or **300 feet slope distance** from edge of wetland, pond or lake, whichever is greatest.			

[2] Hand-cutting activities, LFR – ladder fuel reduction, NCT – non-commercial thinning.
[3] See beaver discussion above for reason for this.

Tree yarding in RRs

Tree yarding would occur outside of no-treatment buffer zones except for one skid trail crossing. Unit 58 is a winter harvest unit with Elderberry Creek running through the middle. This unit would avoid harvest within the full RR, but trees will be harvest on both sides of the RR. One skid trail would cross the intermittent channel during winter harvest conditions using a tracked or rubber tired skidder. The location identified has gentle approaches without steep banks. All other log skidding would occur outside of no-treatment buffers along streams.



Landings

Harvest units would have an average of one landing per 10 acres of harvested area. For the proposed 1,897 acres in harvest units, all harvest acres except the VRR would have landings. This amounts to ~187 landings averaging up to 0.1 acres per landing pile, or about 19 acres of landing piles. Within RRs, there would be 52 acres of commercial harvest in the outer edge that includes ~5 landings or about 1/2 acre total. No landings would occur within the prescribed stream buffers defined on in Table 7. These landings would be located away from channels to prevent sediment delivery to the stream and would only occur on where side slopes are five percent or less. During use in RRs, erosion control measures such as silt fences or other retention methods would be installed prior to landing construction and would remain in place during harvest operations. All landings with heavily disturbed soils and all landings within RRs would be scarified, seeded, and organic debris would be scattered over them after harvest activities are complete. See Appendix C for more details on landings. See Appendix C for more details on landings.

Noncommercial Thinning Units

The project proposes five different non-commercial thinning (NCT) treatments: post and pole thin (PP), young plantation thin (TSI), ladder fuel reduction thin (LFR), wetland thin (WT), and conifer girdling for aspen restoration (CGAR). Resource objectives vary, but collectively they are to improve stand vigor and resiliency, reduce tree densities, inter-tree competition, fuel loading, aspen stand conservation, and wetland habitat. Trees thinned in these treatments mostly represent understory trees and are not in the overstory canopy. One exception is the CGAR girdling, which would cut and leave standing some overstory trees. A total of 10,220 acres of NCT is proposed across the project area. Most of the acres are as LFR (~81%) followed by TSI (~16%). All work would be done by hand with chainsaws. Subsequent slash would be treated to reduce fuel loading, described under Fuels Reduction below. Table 9 shows the acres of each treatment. See Appendix B for detailed descriptions of each treatment.

Within RRs, 668 acres of NCT is proposed followed mostly by pile burning and under burning. Tree cutting buffers would be used to protect banks and filter sediment along perennial and

intermittent streams. No tree felling will be done within 25 feet of intermittent stream channels or within the inner gorge (>35%), whichever distance is greater (Table 9). Along perennial streams, no trees cut within 50 feet of the stream. No slash piles will be constructed or burned within 25 feet of an active channel edge or within the inner gorge of an intermittent or within 50 feet of perennial non-fish and fish- bearing channels, whichever distance is greater. Slash piles would average about 15 per acre with an average size of 4 feet by 4 feet, and would be burned after curing for about one year.

Table 9. Total Non-Commercial Thinning (NCT) treatments and acres within RRs

Row Labels	Sum of Acres	Sum of RR acres	Sum of Acres adjacent to CH
PP	36.2	0	0
TSI	1,737.1	86	24
LFR8*	8,331	534	179
Whip	58.7	0	0
WT	21.6	22	0
CGAR	71.4	26	0
Grand Total	10,220	668	203

* LFR8 associated with post-harvest acres, PP acres, and on acres within the stand-alone fuels units discussed below.

Reforestation Treatments

The 59 acres of regeneration units (VRR) would be replanted to ensure prompt reforestation with desired tree species and stocking levels. Underburning would occur to diminish slash and prepare the sites for replanting. Seed tree regeneration harvest units would be reforested with a combination of hand planting ponderosa pine seedlings and natural regeneration of primarily Douglas-fir seedlings. Approximately 150 pine seedlings per acre would be planted to ensure that minimum tree stocking levels of 100 seedlings per acre are established within five years of the completion of harvest activities. The desired tree species mix of conifer regeneration is approximately 70 percent ponderosa pine and 30 percent other conifer species.

PRESCRIBED FIRE TREATMENTS

Overview

Past timber harvest and fire exclusion within the project area have contributed to extensive changes in forest vegetation over the last century, including increased tree density, decreased average tree size, and increased proportion of multi-story shade-tolerant Douglas-fir forest cover. Several stands are now likely to experience higher severity fire behavior and effects based on FlamMap modeling. In addition, the number of homes and other structures on adjacent private lands (within the WUI) has increased over the past 30 years, increasing the need to keep fuel loading low. Overall, prescribed fire treatment objectives are to reduce stand densities and fuel levels to increase resilience to characteristic wildfire behavior and effects and reduce fire hazard on National Forest lands within the WUI.

To reduce surface, ladder, and crown fuels within the project area, 10,220 acres of prescribed fire treatments are planned as combination of post-harvest treatments, post-NCT treatments, and

standalone fuels units (Table 8 and displayed in Figure 6). Treatment activities include LFR (discussed above), underburning, hand piling, landing piling, machine pilling, pile burning, and dozer and hand fireline construction. Total prescribed fire treatments include 1,897 post-harvest acres, 6,492 acres of stand-alone fuels treatments, and 1,738 acres of post-NCT acres. Total fuels treatment acres treated within Riparian Reserves would be 668 acres, see below for details.

Table 10. Total Prescribed Fire Treatments

Treatment	**Acres**	**Notes**
Total prescribed fire treatments (harvest + standalone acres)	~10,220	
Hand-piling and pile burning	2,901 acres	Average 25 piles per acre, 4x4' area
Machine-piling and pile burning	701 acres	Average 12 piles per acre, 10x10' area
Underburning*	7,361 acres	
Landing pile burning	185 landings	~1 landing per 10 acres, 0.1 acre each
Riparian Burning	**668 acres**	See Table 11 below

*Note – 744 acres of underburning would occur on some units with hand-piling and all machine pile units. This inflated the total acres.

Underburn and Fire Line Treatments

Underburning objectives include reducing surface fuels and to some degree increasing canopy base heights through some minor tree scorching. Prescribed fire are strategically set during times of when flame lengths are expected to be low, fire residence times are expected to be short, soil heating is expected to be low, and the effects of prescribed fires on soil properties are limited in severity and extent. Underburning would retain at least 90 percent of live trees 20 inches diameter at breast height (DBH) and larger in areas where prescribed burning is conducted (Wright et al. 2003). Tree bole char, crown scorch, or root damage would be minimized. Underburns would be ignited by hand or with aerial devices such as a helitorch or plastic sphere dispenser.

Underburning is planned on a total 7,351 acres across harvest units and standalone fuels units. The underburning includes a proportionately small amount of burning in RRs. A total 273.6 acres (<5%) of underburning is planned within RRs. We propose active ignition, as needed, within RRs to better achieve the above burn objectives because active ignition within RRs allows much greater control over fire behavior and spread. See discussion below for more details on this.

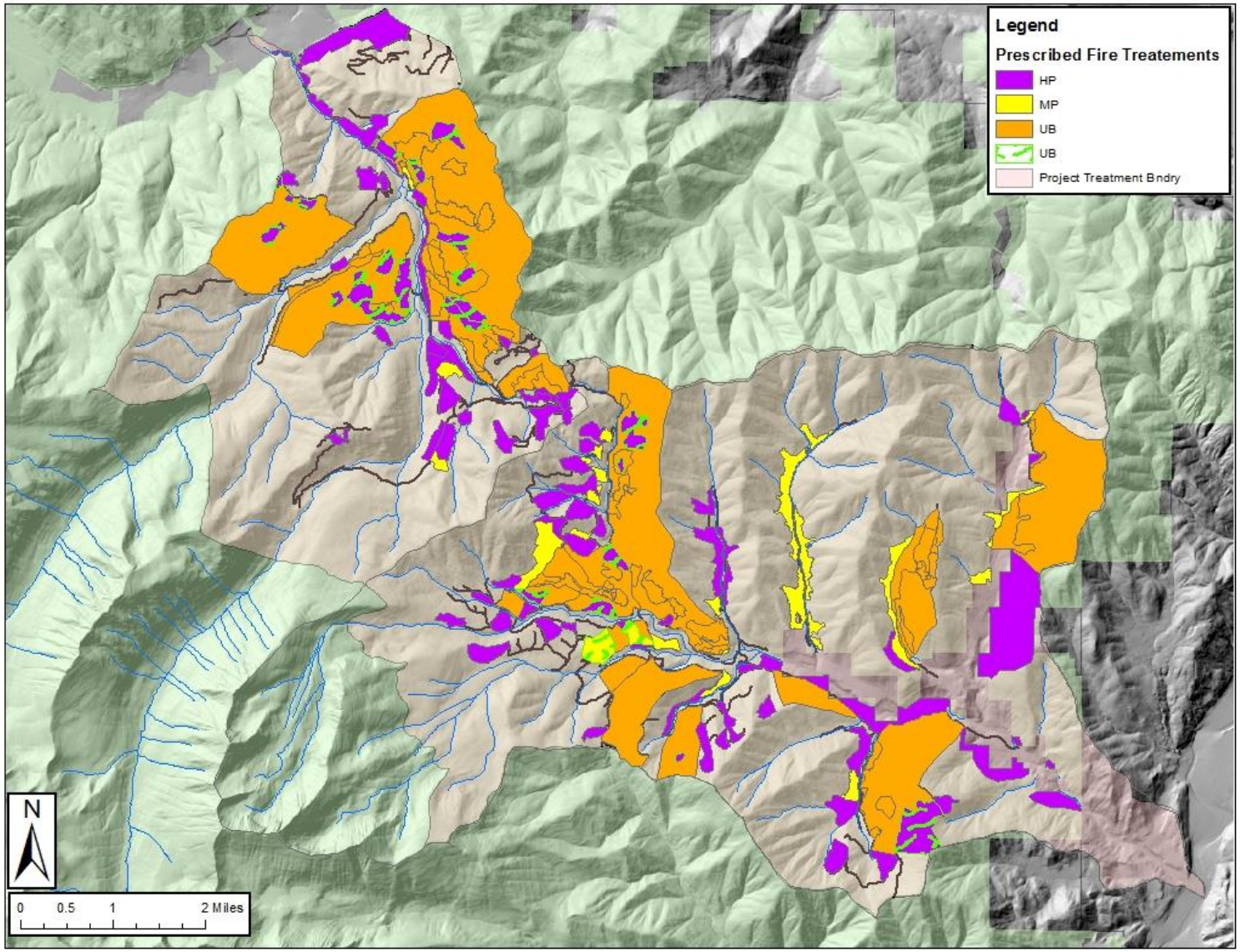


Figure 6. Proposed fuels treatment areas. HP = Hand Piles, MP = Machine Piles, and UB = Underburning. Green underburning would occur after HP treatments.

To control the underburns, fireline would be constructed or existing roads used whenever possible to minimize soil disturbance and erosion. An estimated 2.6 miles of new dozer line (three to five feet wide) and 30 miles of new hand fireline (up to 18 inches wide) would be constructed to contain underburns. The dozer utilized would be a smaller size machine similar to a D3 class dozer and the constructed line would be three to five feet wide. Surface fuels and vegetation would be removed during fireline construction to expose mineral soil. All downhill fireline constructed would be water-barred during construction. Of this amount, about 1.4 miles of new hand fireline would be constructed in Forest Plan Old Growth (FPOG) to contain underburns; another 2.1 miles of existing hand fireline in FPOG would be re-utilized for the same purpose. An estimated 1.9 (0.4 mi Buttermilk and 1.5 Libby) miles of new hand fireline would be constructed in the outer edges of RRs to contain underburns; most of this is comprised by short segments (a few hundred feet each) that tie into features such as roadways, at perpendicular angles to stream features. There will be no dozer line in RRs. See Appendix D Mission Design Criteria (#6) for rehabilitation standards pertaining to firelines.

Machine, Hand, and Landing Piling and Pile burning

A total 3,612 acres of pile burning is proposed across the entire project. Of these acres, 736 acres of machine piling is proposed within harvest units and two TSI units. The remaining acres would be hand pile burning and landing pile burning. Machine piling would consist of an average of 12 piles per acre that are 10'x10' in size. Hand piling would be about 25 piles per acre with a size of 4'x4' in size. Landing piles are bigger, estimated to be 1/10th of an acre in size.

Machine piling would be done with a tracked or wheeled piece of equipment. Unit 347 overlaps a RR to an existing road in the Libby Creek drainage and is proposed for machine piling, as a primary prescribed fire treatment. An additional 9 acres are proposed as an adaptive management strategy if smoke emission clearances are not granted (See below for details). Total machine pile acres for the unit is 2.0 on flat terrain and at least 150 feet from the adjacent stream. Project design details for machine operation would use existing skid trails, whenever possible, and make single passes to collect debris that is reachable from skid trails. Machinery would operate on slash whenever possible and should operate in linear passes to avoid soil displacement from turning. No new detrimental soil disturbance would occur from machine-piling and burning. Hand piling would occur on 390 acres of RRs. All piles would be burned in the fall season after surrounding fuel moistures have increased enough to limit fire creep on the forest floor. Design criteria for pile construction in RRs includes minimizing piles directly within the bottom of ephemeral draws, using the same buffer distances along intermittent streams and slopes as defined for harvest. Along perennial streams, the piles would be located outside of 50ft of perennial streams or above the inner gorge (>35%), or beyond mesic riparian vegetation, whichever is greater. See Tables 8 (above) and 10 for more details. All piles would be allowed to cure for a period, generally from 1-3 years, and then would be ignited by hand using a drip torch, propane torch, or fusee.

Landing piles are built during harvest operations and are about 0.1 acre is size. Appendix C gives more details on landing operations. We estimate 1 landing per 10 harvest acres, excluding the VRR units. This amounts to ~187 landing piles and about 19 acres total spread out over 1,871 acres. With there being about 52 acres of harvest in the outer edge of RRs that amounts to about ~5 landings or about 1/2 acre total. See discussion below for more details.

Prescribed Fire in Specific Areas

The following information describes how the treatments (Rx) described above are implemented in specific areas. Acres listed are included in treatment descriptions above. These are included in the effects analysis and for consultation.

Twisp Annex

The project proposes to reduce fuel loading on FS lands adjacent to private land in the Lower Twisp River sub-watershed. Proposed treatment includes 163 acres of LFR, hand piling, and pile burning. The unit is located outside of the Buttermilk Creek sub-watershed and lies upslope from the Twisp River (~520 feet), well outside the Twisp River RR width. The unit is located within a two small, first order tributary streams to the Twisp River, which would include 22 acres of RR treatment. One objective for this unit was to have no effect to aquatic resources. Therefore, this particular unit would have a 50-foot buffer along the streams thinning, piling, and pile burning to avoid any aquatic/riparian impacts. Trees 50 feet or taller would not be cut within the RR 22 RR acres

Riparian Reserves

Historic fire regimes in the low to mid-elevations of the Mission Project area were mostly frequent (<25 yr), low severity fires with some moderately frequent (25-100 yr), mixed severity fires. Forest stand types are mixed ponderosa pine and Douglas fir forests. Past fire suppression and logging practices altered forest vegetation structure and composition, including RRs. The Mission Project proposes a mix of fire treatments across a range of RRs throughout the project area. An estimated 668 acres of proposed fire treatments lie within RRs (combining standalone fuels units, NCT and post-harvest units), thus about one-eighth of total ~5,000 project area RR acres would have some prescribe fire. These treatments include a combination of 273 acres of underburning, 390 acres of hand piling and burning, 1.8 acres of machine piling and burning, and 52 acres of landing piling and burning (Table 11). See Table 8 and 12 for protection buffers for fuels treatments.

The Mission Project proposes to reintroduce low severity fire (underburning) across 273 acres in RRs with the goal of restoring vegetation species composition and structure that occurs under more natural dry forest conditions. Other goals include increasing resilience to forest fires and climate change, promote snag recruitment, increase natural wood recruitment to streams, and improve overall spatial heterogeneity.

Table 11. Prescribed fire treatments in RRs and adjacent to CH streams.

Treatment	Acres	Acres by CH	Notes	ARBO II (Y/N)
Total Fuels treatments (harvest + standalone fuels)	668	219		
Underburning (harvest + NCT + standalone fuels)	273*	30**	Burn Objectives - maintain 95% survival of overstory trees, 2/3 survival (~66%) of understory/shrub layer, and 65% ground cover/organic material on surface	Yes
Hand pile & pile burn (harvest + NCT + standalone fuels)	390	183	~9,700 piles, **~3.6 acres total pile burning**	No
Machine Piling (harvest + NCT)	1.8	1.8***	~22 piles, **0.04 acres total pile burning**. Above existing road, on flat terrain.	No
Landing Piling (harvest)	52	4.2	~5 landing piles, **1/2 acre total pile burning**	No

*Note – some of these acres appear inflated, but some of the handpile units would be underburned. These numbers represent the total acres for each treatment type.

**Each of these burn units have a control line located at least 200 feet from the stream that would prevent fire from reaching the stream edge..

*** This one unit is along NF Libby Creek and over 250 feet from the creek and on flat ground.

Controlled Burning (ARBO II): The proposed underburning in RRs is intended to re-introduce low severity fire to restore plant species composition and structure that occurs under more natural dry forest fire regimes associated with lands in the eastern Cascade Mountains. These units associated with larger landscape burns with similar treatment objectives for upland vegetation conditions.

Hydrologic effects of prescribed burning mostly depend on fire severity and the amount of area burned (Troendle et al. 2010 and Robichaud et al. 2010). High severity burns that consume protective ground cover and expose mineral soils generally increase runoff and surface erosion. Alternatively, low severity burns that only consume the upper litter layers have little hydrologic and surface erosion effects (Troendle et al. 2010 and Robichaud et al. 2010). Prescribed fire, specifically broadcast burning, is intentionally set during times when relative humidity is higher and air temperatures are lower. This provides for achieving low flame lengths, short fire residence times, and low soil heating. To this end, underburning activities in RRs would be designed with the goal maintaining 95% survival of overstory trees, 2/3 survival (~66%) of understory/shrub layer, and 65% ground cover/organic material on surface.

In order to achieve the goals for burn severity and overstory maintenance, burn and riparian resource objectives, the project proposes prescribed burning within RRs using ignition. During the development of a burn plan, each unit has a site-specific criteria that considers the unit's topography, stand structure, and fuel loading. The burn plan uses fire behavior modeling, which sets target environmental conditions like fuel moisture, wind speed, and humidity based on the above unit's site conditions. To promote retention of surface coarse woody debris (CWD, greater than 6" diameter), fuel moistures for that fuel size class are measured and they need to be high enough to impede ignition and consumption before burning begins. The modeling allows the burn planner to create desired fire behavior, which is appropriate flame lengths or tree scorch heights, so resource objectives can be met. When burn units include RRs, the goal is full retention of shade and sediment buffers to maintain stream temperature and achieve no sediment delivery. Several tools or tactics become available when fire managers are actively bringing fire through the RR that are not available when just allowing backing fires to burn in. During implementation, the burn boss monitors environmental conditions and fire behavior, and adjusts lighting tactics to meet burn and resource objectives. A tactic to limit consumption of CWD is avoid direct ignition of downed wood. A tactic to limit consumption of ground cover in RRs is to use "spot lighting" technique: the lighter starts a small ignition point in one location, moves 15 to 30 feet away (depending on slope, fuel loading, and environmental variables), and ignites another spot, while monitoring consumption and spread and adjusting techniques accordingly. To limit mortality of shrubs and overstory trees, tactics may include using shorter distances between ignition strips; using downslope backing fire rather than upslope head fires; waiting until flame lengths from previous ignition strips are less than two feet before starting the next strip; and pre-burn preparations like scattering concentrations of debris (jackpots). These tactics provide for much greater control when introducing controlled fire into RRs that cannot be achieved from backing fires burning in from the RR boundary.

As an additional protection measure, there would be no active lighting within 25 feet of either side of the intermittent streams and within 100 feet of perennial streams or wetlands. Fire would be allowed to back in. Design criteria like this would be incorporated to minimize and avoid adverse effects to habitat indicators within RRs.

Overall, up to about ~7,351 acres are proposed for possible underburning over about a ten-year period. Roughly half (43%, 2,816 acres) would occur in the Buttermilk Creek drainage and about 57% (3,790 acres) would occur in the Libby Creek drainage. Proposed underburn treatments within RRs would occur as described in Table 12. The acreages for underburning are well below 20% in each sub-watershed. Underburning design criteria within RRs would follow those outlined in the 2013 ARBO II under #35. **Riparian Vegetation Treatment (controlled burning).**

Hand Piling/Pile Burning: A total 390 acres of hand piling of slash and pile burning is proposed within RRs across the entire project. Piles would be built at 25 piles per acre and 4'x4' or 16ft^2 in size, which amounts to an estimated total of 3.25 acres of burned ground over the entire 390 acres. Piling and pile burning would follow the design criteria listed in Table 8 for the LFR8/NCT column. This would leave at least 25 foot buffers along intermittent streams and 50 foot buffers along perennial streams, spread out over ~400 acres.

Machine Piling and Landing Piling /Pile Burning: Out of the estimated 736 acres of machine piling, 5.5 acres are proposed within the outer edge of RRs. Harvest units 022 and 347 overlap with the RR up to an existing road with the resulting slash would be treated by machine. Piling would consist of an average of 12 piles per acre that are 10'x10' in size, which equates to a total of 0.15 acres. The RR portion of unit 022 is bordered by a road and on almost flat ground (<10% gradient). The distance to Blackpine Creek is at least 150 feet. Unit 347 also borders an existing road, is on mostly flat ground, and located at least 250 feet from NF Libby Creek.

The project proposes 52 acres of harvest units in the outer edge of RRs that would have landings and landing pile construction/burning. Based on 1 landing per 10 acres, the maximum number of landings would be 5 or 1/2 acre total over the 52 treatment acres. In order meet ACS Objectives, new landings in RRs would be avoided except for rare circumstances where using an existing site would cause more riparian/aquatic resource damage than constructing a new landing. Landings would be limited to ground with slopes greater than 5% slope would not be approved, the streamside buffer must be well vegetated, any landing used would be above the road, and erosion control measures would be used. See Appendix C for RRs.

Table 12. Prescribed Fire Treatment Design Criteria.

Stream flow regime	**NWFP designated RR management zone. All treatments must maintain or help achieve ACSOs**	**Hand Pile Burning**	**Machine Pile Burning**	**Rx Underburning**
Ephemeral Drainage Features	Ephemeral draws are defined as draws with no defined channel or signs of annual scour or deposition. NWFP does not designate RRs for ephemeral drainage features.	Avoid piles directly within low point of draws, unless no other option is feasible.	Minimize crossings, do not use low point of draw as travelway for equipment. Perpendicular crossings. Avoid piles directly within lowpoint of draws	No restrictions
Intermittent Streams (defined by presence of defined channel, scour/deposition)	Category 4 - Minimum 100 feet slope distance (200 feet total, plus stream), see above	Same as Harvest Rx	Permitted in outer edge of RR in unit 347 in Proposed Action. None other is proposed as a primary prescribed treatment. As an adaptive management strategy, it would be permitted in outer edge of RR in units 019 and 064 in Adaptive Strategy. None other proposed under AS.	Active lighting **within** RR up to 25 feet of channel with maintaining 95% survival of overstory trees, 2/3 survival (~66%) of understory/shrub layer, and 65% ground cover/organic material on surface. No ignition within 25 feet of stream channels, creeping fire into this zone is acceptable.
Perennial non-fish-bearing streams	Minimum 150 feet slope distance (300 feet total, plus stream), see above	50ft, above inner gorge (>35%), beyond mesic riparian vegetation, whichever is greater.		Active lighting **within** up to 100 feet of channel or wetland with maintaining 95% survival of overstory trees, 2/3 survival (~66%) of understory/shrub layer, and 65% ground cover/organic material on surface. No ignition within 100 feet of stream channels, creeping fire into this zone is acceptable.
Perennial fish-bearing streams	Minimum 300 feet slope distance (600 feet total, plus stream), see above.			
Constructed ponds and reservoirs and, wetlands >1 acre	Minimum 1**50 feet slope distance** from edge, see above.		Permitted in outer edge of RR in units 022 and 347 in Proposed Action. None other is proposed. Permitted in outer 50' of 150' RR. Not permitted anywhere where mesic riparian vegetation dominates.	
Lakes and natural ponds	Minimum **300 feet slope distance** from the edge, see above.		None proposed	

Adaptive Management strategies for prescribed burning

Prior to implementation of prescribed fire treatments, the Fuels Planner would assess fuel loadings and if needed, apply the following adaptive management strategies to better meet treatment objectives. Changes occur that warrant different approaches to managing fuels and using prescribed fire.

- Chipping would be allowed where debris is collected at landings or accessible within approximately 50' from existing open roads. Chipped debris would be widely scattered on forest floor. Chipper and transport vehicle would only use open roads and would not go off roads. This activity would applies to approximately 397 gross acres in 13 units. Biochar production from landing piles has been analyzed as an alternative to landing slash pile burning.
- Debris from thinning would be machine-piled and piles burned in some units as a substitute for underburning in mechanical thinning units if underburning is curtailed by smoke emission restrictions. This would allow treatment of debris by alternative means if underburning were curtailed. Applicable to 1,028 gross acres in 53 units. If this were to occur, it would happen before the purchaser rehabilitated all skid trails and landings.
- Debris from thinning would be hand-piled and piles burned in some units as a substitute for underburning if underburning is curtailed by smoke emission restrictions. Where machine piling is proposed, if debris is too light for machine piling but still in need of fuel reduction, then debris would be hand-piled and piles burned. This would allow treatment of debris by alternative means if underburning were curtailed or machine piling unnecessary. This applies to 6,199 gross acres in 55 units. The vegetation treatment is same and the only difference is piling downed material into hand piles and pile burning. If this occurs, piles would be built and burned following the stream buffers described in Table 8 for LFR/NCT.
- Firewood collection would be encouraged where landing piles and scattered thinning debris are accessible from open roads, and where consistent with current firewood collection regulations. Only landing pile wood and downed wood in NCT units would be available for collection. Cutting standing trees would be prohibited. This activity would reduce emissions from prescribed burning and applies to approximately 179 gross acres on landings and any thinning units adjacent to open roads. Each firewood collection area (landing piles and NCT units) would be limited to ML 2 or higher roads. Firewood collection would not be allowed from machine piles or hand piles or any roads temporarily open for timber harvest. Areas where material from landing piles and scattered material would be consistent with standard Oka-Wen firewood permits guidelines, which excludes RRs.

Treatments in RRs amount 394 total acres (Table 13). Very limited changes are proposed within RRs associated with critical habitat or occupied steelhead streams. Potential acres for machine piling in RRs, under the adaptive strategy, would be 9 acres in units 019 and 064. Each of the units boarder existing open roads and are located on nearly flat ground (<10%) gradient. Distance to adjacent streams is at least 100 feet or one site potential tree (SPT) length. See accompanying PDF for Adaptive Management Treatments.

Table 13. Adaptive Management Summary.

Alternative Treatment (Total Acres)	Primary Prescription	Primary Acres RR	Alternative Acres RR	Acres Adjacent to CH/STHD	Notes
Chipping (397)	Hand Pile Burn	HP - 122	Chip – 122	Chip - 67	Chipper would only use open roads and would stay on the road.
Machine Piling/Burning (1,028)	Underburn	UB - 9	MP – 9	0	MP acres are in two units, 100-250 feet from stream edge on flat ground
Hand Piling/Burning (6,199)	Underburn	UB - 263	HP - 263	HP - 18	
Total Acres	7,625	394		85	

TRANSPORTATION TREATMENTS

The goals for the road treatments in the Mission Project is to provide for long-term sustainable resource management, recreation use, reduced maintenance costs, and reduced impacts to aquatic and wildlife resources. A travel analysis has been completed to support these actions, including a minimum roads analysis (MRA), and is available in the project record. There is an estimated 134.6 miles of roads in the project area boundary.

The MVRD proposes road treatments for accessing harvest units and for restorative purposes. The proposed transportation plan, available in Appendix E and the project transportation plan map, lists roads identified within the project area, their current status, and the management activities proposed for each road. Mission project road treatments include the following activities:

- Up to 6 perennial road-stream crossings rocked prior to summer hauling in Libby Cr Drainage, if used for summer log hauling
- 1.2 miles of temporary new road construction, all is outside of RRs
- Log hauling on 55.7 miles or roads, part will be winter
- Opening 20.4 miles of closed roads to access units
- Road maintenance on 55.7 miles of open roads (includes reconstruction ~15 miles of road)
- ~34.8 miles of roads will be ML1 following the project, hydrologically closed
- Decommissioning 31.7 miles of road, 2 miles converted to small cattle trail
- Rock armoring up to 27 road-stream crossings
- Adding 3.5 miles of unauthorized roads to the system (82% as ML1)
- Adjusting ML of existing roads

An action under this proposal is for some key ‘unauthorized’ roads to be added to the road system. The majority of these roads were designed and built by the Forest Service for land management. For reasons unknown, all these roads were removed from the National Forest System (NFS) road database, but they remained on the ground. Under the proposed action, some of these roads would be put on the NFS database and retained as a system road. This is merely an administrative change, as it involves no change on the ground (i.e. ground disturbance). At the conclusion of the Mission Project, all inventoried (to date) unauthorized roads in the project area will either be

decommissioned or be assimilated onto the NFS. Table 14 below lists the total miles of road before, during and post project. Table 15 describes the road treatment activities for the project.

Table 14. Project area open and closed road total mileages by project-phase.

Sub-WA	Road mileage	Project phase (mi)		
		Existing condition	During Harvest	Post-project
Buttermilk	Open roads ML2+	19.03	28.2	21.83
	Closed roads ML1	29.52	21.52	13.69
	Unauthorized (Open - drivable)	0.48	0.38	0
	Unauthorized (Closed)	4.82	4.56	0
	ML2 Administratively Closed	0	0	8.99
	Road Decommissioning	0	0	**(-) 9.0**
	Road to Cattle Trail (non-motorized)			**(-) 0.34**
Libby	Open roads ML2+	36.34	48.82	28.19
	Closed roads ML1	29.28	19.85	16.72
	Unauthorized (Open - drivable)	0.13	0.13	0
	Unauthorized (Closed)	9.94	7.26	0
	ML2 Administratively Closed			6.46
	Road Decommissioning			**(-) 22.7**
	Road to Cattle Trail (non-motorized)			**(-) 1.62**
Annex	Open roads ML2+	0.69	0.69	0.69
	Closed roads ML1	4	4	4
	Unauthorized (Open - drivable)			
	Unauthorized (Closed)	0.4	0.4	0.4*
	ML2 Administratively Closed			
	Road Decommissioning			
	Road to Cattle Trail (non-motorized)			
	All roads	**134.63**	**135.81**	**100.97**

*Roads in the Annex area were not included in the Mission Transportation Analyses because they are part of a different road network. However, they roads were included in the project road tables. They will addressed in the upcoming Twisp River Restoration Project.

Table 15. Proposed changes to the transportation system associated with the harvest and changes associated with watershed restoration.

Part A – Harvest related road treatments or otherwise not covered under ARBO II.

Activity Type	Actions	Miles or Count	Miles or Counts within RRs/Adjacent to CH
Rock Armoring	Apply crushed rock on road-stream crossings in Libby Cr drainage if where summer haul occurs.	6	6
New construction	New permanent construction	0	0
	Temporary Road Construction	1.2 (none in RRs)	0
Opening Closed Roads/Reconstruction (ML1 and Closed Unauthorized)	ML 1 is upgraded for log hauling, then ML 1 hydrologically closed, decom'd, or ML 2 Admin as part of project completion.	20.4 closed roads will be opened, these are not hydr. closed	2.9**/0.6***
Long-term road maintenance level/system conversion	Upgrade System Rd Condition (maintenance on Open Roads)	55.7	8.6/3.75
	ML 1 to ML 2	4.4	0.4/0.2
	ML 1 to ML 2 Admin	9.9	0.5/0
	ML 2 to ML 3	0.25	0/0
	Adopt/add unauthorized roads as system	0.2*	0.1/0
Log Hauling	Haul routes on all roads (system and unauthorized)	55.7	11.5/4.3****
Road Decom (#crossings)	Light to heavy decommissioning	7.1 (12)	1.6/0.6
Road to cow trail conversion	Road to 4ft wide cow trail, non-motorized	0.7 (0)	0.6/0
Road Clsr (# of crossings)	Hydrologic Storage	12 (4)	0.6/0
Road to ML 2 Admin	Haul routes and currently closed roads that will be closed with gate and drivable dips	12.54	1.01/0

*These miles are unauthorized road added to the system that would not be restorative (Open roads).
**This involves six stream crossings on intermittent channels.
***This involves four total road segments that lie at least 170 feet from adjacent stream, with no avenues for sediment delivery.
****This includes 2.2/1/9 miles of paved ML4 roads.

Part B – Watershed Restoration Related road/landing work (ARBO II)

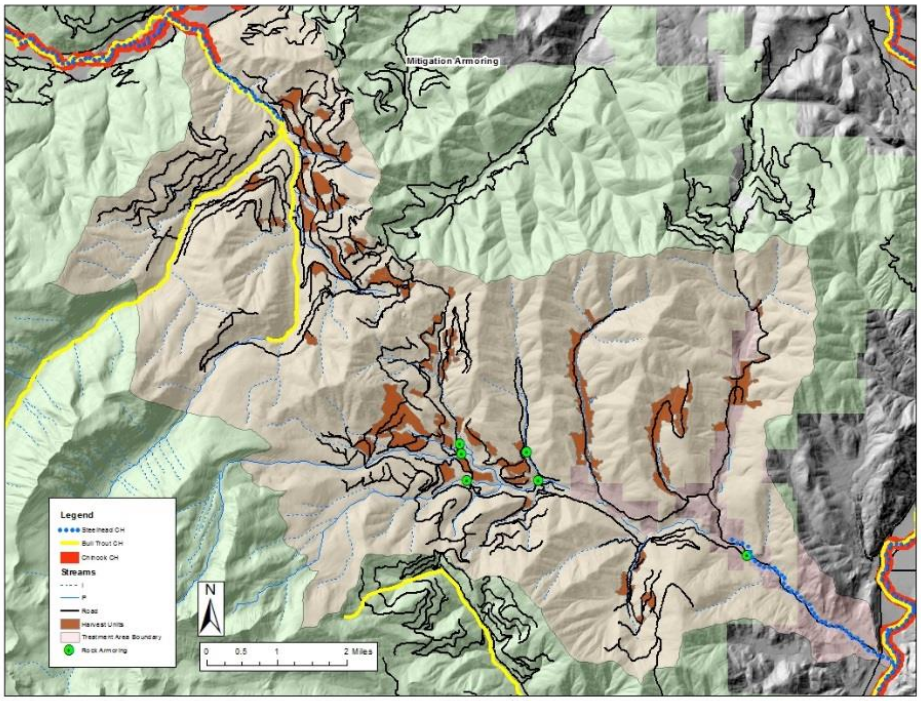
Action	Activity Category	Miles or Counts	Miles or Counts within RRs/Adjacent to CH
Road Decommissioning	System Roads	15.3	4.3/0.4
	Unauthorized Roads	9.3	1.9/0.2
Road to Stock Trail	Road to non-motorized livestock trail	1.3	0.6/0.2
Road to ML 2 Admin	Currently open roads to be closed with drivable dips	2.90	0.42/0

Action	Activity Category	Miles or Counts	Miles or Counts within RRs/Adjacent to CH
Road Closure	Hydrologic Closure (ML1 impassable)	22.8	0.7/0
	Administrative Closure (ML2A passable)	10.2	0.7/0
	Adding unauthorized roads to system, hydrologically closing.	2.7	0/0
Rock Armoring	Apply crushed rock on road-stream crossings on all crossings >3% gradient.	27	27/3
Ford	Remove stream pipe and road fill, construct hardened ford*	4	4/0
Fish Barrier Repair	Replace barrier culverts with Aquatic Organism Passage pipes	8	8/3
Undersized Stream Pipe Upgrade	Replace undersized headwater stream pipes with 100-year flow event capacity	15	15/0

*Fords are located on fishless, intermittent headwater streams. Goal is for improved stormproofing.

Pre-project Rock Armoring

The first phase of transportation-related actions includes pre-project rock armoring.
All summer log haul routes, with perennial stream crossings 3 percent gradient or higher, within the Libby Creek drainage, would be rocked prior to hauling. The Libby Creek drainage was selected for because fine sediment levels are elevated there and this effort would start an immediate reduction in chronic sediment delivery (Ward and Seiger 1983). This includes crossings over critical habitat or streams with ESA species. This action would also offset potential sediment increases associated summer log haul traffic.



The proposal includes rocking up to 6 road-stream crossings on three roads: 4300000, 4300100, and 4340700. In general, each crossing (>3%) is estimated to require 3-7 cubic yards of crushed rock. Road crossings with visible surface erosion would be prioritized for treatment.

New Permanent Road Construction

No new permanent road construction is proposed.

Temporary Road Construction

The project proposes 1.2 miles of new temporary road construction spread across 9 individual road segments. These roads range in length from 100 feet to 0.3 miles. There are five proposed in the Libby Creek drainage and four in Buttermilk. All of these roads would be located in the uplands, outside of any RRs with no mechanism to affect streams.

All temporary roads would be constructed to the minimum standards necessary for safe use. The construction of each road will follow the National BMP for temporary roads (Road-5. Temporary Roads). Each of these would be fully decommissioned as part of the timber sale contracts and per the design criteria discussed in Appendix B. Decommissioning methods include current standards that are similar to the designs and standards similar defined under ARBO II design criteria; however, this action is not covered under the programmatic.

Opening Closed Roads/Road Maintenance/Road Reconstruction

Currently there are about 134.6 miles of roads in the project area that include open and closed system and unauthorized roads. Of these total miles, 77.9 miles are closed. For the total road maintenance, including open and closed roads, we estimated 8.6 miles total of road maintenance would occur in RRs. During the project, about 20 miles of closed roads would be opened specifically for the project. This does not include the 1.2 miles of temporary new construction that would be used for timber haul purposes.

The ~20 miles of closed roads (ML1 and unauthorized) opened for log haul includes about 17 miles of NFS roads and 3 miles of unauthorized roads. Post-log hauling, 7.3 miles would be decommissioned, 2.6 miles would be converted to ML2 Administrative Access (closed to the public), and 10.5 miles hydrologically closed. Of the unauthorized roads (3 mi), 2 .7 miles would be decommissioned, 0.2 miles added as ML1 and 0.1 mile added as ML2. Roads put into ML1 status would be hydrologically stored.

About 3 miles of closed roads proposed for log hauling lie within RRs. These road segments range from low to high aquatic risk, but mostly are moderate risk (High 6%, Mod 72%, Low 22%). Nine stream crossings (intermittent/perennial) occur on these 3 miles of roads proposed for log hauling. There would be no crossings over critical habitat or occupied steelhead habitat. Table 16 shows all the stream crossings plus nine ephemeral crossings. Two roads were identified as high risk and they both cross Chicamun Creek as fords. During use, temporary culverts would be installed to minimize sediment delivery. These roads would be decommissioned following harvest. The remaining road segments have a total of seven combined intermittent or perennial stream crossings, some with existing culverts and some without. These roads were classified as moderate risk and are spread out over Buttermilk and Libby Creek drainages. These roads would either be decommissioned or hydrologically closed following log haul resulting in a net reduction in five stream pipes. All work would occur on the existing road prisms and in the dry.

Table 16. Stream crossings used on closed roads for log hauling

Current Road Status	**Stream Flow**	**Stream Xings (culverts)**	**Pipes During Haul**	**Pipes Post Project (Net change in # of pipes)**	
Closed Roads (ML1 and Unauth)	Ephem	9 (1)	1	0 (-1)	Roads will be hydrologically closed or decom'd
	Interm	4 (0)	4	0 (0)	
	Peren	5 (4)	5	0 (-4)	

Opening closed roads will require a range of road treatment, ranging from little to no work to up to heavy maintenance or reconstruction. Some closed roads have workable running surfaces and will just need opened and just some removal of downed wood. Most roads will need normal road maintenance that includes surface blading, cleaning ditches, cleaning culverts, and shaping road surfaces to meet current BMPs. Some roads will need "heavy maintenance" or reconstruction, which means they have not been used for many years. The mileage of this heavy maintenance need is not identified. Conservatively, we estimate 3/4 of the closed roads opened for log hauling or 15 miles would need road reconstruction for log hauling. Heavy maintenance or reconstruction would include vegetation removal on road surface, reshaping the road surface, removing cut-slope slide material, grading or blading, adding rock surface, installing drainage dips and cross-drains, and spot rock placement. The following BMPs would be used when opening of closed roads:

- Temporary and long-term erosion control,
- Measures to reduce erosion and maintain overall slope stability,
- No side casting in RRs,
- Avoiding deposition of materials outside of the roadway limits.
- To minimize runoff effects, the roads would be outsloped and drain dips would be constructed.

Not all road openings would occur at the same time. The project duration of harvest would be from 2018 to ~2028 and harvest related roadwork is expected to last for about 2 years beyond to 2025. During that time, the number and miles of roads open to the project will vary year by year but not all roads would be open at any one time.

<u>ML changes with NFS roads (excluding closing roads and administratively closed roads)</u>
The Mission project would include decisions to increase maintenance levels on up to ~4.6 miles of road (e.g. ML2>ML3 or ML1>ML2). Increasing a roads ML is rare because of the Forest Service's nationwide goal to reduce road maintenance costs. The following ML level changes are proposed:

- 4.2 miles of ML1 to ML2 – The purpose is to re-establish vehicle access up to Scaffold Ridge on FS road 4300560. Scaffold Ridge and the trailhead is a popular hiking destination. Several years ago the wooden bridge over WF Buttermilk Creek rotted out and was condemned for safety reasons. This decision closed vehicle access up to the Scaffold Ridge trailhead. This road also is important for range management purposes. The proposal is to repair the bridge at a later date and once this occurs, the road would be cleaned up and open for general vehicle access. Additionally, two short ML1 road segments (totaling 0.07 mi) located on ridges would be converted to ML2 for long-term vegetation management and public hunting access.
- 0.26 miles of ML2 to ML3 – Black Pine Lake campground road that currently is a ML2, would be changed to a ML3 and consistent with all campground roads.

<u>Unauthorized Roads Added to NFS</u>
There are about 15.8 miles of unauthorized roads in the project area. Some of these roads are user-built roads where the public accesses fire wood and the repeated use makes the road more drivable so other publics start to use. These roads are few in number and would not be maintained. However, the majority of these roads was designed and built by the Forest Service for land management. For reasons unknown, all these roads were removed from the National Forest System (NFS) road database, but they remained on the ground. Under the proposed action, 12.0 miles of these roads

would be decommissioned (2.7 mi – timber sale and 9.5 mi other funding) would be decommissioned and 3.5 miles would be added to the system. These metrics are accounted for and defined as ARBO II and non-ARBO II under the road decom section below. Of these miles, 2.7 miles would be added as ML1 roads and hydrologically closed, 0.35 as ML2, and 0.26 as ML3. One road (0.12 mi) would be added that is located in the RR. This road located in upper Smith Canyon with a 2/3 mile subsurface reach below that would prevent any sediment delivery to Libby Creek

Administrative ML2 Roads for Livestock Permittees (Non-ARBO & ARBO II)

The Lookout Mountain grazing allotment exists within the project area that requires regular maintenance of infrastructure like fences and water developments for proper management. During the project planning process, several roads identified that are needed for long-term forest management were also identified as needing access for range management. About 15.4 miles are needed by permittees to successfully operate their grazing allotment, using ATVs to maintain infrastructure. About 10 miles of these roads are currently ML1 roads and the other ~5.4 miles are ML2 roads.

Under this proposed action, these 10 miles of roads would be managed as ML2 Administrative Restricted Use. Such roads will be closed to the public in such a way to still accommodate ATV/UTV access for maintenance of stock tanks or other legitimate reasons. ATV/UTV access would be authorized for administrative use only on roads identified in Appendix E.

One of the goals is to reduce impacts on the stream network while maintaining administrative access. Limiting vehicle use to ATV/UTV type vehicles allows for heavy storm proofing of these restricted ML2 roads. Road treatments may include but is not limited to installing drain dips and water bars, and blocking the road with a steel gate. Three of the hardened fords occur on these ML2A roads. Log hauling is proposed on 5.19 miles of roads and 7.34 miles of currently closed roads (ML1 and UA) would be changed to ML2 Admin. These changes are either timber sale related or not restorative and will be analyzed through the BA. Close to 3 miles of currently open roads would be closed to public access and storm-proofed and is consistent with ARBO II. The Table 16b below describes the non-ARBO II and ARBO II road breakdown.

Table 16b. ML2 Administratively closed roads.

ESA Bin	Use or Condition	Miles	Miles in RRs/by CH
Non-ARBO II	Log hauling route	5.19	0.71/0
	Non-haul, but currently ML1 or closed UA.	7.34	0.3/0
ARBO II	Non-haul, currently ML2	2.91	0.42/0
Total		**15.44**	**1.43/0**

Log Hauling

Log hauling would occur on an estimated 55.7 miles of road across the project area. An estimated 6.3 MMBF of saw logs would be harvested, which would result in an estimated 1,575 log truckloads. There is about 11.6 miles of haul route within RRs and they would cross 17 streams on gravel or natural surfaced roads.

About 1/3 of the harvest would occur as winter season harvest and hauling when roads are frozen and runoff would not occur (generally Dec 15-Feb 15). All other hauling would occur during the summer or as optional winter or summer hauling.

Regardless of season, log hauling would be restricted during periods of wet weather when ground conditions are such that excessive damage to soils would occur. This is effective when implemented because it prevents the formation of ruts. Historically, the low frequency of heavy precipitation events coupled with the presence of well-drained soils rarely results in conditions where log hauling is required to stop.

To reduce sedimentation into stream channels from log truck traffic, the contractor may apply water to minimize dust on the gravel and natural surface roads. Chemicals use for dust abatement would not be allowed. Water withdrawal methods are described in Appendix D (#91).

Log hauling on gravel roads will cross CH and other streams with documented bull trout and steelhead presence. The 4300000 road crosses steelhead CH on Libby Creek and the 4300500 road crosses bull trout CH on EF Buttermilk. Additionally, the proposed log hauling route includes four crossings over occupied steelhead streams and one infrequently used bull trout creek. To reduce sediment delivery during log hauling, all crossings in the Libby Creek drainage with >3% gradient and used outside of winter would be rock armored prior to hauling.

Decommissioning/Road to Cattle Trail (Non-ARBO & ARBO II)
Through the Travel Analysis process, we identified the high, medium, and low risk roads, which equaled approximately 29, 32, and 39 percent of the total 134.6 miles of roads (See table below). There are an estimated 21.9 miles of RR roads and 70 stream crossings. Decommissioning is planned for 31.7 miles of existing roads, which includes 9.0 miles of RR roads (41%) and would remove up to 28 stream crossings (~26%). These stream crossings removed are on intermittent and perennial streams, but an additional eight crossings on ephemeral draws would be removed, further reducing the drainage network. Under the proposed action, the project would decommission 3, 30, and 35 percent of the high, moderate, and low aquatic risk roads.

Aquatic Risk	Total Miles	Miles of Decom'd Rds/ % of Aq Risk Rds	
High	39.6	1.5	3%
Moderate	43.5	13.6	30%
Low	51.5	18.5	35%
Total	134.6	33.6	

Log hauling is proposed on 7.1 miles of road proposed for decommissioning that includes six stream crossings removed. These road treatments, although restorative, are part of the timber sale and considered non-ARBO II bin actions. The remaining 24.6 miles of road decommissioning would occur purely as restoration treatments and fit under ARBO II actions.

Decommissioning would be accomplished by a host of treatments that include some or all of the following techniques: decompacting the surface of the road, partial re-contour, removal of all existing stream culverts and cross-drain culverts, sloping the stream channel exposed by culvert removal to adjacent natural slopes, as well as seeding and planting raw streambanks to minimize

soil erosion. The actual treatments to each decommissioned road segment would be commensurate with the site conditions of the road and how it influences hydrologic process. Roads will be decommissioned during the dry time of the year. Road decommissioning design criteria would follow those outlined in the 2013 ARBO II under #32. **Road and Trail Erosion Control and Decommissioning.**

Six proposed road decommissioned segments, which amount to 2.0 miles, occurs on roads that a permittee uses to drive cattle between pastures. The roads are not needed for timber or fire suppression needs, but a path to move cows by horse is needed for range management. The proposal is to remove the road prism and culverts/crossings as with normal decommissioning, while leaving a 3-4ft wide cow trail to move cows. Trail use would provide for cows and horse riding; any motorized use would be prohibited. This action would substantially reduce the footprint of the existing roads and subsequent surface erosion. Work associated with this conversion consistent with design criteria outlined in the 2013 ARBO II under *#32.* **Road and Trail Erosion Control and Decommissioning**.

Closing Roads (Non-ARBO & ARBO II)

Once this project is completed, there would be 30.4 miles of closed roads put into hydrologic storage. Of these miles, about 20.4 miles would be used for harvest and subsequently closed by the timber purchaser. These roads will be assessed as non-ARBO II treatments in this BA. The other 10.0 miles of roads would be closed from other funding sources and are binned as ARBO II treatments. Road closure work (changing roads to Maintenance Level 1 status) may include, but is not limited to pulling stream and cross drain pipes (where they exist), sloping stream crossings back to natural gradients, blading and shaping the road surface to restore proper cross-slope, reinstalling drain dips and installing waterbars, spreading slash or debris over the road surface, and blocking the road with an earthen berm. Road closure treatments would include pulling all culverts and stream crossings, constructing waterbars, constructing a earthen barrier at the road start. Road closure work would occur during the dry. Road closure design criteria would follow those outlined in the 2013 ARBO II under #32. **Road and Trail Erosion Control and Decommissioning**.

Fish Passage Culverts (ARBO II)

Eight stream culverts within the Mission Restoration project area were identified that fully or partially block fish passage. These culverts are located on Black Pine Creek, North Fork and South Fork Libby Creek, Ben Canyon Creek, and Hornet Draw. Species affected include steelhead, resident trout, and possibly bull trout. The proposed action would replace the barrier culverts with Aquatic Organism Passage structures that provide full access for all aquatic and riparian dependent species at all life stages. Restoring full fish passage at these sites would improve access on about six miles of suitable habitat. Work associated with the AOP upgrades would be consistent with design criteria outlined in the 2013 ARBO II under *#21.* **Fish Passage Restoration**. See Appendix F for more details.

Upsizing Stream Pipes (ARBO II)

Fifteen undersized stream pipes were identified during the planning process. The project proposes to upsize these pipes to meet current standards that includes passing 100-year flow events. This effort is to respond to future climate change and to build more resilient road networks. Work associated with the upsizing stream pipes would be consistent with design criteria outlined in the 2013 ARBO II under *#32.* **Road and Trail Erosion Control and Decommissioning**. See Appendix F for more details.

Rock Armoring (ARBO II)
An additional 27 road-stream crossings are proposed for rock armoring. Sixteen are proposed in the Buttermilk Creek drainage and 17 in the Libby Creek drainage. Work associated with rock armoring road surfaces over streams would be consistent with design criteria outlined in the 2013 ARBO II under *#32.* **Road and Trail Erosion Control and Decommissioning**. See Appendix F for more details.

Stream Ford (ARBO II)
Four intermittent road-stream crossings with culverts are proposed to be converted to drivable fords. This effort is to respond to future climate change and to build more resilient road networks. Work associated with the drivable fords would be consistent with design criteria outlined in the 2013 ARBO II under *#32.* **Road and Trail Erosion Control and Decommissioning**. See Appendix F for more details.

Bridge Replacement (ARBO II)
The wooden bridge over WF Buttermilk Creek has been condemned due to the wood structure failure. A new bridge would be installed over WF Buttermilk Creek. This effort would be consistent with bridge design criteria outlined in the 2013 ARBO II under *#21.* **Fish Passage Restoration**. See Appendix F for more details.

AQUATIC/WATERSHED RESTORATION TREATMENTS

The overall goals for aquatic/watershed restoration treatments are to begin to address deficient or degraded habitat conditions affecting ESA listed salmon and trout productivity in the project area sub-watersheds and their relative importance in limiting the productivity of naturally producing salmonid populations sub-basin-wide. The project relied heavily on previous work such listed on page 8 and field observations and recent habitat data. Water quality and quantity, fish habitat diversity, fish access, and riparian function (resiliency) were the key limiting factors this project chose to improve.

LWD Placement (ARBO II)
The MVRD proposes to increase habitat complexity in eight miles of high priority fish bearing streams within the Mission Project area. These reaches were identified as a priority for spawning and rearing habitat and deficient in wood loading from past riparian logging. The proposed treatment is to fell dead and live trees into key locations in the identified reaches in the Buttermilk and Libby Creek drainages. All wood would be individually identified for use and directionally fell by hand and chainsaw in key locations to interact with the channels. Dead trees would be targeted, but live trees in high concentration areas would be selected as well. Tree species include Douglas fir, spruce, and ponderosa pine. Cottonwood and cedar trees would be avoided. Additionally, trees between the units 53-57 and Chicamun Creek would be hand-felled toward the stream to add coarse woody debris into the channel or girdled to retain an average live conifer stocking level of the largest 20 to 30 trees per acre to reduce conifer competition with existing deciduous vegetation and promote the establishment of additional deciduous trees and shrubs. No commercial harvest would occur in this zone. Work associated with the LWD placement would be consistent with design

criteria outlined in the 2013 ARBO II under *#22.* **Large Wood, Boulder, and Gravel Placement**. See Appendix G for more details.

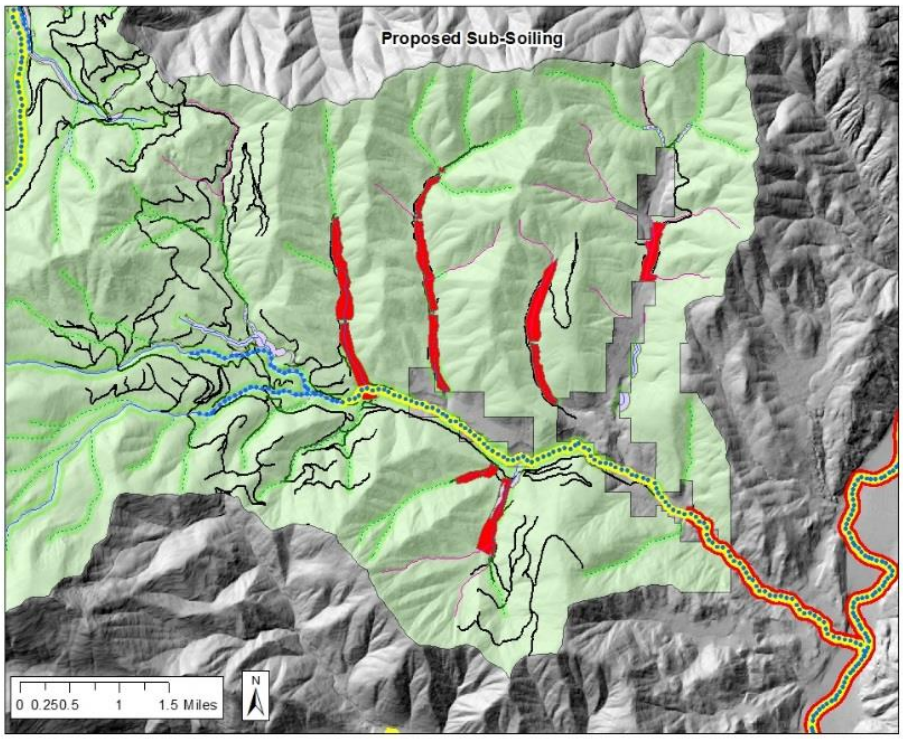
Beaver Release Site Enhancement (ARBO II & Non-ARBO)

The goal for the beaver site enhancement (BSE) treatments are to improve release sites to increase the chance for viable beaver colonies. The long-term goal is to increase wetland habitat and improve summer base flows across the project area. The BSE sites have been selected based on exhibiting suitable gradient, presence of surface water and an identifiable stream channel, availability of forage and dam building materials, and potential for long-term success and restoration. These sites lack one or a few of the necessary site characteristics that site enhancement would accomplish. Treatments to enhance beaver release sites include constructing beaver dam analogs (BDAs), fencing to exclude livestock, placement of small diameter wood, wetland NCT, and commercial harvest along Chicamun Creek. Of these actions, the fencing, BDAs, and small diameter wood fit under ARBO II treatments while the NCT and commercial thinning do not. These actions are assessed through the BA in detail. The above specific BSE treatments would be consistent with design criteria outlined in the 2013 ARBO II under *#38.* **Beaver Habitat Restoration**. See Appendix G for more details.

The commercial thinning and wetland NCT, which are non-ARBO II treatments, are described in detail above on pages 22 and 27 and in Appendix A. Thirty-two acres of RR along Chicamun were identified as suitable beaver release sites, but need more shrubs and hardwoods for beaver food. These sites are associated with intermittent streams and within drier RR sites in Libby Creek. Increasing sunlight and reducing competition for water and nutrients would allow more hardwoods and shrubs to grow. Opening up these drier sites would allow more hardwood generation, setting these areas up for future beaver release. Once beavers are established, we anticipate increased natural water storage and improved base flows. Non-commercial thinning treatment of young conifers growing in wetlands located in Blackpine Meadows and around the perimeter of Mission Pond. Conifers 10 inches DBH and smaller would be felled with chainsaws (no ground disturbing mechanized equipment) to reduce conifer encroachment on wetland vegetation. No aspen or other broadleaf deciduous trees would be felled. Conifer encroachment is making the meadow less suitable for beavers because they prefer deciduous shrubs. This treatment, coupled with BDAs would make the site highly suitable for beaver release. These actions are discussed through the BA as non-ARBO II bin actions.

SOIL TREATMENTS (ARBO II)

Soil compaction in the project area limits native plant growth, reduces soil biological activity and water infiltration, limits soil productivity, and reduces the resiliency of plant communities to climactic and biological changes over time. The project proposes sub-soiling 486 acres of previously compacted soils. This effort would restore disturbed soils and restoring infiltration rates. All acres are located within the Libby Creek drainage and within or adjacent to Riparian Reserves, where improvements would be the most beneficial to aquatic resources. The soil treatments would occur after all other ground-disturbing treatments and are not as mitigation. Map below shows unit locations in Smith Creek, Elderberry, Chicamun, Ben Canyon, and Hornet Draw.



FOREST PLAN AMENDMENTS

This project proposal includes project-specific, non-significant, temporary amendments to Forest Plan Standards and Guidelines to achieve objectives related to soil protection and forest health. These amendments may allow short-term, adverse impacts while facilitating treatments that would make the ecosystem more resilient in the long-term. To meet the following objectives, Forest Plan amendments would occur as described below.

Amendment Objective: Soil Protection

One method to protect sensitive ash-capped soils from compaction, rutting, displacement or other disturbances is to operate during the winter when the ground is frozen and snow-covered. In this project, winter operations would require snowplowing Forest Road 43 and winter access on deer winter range, which would require amending the following Standards and Guidelines:

Forest-wide Standard and Guidelines 17-6 and 17-8 – Access

Standard and Guideline (S&G) 17-6 states that "Winter logging operations shall be coordinated with winter sports activities. The following road shall not be snowplowed and shall be closed to motorized wheeled vehicles from Dec.1 to Apr 1: Forest Road 43 from the junction with Forest Road 4300300 to the junction with Forest Road 4340."

S&G 17-8 states that "The following roads shall not be snowplowed or open to motorized wheeled traffic from December 1 – April 1 in the same year (if one is open or plowed, then the other will not be):

- Forest Road 4300300 or Forest Road 43 from the junction with Forest Road 4300800 to the junction with Forest Road 4300300;

- Forest Road 43 from private land in Section 23, Township 32 North, Range 21 East to the junction with Forest Road 4340 or Forest Road 4340 from the private land in Section 11, Township 31 North, Range 21 East to the junction with Forest Road 43.

Rationale: Amending these S&Gs would provide for snowplowing up to 16 miles of Forest Road 43 that accesses proposed winter harvest units for the purpose of implementing the Mission Restoration Project. Plowing on this road would essentially preclude snowmobiling on this portion of Road 43 for up to three seasons. Groomed snowmobile routes are available in adjacent areas to provide continued opportunities for this activity.

Management Area Prescription MA14-17B
S&G 14-17B states that "Access by motorized vehicles shall be prohibited on deer winter range, December through March, except for designated through routes. Winter haul may be permitted, provided the goals of the Management Area are met."

Rationale: This amendment would allow for allow temporary winter operations and access for implementing the Mission Restoration Project in winter conditions favorable to soil protection. Winter harvest could occur on 5% (557 acres) of deer winter range in the Libby Creek block in the project area. Harvest would occur along the drainage bottoms in five areas: Smith Canyon, Elderberry Creek, Chicamun Creek, Mission Creek, and Hornet Draw. It is likely that only one area would be operational at any time, reducing effects of temporary displacement on mule deer. It should be noted that the Libby Creek block has private residences in the area, so access to deer winter range is ongoing during the winter months. Disturbance to deer would be temporary and short-term, and adjacent undisturbed areas are available for animals to use. Previous experience in the area has demonstrated that deer may not be displaced from an area by logging, but may remain in the area to forage on lichens found on logging slash. In the longer term, harvest will remove shading by trees and encourage growth of shrubs used as forage, providing more food resources available to deer.

Amendment Objective: Forest Restoration
Proposed thinning treatments that meet restoration and forest health objectives would require removal of some vegetation for the purposes of forest health and resilience to disturbance. These treatments may cause a reduction in deer winter thermal cover to levels below Forest Plan Standards and Guidelines within the project area, which would require amending these prescriptions:

Management Area Prescriptions Wildlife MA 14 and MA 26
These prescriptions provide for deer winter thermal cover as follows:

Deer Winter Range Cover Guidance

Winter Range Cover	MA14 & MA26
Snow intercept Thermal	≥ 15%
Winter Thermal	> 25%
Hiding	≥ 0%
Total:	**≥ 40%**

Rationale: This amendment would affect up to 17% (2,075 acres) of deer winter range in the project area. Currently within the project area, MA-14 has 52% cover, and MA-26 has 35% cover. Post-project, MA-14 would have 37% cover, and MA-26 would also have 33% cover. To mitigate cover post-treatment levels below Forest Plan standards, and to provide for adequate cover distribution across the project area, each ladder fuel reduction unit would leave 20% of the area untreated, in patches from 0.1 acre to multiple acres in size, which would result in additional cover.

Since the Forest Plan was written, studies have found that thermal cover is not as critical as forage quality and quantity for winter survival of deer (USDA 2012a). Cook et al. (1998) concluded that their findings, combined with those of other thermal cover studies (e.g., Robinson 1960; Gilbert and Bateman 1983; Freddy 1984, 1985, 1986), offered strong evidence that influences of thermal cover on animal performance and, by extension, population dynamics was rarely of consequence. Cook et al. (2005) noted that there are tradeoffs between providing dense forest cover and providing forage resources, and concluded that cover is needed where security is low or where snow accumulations are factors limiting animal performance. Mysterud and Ostbye (1999) found that, although cover is important for habitat selection of temperate ungulates, there is no hard evidence that cover affects demography so much that it limits population growth in forested areas, and that there is no evidence that specific arrangements of food and cover areas confer any large advantage to deer. The Okanogan-Wenatchee Restoration Strategy suggests that emphasizing the reduction of road density and enhancement of forage can allow reduction in thermal cover while meeting the intent of standards for deer winter ranges, resolving the potential conflict between restoring forests and winter range thermal cover.

Mule deer populations in Washington Department of Wildlife's Region 2, where the project is located, have experienced a gradual long-term decline in numbers which is attributed to reduced shrub diversity, declining productivity of aging shrubs and lack of recruitment of new shrubs due to fire suppression (Fitkin and Heinlen, 2012). Herd growth has plateaued, and productivity and recruitment has fallen off as the herd reached 20-25,000 animals, which appears to be the landscape carrying capacity for deer (Fitkin and Heinlen, 2012). Fitkin and Heinlen conclude that unless steps to revitalize shrub growth on winter range and human development is managed, this declining trend can be expected to continue. This project would increase forage on more than 2,000 acres of winter range, and move habitat conditions closer to historical characteristics that developed under natural disturbance regimes.

PROJECT MONITORING

Monitoring would occur during implementation and to assess potential impacts caused by project activities. Depending on the impacts observed, specific mitigation measures would be implemented to reduce negative effects. Design criteria, monitoring plans, and mitigation measures are detailed in Appendix D.

Fisheries and Hydrology

The fisheries biologist and and/or hydrologist would conduct post-project assessments in a manner that meets Aquatic Restoration Biological Opinions II (ARBO II) monitoring requirements. All of the Mission Restoration aquatics/watershed projects will occur in or near streams and some that are occupied by ESA-listed fish, and such actions are covered by two biological opinions, both of which contain monitoring procedures that are to be followed for each project:

- National Marine Fisheries Service: Endangered Species Act Section 7 Formal Programmatic Conference and Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for Aquatic Restoration Activities in the States of Oregon and Washington (ARBO II). NWP-2013-9664
- US Fish and Wildlife Service: Programmatic Opinion for Aquatic Restoration Activities in the States of Oregon and Washington (ARBO II). 01EOFW00-2013-F-0090

Monitoring procedures included in the ARBOIIs include the following:

- Implementation
    - Visually monitor during project implementation to ensure effects are not greater (amount, extent) than anticipated and to contact Level 1 representatives if problems arise.
    - Fix any problems that arise during project implementation.
    - Regular biologist/hydrologist coordination with the COR if biologist/hydrologist is not always on site to ensure contractor is following all stipulations.
- 401 Certification – To minimize short-term degradation to water quality during project implementation, follow current 401 Certification provisions of the Federal Clean Water Act for maintenance of water quality standards described by the Memorandum of Understanding between the Washington Department of Fish and Wildlife and Forest Service regarding Hydraulic Projects Conducted by Forest Service, Pacific Northwest Region (WDFW and USDA-Forest Service 2012).
- Post project – A post-project review shall be conducted after winter and spring high flows.
    - For each project, conduct a walk through/visual observation to determine if there are post-project affects that were not considered during consultation. For fish passage and revegetation projects, monitor in the following manner:
        - Fish Passage Projects – Note any problems with channel scour or bedload deposition, substrate, discontinuous flow, vegetation establishment, or invasive plant infestation.
        - Revegetation – For all plant treatment projects, including site restoration, monitor for and remove invasive plants until native plants become established.
- In cases where remedial action is required, such actions are permitted without additional consultation if they use relevant PDC and aquatic conservation measures and the effects of the action categories are not exceeded.

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Status of Listed Wildlife Species and Effects Analysis

Threatened and Endangered Species

The following listed wildlife species are considered in this assessment:

Wildlife Table 15. Listed and Proposed Wildlife Species for the Mission Project

Wildlife		**Designation**
Gray wolf	*Canis lupus*	Endangered
Grizzly bear	*Ursus arctos*	Threatened
Canada lynx	*Lynx canadensis*	Threatened
Northern spotted owl	*Strix occidentalis caurina*	Threatened
Critical Habitat for Canada lynx		Designated
North American Wolverine	*Gulo gulo luscus*	Proposed threatened

Determinations are:
"May affect, not likely to adversely affect" for wolf, grizzly bear, lynx, spotted owl and Critical Habitat for lynx.
"No effect" for wolverine, because no activities are proposed in high elevation habitat for wolverine.

Gray Wolf
The gray wolf is federally listed as endangered across most of the Okanogan-Wenatchee National Forest. The species was delisted as a federally endangered species on the eastern portion of the Tonasket district in 2011, and is now managed as a Regional Forester's sensitive species in that area. Gray wolves remain protected under the Washington State Endangered Species Act as an endangered species throughout the rest of the state.

Gray wolves historically occurred throughout the Cascade Mountains in Washington and Oregon. Aggressive predator control efforts in the early 1900s nearly extirpated wolves from Washington by the 1940s. In the 1980s, Laufer and Jenkins (1989) documented several reports of gray wolves in the Washington Cascades, and in the 1990s gray wolves were documented at several sites, including two sites with pups.

Wolf populations in Washington are steadily increasing. Annual surveys by the Washington Department of Fish and Wildlife showed the number of wolves growing by 28% in 2016 (WDFW et al., 2017). As of December 2016, there were 10 successful breeding pairs, and 20 confirmed wolf packs in Washington State (WDFW et al., 2017). Three packs are known to inhabit the Okanogan-Wenatchee National Forest.

Gray wolves are one of the most adaptable large predators in the world (USFWS 2009). They require only a sufficient year-round prey base and protection from excessive human-caused mortality. Restrictions on human development and other land use practices have not been necessary to achieve wolf recovery in Idaho, Montana, and Wyoming (USFWS 2009), and the U.S. Fish and Wildlife Service did not designate critical habitat for wolves in the western United States (Wiles et al. 2011).

In Washington State, restriction on timber harvest is not considered to be necessary to maintain or promote wolf habitat. Washington Department of Fish and Wildlife's Wolf Conservation Plan (Wiles et al., 2011) states that wolves are adaptable, and will enter and forage in towns and farms, cross highways and open environments, and den near sites heavily disturbed by people such as logging sites and military firing ranges. It goes on to state that wolves are also fairly tolerant of moderate amounts of human disturbance, even in the vicinity of active wolf dens (Thiel et al. 1998, Frame et al. 2007) and that restrictions on land use practices have not been necessary to achieve wolf conservation in Idaho, Montana, and Wyoming (USFWS 2009). The Conservation Plan concluded that "*wolf reestablishment in Washington is not expected to result in the imposition of any land use restrictions to protect and conserve wolves other than those that occasionally may be needed to temporarily protect den sites from malicious or careless destruction during the denning period (see Chapter 8). In neighboring states with wolves, no restrictions have been placed on the forest products industry regarding timber management and logging to protect wolves."*

Person et al. (2009) recommended that, because timber harvest may affect prey populations, increase access that facilitates hunting and trapping or disturb dens (Persson et al. 1996, Persson and Russell 2008), that retaining roadless forested buffers around low elevation major lakes and streams and closing roads within that buffer, likely would reduce the effects of existing roads on den site selection and retain watershed-scale habitat reserves that encompass productive habitats for ungulate prey and suitable denning locations. This would reduce turnover in wolf packs and ensure that wolf populations are resilient to habitat change owing to human activity (Persson et al. 1996, Persson and Russell 2008).

Wolves are habitat generalists, but in the western United States occur most frequently in forests (USFWS 2009). Diet consists mainly of ungulates, with elk, deer and moose expected to be the main prey in Washington. Territory sizes usually average about 200 to 400 square miles in the western United States (WDFW, 2009). Monitoring of the Lookout Pack showed that their territory was about 350 square miles (Wiles et al., 2011). The estimated mean home range size of 14 packs in Eastern Washington with known territories was approximately 354 square miles and ranged from an estimated 120 square miles to 635 square miles (WDFW et al., 2017).

In the northwestern United States, most wolves die from human causes such as control efforts to stop livestock depredation or illegal hunting. However, in areas where wolves are fully protected, such as large national parks, most wolves die from territorial conflicts with wolves in neighboring packs, starvation, or disease (Wiles et al., 2011).

Gray wolves are sensitive to road-associated factors but are not particularly affected by summer recreation trails (Mech et al. 1988, Thurber et al. 1994, Boyd and Pletscher 1999). However, Whittington et al. (2004) found that trails affected movement behavior of wolves equally, if not more, than roads in Jasper National Park. While roads are not a physical barrier, they usually increase human presence and the likelihood of negative contacts (Wisdom, et al 2000). A disproportionate number of human-caused mortalities and vehicle collisions (Bangs and Fritts 1996) occur near roads. Both Mech et al. (1988) and Thiel (1985) found that when road densities exceed about 1.6 km/0.9 km radius circle (1 mile/square mile$^{2)}$, wolves avoided or were displaced from areas. Mladenoff et al. (1995) found that road density was the major predictor of wolf pack location. Jensen et al. (1986, in Gaines 2003) reported that road densities >0.6 km/km^2 were apparent barriers to wolf dispersal. Road access also increases the likelihood of habituation to humans. Individual wolves can become accustomed to human presence, leading to nuisance situations that can result in the death of the habituated animal. Roads influence the effectiveness of habitat for ungulates (Mladenoff et al. 1995), which are the primary prey base for wolves in Washington (Wiles et al., 2011).

Singleton et al. (2002) assessed landscape permeability for wolves in Washington State and portions of northern Idaho and southern British Columbia. They reported that landscapes in the Cascades, north-central and northeastern Washington, and parts of the interior lowlands of British Columbia were broadly conducive to dispersal by wolves. Habitat association models identified 3 habitat concentration areas across the Okanogan-Wenatchee National Forest for wolves (North Cascades, Central Cascades and South Cascades), separated by landscapes of varying permeability for animal movement. Three "fracture zones", defined as areas of reduced landscape permeability between habitat concentrations for wolves, were identified within or near forest boundaries in the Okanogan Valley, Stevens Pass-Lake Chelan, and Snoqualmie Pass areas (Singleton et al. (2002). These zones generally represent developed valley bottoms with discontinuous forest cover, sizeable human populations, high road densities, or reservoirs.

Analysis Area

An assessment of the effects of roads and trails on gray wolves should be based on an area that approximates their extensive home ranges (Boyd et al. 1995, Mech 1970 *in* Gaines et al. 2003). Gaines et al. (2003) recommends BMUs for analysis of effects to wolves. The analysis area is the two Bear Management Units that the project area resides in- Upper Twisp River and Libby Creek.

Analysis Methods

A moving windows (GIS) road and motorized trail density analysis was used to compare the amount of security habitat for each alternative by BMU (Bear Management Unit)(Gaines et al. 2003). This analysis classified areas as follows: areas with no open roads or motorized trails, areas with densities from >0 to 1.6 km/0.9-km-radius circle (>0 to 1.0 mi/mi2), and areas with densities that are >1.6 km/0.9-km-radius circle (>1 mi/mi2) within a 4th-field subbasin. Outputs of this model for each BMU or subbasin include (1) the amount and location of areas with no open roads or motorized trails, (2) the amount and location of areas with open road and motorized trail densities >0 to 1.6 km/0.9-km-radius circle (>0 to 1.0 mi/mi2), and (3) the amount and location of areas with open road and motorized trail densities >1.6 km/0.9-km-radius circle (>1 mi/mi2). Areas with open road densities <1.6 km/0.9 km (<1 mi/mi2) are referred to as security habitats.

Existing Condition

The project area is part of the Lookout Pack's territory. Gray wolves and a rendezvous site are documented in the project area, but no den sites have been found. Timing restrictions may be implemented if a den or rendezvous site is found. Deer are found across the project area, year-round, and provide a prey base. Current open road density in the project area is 1.1 mile per square mile, and will be increased to 1.2 post-project with alternative 2 (although 13.2 miles of the increased road miles are administrative use, which is estimated to average 1-2 vehicles per year). Security habitat currently comprises 63.3% of the Upper Twisp River BMU and 44.5% of the Libby BMU.

Effects

Potential effects to wolves could occur from construction of new temporary roads, decommissioning of roads, disturbance during project activities, or vegetation changes resulting from project actions. Potential effects to wolves from these actions are:

- Change in the amount of motorized access which could lead to mortality from hunting, trapping, poaching and vehicle collisions;
- Change in potential for disturbance at den and rendezvous sites;
- Changes to the ungulate prey base.

Motorized Access – The changes to the road system would result in changes to security habitat for wolves.

The following table displays the changes to the existing road network during each phase of the project for the project area.

Wildlife Table 16. Proposed Transportation Network Changes

Road mileage	Project phase (mi)		
	Existing condition	**During Harvest**	**Post-project**
Open roads ML2+ (Unauthorized)	56.7 (0.61)	87.9	50.7
Closed roads ML1 (Unauthorized)	77.9 (15.1)	47.9	34.8
ML2 Administratively Closed	0	0	15.4
Road Decommissioning	0	0	33.7
Road to Cattle Trail (non-motorized)			1.9
All roads	134.6	135.8	100.9

Approximately 1.2 miles of temporary road would be built for use during harvest operations. Temporary roads would not be open to the public at any time, and would be decommissioned immediately after harvest is completed.

Post-harvest, decommissioning would occur on all temporary roads and some other roads used during harvest that are no longer needed, which would reduce access that could result in mortality to wolves. Road closures would also reduce access, but were not modeled as a reduction in motorized access, because they are still open to OHV use (until the Travel Management project takes effect). This likely over-represents the level of disturbance and human access that would affect wolves, since some of these roads are probably not receiving any use by OHVs.

Additional road decommissioning would occur post-harvest through other funding sources. A total of 33.7 miles would be decommissioned, with 12.2 miles being unauthorized (not system) roads.

Security habitat for wolves, defined as areas with open road densities <1.6 km/0.9 km (<1 mi/mi2), would change as the project is implemented. The table below estimates the amount of security habitat that would be present at each phase of the project. The post-project calculation assumes that all the roads covered for decommissioning in the NEPA analysis are decommissioned.

Wildlife Table 17. Security Habitat by BMU

Upper Twisp River

	total security habitat	***Proportion of BMU that is security habitat***	***level of human influence***
	acres		(Gaines et al. 2003)
current	99,326	63.3%	Moderate
during harvest	99,326	63.3%	Moderate
post-project	99,651	63.5%	Moderate

Libby Creek

	total security habitat	***Proportion of BMU that is security habitat***	***level of human influence***
	acres		(Gaines et al. 2003)
current	65,844	44.5%	High

during harvest	65,675	44.4%	High
post-project	68,044	46.0%	High

Disturbance at den or rendezvous sites: It is possible that project activities could affect wolves at a sensitive site that was not identified. If a den or rendezvous site is located, project activities will be timed to avoid disturbance to wolves. Any of the project activities, including the ARBO II compliant activities, could result in short-term disturbance.

Changes to the ungulate prey base: Changes in deer and other ungulate populations are not expected to occur as a result of this project. Increases in forage across the project area may improve distribution of deer across the project area.

Deer forage is expected to increase in quantity and palatability as a result of planned treatments, which may increase deer numbers in the area. Disturbance and vegetation changes from treatments would not be expected to negatively affect wolves, although wolves and prey may be temporarily displaced during activities.

Determination
The determination for wolves is "may affect (due to temporary and short-term disturbance), not likely to adversely affect". Reduction in open roads would be a beneficial effect for wolves and their prey.

Grizzly Bear
Grizzly bears are wide-ranging omnivores that use a variety of plant and animal foods, including roots, bulbs, tubers, fungi and tree cambium, ungulates, squirrels, carrion, fish and garbage. Habitat selection is affected by (1) abundance and quality of foods; (2) gender-specific orientation to different nutrients; (3) reproductive status of females and concerns about security of dependent young; (4) presence and identity of other bears, especially adult males; and (5) presence of humans and prior contact with humans (Wisdom et al. 2000, USFWS 2011). Grizzly home ranges encompass large areas and average 489 square kilometers (189 square miles) for males in the Northern Continental Divide Ecosystem (USFWS 2011). Important seasonal foraging areas for grizzlies include riparian areas, wetlands, berry fields, avalanche chutes and ungulate winter ranges.

Human-caused mortality from human-bear conflicts, vehicle collisions, and hunting/poaching are the major factors limiting the recovery of grizzly bears (Knight et al. 1988; U.S. Fish and Wildlife Service 1993). Human access facilitated by roads and trails increases the potential for poaching, collisions with vehicles, and chronic negative human interactions at campgrounds and campsites (Gaines et al. 2003). Roads reduce habitat quality for large carnivores as a result of noise, avoidance of humans and habitat fragmentation (McLellan and Shackleton, 1988) and convert areas to non-habitat (Forman 2000, Reed et al. 1996).

Road avoidance leads to underutilization of habitats that are otherwise high quality (Wisdom et al, 2000). Mace et al. (1996) found that grizzly bears in Montana avoided roads with traffic levels greater than 10 vehicles per day. In southeastern British Columbia, grizzly bears underutilized about 9 percent of available habitats by avoiding areas 100 meters (328 ft.) from roads, regardless of traffic volume (McLellan and Shackleton 1988).

Graves (2002) studied grizzly bear use of habitats in relation to motorized trails and found that grizzly bears used areas near ATV and motorcycle trails less than expected. Bears selected against areas within 250-900 meters (0.2-0.5 miles) of ATV trails and within 450-600 meters (0.3-0.4 miles) from single-track

trails. Graves et al. (2004) concluded that bears were less likely to spend time near trails with high (~5 trips/day average) motorized use than trails with low motorized use.

Because of the potential affects that road and trails can have on grizzly bears, human access management remains one of the most powerful tools for protecting and recovering grizzly bear populations (McLellen et al. 1999, USFWS 2011).

Currently, Forest policy includes guidelines for reducing the potential for bears to become food conditioned to human foods and require "no net loss" of core areas, in order to provide effective habitat for bears.

Methods
Effects to grizzly bears were assessed by buffering roads, motorized trails and high-use non-motorized trails by 500 meters, to calculate the amount of core area in the two BMUs, as described in Gaines et. al (2003). The area outside of the buffer is the core area. This measure is intended to assess how much undisturbed habitat is available to grizzly bears.

Affected Environment
The Upper Twisp River and Libby BMUs have about 69% and 49% core area, respectively. A variety of plant and animal foods, including deer on all seasonal ranges, are found in the BMUs.

Effects
The project area is in the North Cascades Grizzly Bear Recovery Zone. Habitat for grizzlies and a food source (deer, plants) occur across the area. No sightings of grizzly bears have been reported in the project area, but a confirmed sighting occurred in 2015 approximately 60 miles north. Deer, a prey item for bears, would benefit from increased forage expected from project activities. Disturbance to bears and deer would occur during project activities and could displace them temporarily. Road closures and decommissioning would occur and would increase core area for bears. There would be no net loss of core in the bmus. Temporary roads are not in core area.
Changes to core area are displayed in the table below.

Wildlife Table 18. Changes to Core Area

		Current Core		***During Project***		***Post-project***	
BMU	***acres***	***acres***	***%***	***acres***	***%***	***acres***	***%***
Upper Twisp	156,983	108,500	69.1%	108,500	69.1%	108,766	69.3%
Libby	147,908	72,459	49.0%	72,459	49.0%	73,749	49.9%

The changes to core area in this BMU are minor for grizzly bears, but would provide increased areas of relatively undisturbed habitat for a variety of other wildlife species that utilize smaller home ranges.

Vegetation changes would occur as a result of the timber harvest, thinning and burning, and would provide increased availability and quality forage for bears and ungulate prey. Some loss of cover for deer (used for hiding and meeting energetic needs) would occur, but abundant cover would remain. Disturbance would occur during implementation and could temporarily displace bears and ungulate prey. Any of the project activities, including the ARBO II compliant activities, could result in short-term disturbance.

Determination
The proposed action may effect (due to short-term disturbance), not likely to adversely affect grizzly bears due to increases in vegetation foods for bears and ungulate prey and increases in core area.

Lynx
Lynx are medium size cats that inhabit moist, coniferous forests that have cold, snowy winters and provide habitat for snowshoe hares (Koehler 1990, Koehler and Aubry 1994, Mowat et al. 2000, McKelvey et al. 2000, Ruggiero et al. 2000). Good snowshoe hare habitat is comprised of dense, horizontal vegetation 3-10' above the ground or snow level that provides both browse and cover. In Washington, lynx are primarily found in high-elevation forests of northcentral and northeast Washington, including areas in Okanogan, Chelan, Ferry, Stevens, and Pend Oreille counties (Stinson, 2001).

Both snow conditions and vegetation type are important factors to consider in defining lynx habitat (Hoving et al. 2005). In the Western U.S., an evenly dispersed mosaic of mature multistory and a lesser component of young regenerating stands with increased horizontal cover and high snowshoe hare densities provide the habitat required to support lynx (Koehler et al. 2008, Maletzke et al. 2008, Squires et al. 2008, Squires et al. 2010). Mature multistory forests provide the structure and cover for snowshoe hares that sustain lynx through the winter (Koehler et al. 2008, Squires et al. 2010).

In northern Washington, the primary vegetation that contributes to lynx habitat is lodgepole pine, subalpine fir, and Engelmann spruce (Aubry et al. 2000). Secondary vegetation that, when interspersed within subalpine fir forests, may also contribute to lynx habitat, includes cool, moist Douglas-fir, grand fir, western larch, and aspen. Dry forest types (e.g., ponderosa pine, dry Douglas-fir) do not provide lynx habitat (Koehler et al. 2008, Maletzke et al. 2008, Squires et al. 2010). On the Okanogan-Wenatchee National Forest, lynx habitat is generally above 4,000 feet elevation (von Kienast 2003, Koehler et al. 2008).

Squires et al. (2010) found that forest stands with mature and large diameter trees were used less often during summer than during the winter. During summer, lynx broaden their selection to include younger regenerating stands of Engelmann spruce and subalpine fir species compositions with abundant small diameter, and pole-sized trees (8-18 cm dbh), abundant total shrubs, and high horizontal cover (Squires et al. 2010).

In the winter, lynx do not appear to hunt in openings, where lack of above-snow cover limits habitat for snowshoe hares (Mowat et al.2000, Maletzke et al. 2008, Squires et al. 2010). Consideration of size and shape of clearcuts in subalpine forests is important because the size of harvest units also increases distance to forest edge and can reduce density of seedling regeneration and stocking densities. Within about 10 to 30 years following disturbance (length of time varies, depending on site productivity, forest type and intensity of disturbance), lynx begin to forage for hares in vegetation that provides a high density of young conifer stems and/or branches that protrude above the snow (Sullivan and Sullivan 1988, Koehler 1990). In northcentral Washington, "high" density of stems and/or branches was quantified as >11,250/hectare (>4,500/acre; Koehler 1990). High snowshoe hare densities (>1.0 hares/hectare, 0.4 hares/acre) were associated with sapling (<3.9" dbh) densities of 2,784 ± 281 stems/ha (1127± 114 stems/acre) and medium-sized (3.9-11.0" dbh) tree densities of 712 ± 80 stems/ha (288± 32 stems/acre)(Walker 2005).

Lynx denning habitat is generally correlated with large wood, down logs, root wads, or live trees (Slough 1999, Koehler 1990, Mowat et al 2000, Squires and Laurion 2000, Apps 2007, Squires et al. 2007). These sites can be in regeneration forests (Slough 1999), or in mature conifer or mixed-conifer-deciduous forests (Koehler 1990, Squires et al. 2007). Stand structure appears to be of more importance than forest cover type (Mowat et al. 2000). Squires et al. (2007) found low den site fidelity in a western Montana

study. Den sites for 13 female lynx averaged more than 2 kilometers (1.2 miles) from the previous year's site. They suggest that low reuse of den sites may mean that many suitable sites are present throughout female home ranges.

Snowshoe hares *(Lepus americanus)* are the primary prey of lynx, comprising 35-97% of the diet throughout the range of the lynx (Koehler and Aubry 1994). Research on lynx winter diets in the southern portion of its range demonstrates that snowshoe hares are the primary prey (Koehler 1990, Squires and Ruggiero 2005, Burdett 2008, Hanson and Moen 2008, Maletzke et al. 2008). Other prey species include red squirrel (*Tamiasciurus hudsonicus*), grouse (*Bonasa umbellus*, *Dendragopus* spp., *Lagopus* spp.), flying squirrel (*Glaucomys sabrinus*), ground squirrel (*Spermophilus parryii, S. richardsonii*), porcupine *(Erethrizon dorsatum*), beaver (*Castor canadensis*), mice (*Peromyscus* spp.), voles (*Microtus* spp.), shrews (*Sorex* spp.), weasel (*Mustela sp.*), fish, and ungulates as carrion or occasionally as prey (Saunders 1963*a*, van Zyll de Jong 1966, Nellis et al. 1972, Brand et al. 1976, Brand and Keith 1979, Koehler 1990, Staples 1995, O'Donoghue et al. 1998, Fuller 2007, Poszig et al. 2004, Squires and Ruggiero 2007).

Much research has focused on the winter diet, and diets in the summer are poorly understood throughout the range. Indications are that the summer diet may include a greater diversity of prey species (Koehler and Aubry 1994). Mowat et al. (2000) reported through their review of the literature that summer diets have less snowshoe hare and more alternative prey, possibly because of a greater availability of other species.

Most snowshoe hare occur within conifer forests; elevations range from 1,980 to 3,505m. Snowshoe hare habitat includes lodgepole pine and Engelmann spruce – subalpine fir forests (Hodges 2000, Zimmer 2004). Snow conditions, horizontal cover and vegetation type are considered three important factors in defining snowshoe hare habitat throughout their range. Snow conditions that favor hares across northern boreal forests in Canada are cold and dry, with depths relatively uniform and moderately deep. In their southern range, snowshoe hare are more abundant within higher elevation forests where snow depth is deeper and duration of snow cover longer, which limits their exposure and vulnerability to predators (Sievert and Keith 1985, Murray and Boutin 1991). High horizontal cover also provides refuge from predators, which is perhaps the most important factor driving habitat selection (Murray 2003 in LCAS, 2013). Additional benefits of high horizontal cover include thermal protection and winter food (Belovsky 1984, Siervert and Keith 1985, Murray 2003).

Landscapes with various age classes, primarily mid- to advanced-successional stages resulting from burns or clearcuts that support dense understory vegetation, may be more likely to support high snowshoe hare populations (Poole et al. 1996). Koehler (1990) suggested that snowshoe hares avoided openings and very young vegetation (especially in winter when vegetation is covered by snow) and Conroy et al. (1979) found areas with greater interspersion of habitats may receive greater use by hares. Snowshoe hare population densities and overwinter survival are positively correlated with understory densities, particularly of conifers that provide winter forage, thermal cover, and escape cover (Adams 1959, Pease et al 1979, Wolff 1980, Litvaitis et al. 1985). In a study of hare habitat on the Okanogan National Forest, Walker (2005) documented that at the landscape scale, snowshoe hare densities were best correlated with the amount of boreal forest, while at the stand level the density of saplings and medium-sized trees were the best predictors of hare density.

Studies in Montana, Wyoming and southern British Columbia have documented exploratory movements by resident lynx during the summer months (Apps 2000, Squires and Laurion 2000). Aubry et al. (2000) described this type of movement as long-distance movements beyond identified home range boundaries, but returning to the original home range. Exploratory movements were highest for males during the breeding season (March) when the majority of the long distance movements were observed most likely to

maximize breeding opportunities (Burdett et al. 2007). Distances of exploratory movements in Montana ranged from about 15 km (9 miles) to 40 km (25 miles), and duration away from the home range was 1 week to several months (Squires and Laurion 2000). A resident lynx traveled a similar exploratory path (path distance of 728 km minimum distance) from its home range in the Wyoming Range to the Wind River and Teton Range in western Wyoming during three consecutive summers (Squires and Oakleaf 2005). This type of movement was not detected during the study in northcentral Washington (Koehler 1990). Aubry et al. (2000) speculated that these movements might be more likely to occur in areas with high spatial variation, especially montane systems.

Both adult and subadult lynx are known to make long-distance movements during periods of prey scarcity; recorded distances have been up to 1,000 km (600 miles) (Mech 1980, Slough and Mowat 1996, Poole 1997). In the Yukon, rates of emigration (lynx leaving their home ranges within the study area) increased as the peak in hare numbers started to decline to the low phases of the hare population cycle (O'Donoghue et al. 2001). Several of the lynx that had emigrated were recovered from fur-trappers and had traveled distances that ranged from 23 to 830 km.

The Lynx Conservation Assessment and Strategy (LCAS), which is considered the best available science currently, provides conservation measures that are the basis for ESA consultation with US Fish and Wildlife Service. Measures applicable to this project are, in part:

- Maintain a mosaic of lynx habitat across LAUs.
- Design vegetation management to develop and retain dense horizontal cover.
- Do not reduce stem density through thinning, until stands no longer provide winter hare habitat.
- Retain mature multi-story conifer stands providing horizontal cover.
- No more than 30% of the habitat in an LAU is in early stand initiation structural stage or treated to remove horizontal cover (i.e. does not provide winter hare habitat.).
- When designing fuels reduction projects, retain patches of untreated areas of dense horizontal cover within treated areas.
- Management change of habitat on federal lands that creates early stand initiation structural stage or treated to reduce horizontal cover should not exceed 15% of lynx habitat on federal lands within a LAU over a 10-year period.

In addition, the LCAS notes that in drier forests adjacent to the boreal forest, fire suppression may have resulted in unnaturally dense fuels, and restoration of these communities may be desirable to reduce the risk of spreading frequent of severe fires into lynx habitat. This is the case in the project area.

There is little information available on the effects of roads and trails on lynx or its prey (Apps, 2000, 2007, McKelvey et al. 2000). Squires et al. (2007) found that lynx denned farther from all forest roads, open or closed, in their study area compared to random expectation, but concluded that this was likely a function of fewer roads in mature forests where lynx mostly denned rather than active avoidance of human disturbance. Apps (2000) found that lynx in the southern Canadian Rockies crossed highways within their home ranges less than expected. Apps (2007) evaluated lynx response to 3 highway types and considered adjoining habitat quality. He determined that lynx will cross highways, but the highways may affect lynx movements depending on the highway type. A male lynx was documented crossing several two lane highways during exploratory movements in western Wyoming (Squires and Oakleaf 2005). Areas with high road densities, human activity and associated development appeared to be lower habitat quality based on the decreased rate of occupancy of lynx for areas on the Southern range edge in Alberta, Canada (Bayne et al. 2008).

Koehler and Brittell (1990) found that lynx used the road bed of less-traveled forest roads for travel and foraging. McKelvey et al. (2000) reported that lynx crossed roads in the Okanogan National Forest at frequencies that did not differ from random expectation. They found no evidence that habitat use by lynx was affected by narrow, forest roads at the relatively low densities that characterized their study area on the Okanogan National Forest. Squires et al. (2010) reported results similar to McKelvey et al. (2000), that lynx were not sensitive to forest roads, including roads used by snowmobiles during winter. No evidence of lynx avoiding graveled forest roads was observed in Montana through snow tracking or telemetry (Kolbe et al. 2006, Squires et al. 2010). Ruggiero et al (2000) found that preliminary information suggested that lynx do not avoid roads, except at high traffic volumes. Ruediger et al. (2000) concluded that, at that time, there was no compelling evidence to suggest that management of road densities was necessary to conserve lynx. The effects on lynx of road densities and traffic volumes on forest roads are unknown, and present a data gap.

Habitat connectivity is important for lynx conservation (Ruediger et al 2000). Lynx movements may be negatively influenced by highways due to habitat fragmentation and direct avoidance, an important consideration for their conservation (Ruediger 1996, in Ruggiero et al 2000). It is unknown at what traffic volume or number of lanes a highway becomes a barrier or impediment to movements.

Roads are a source of mortality for lynx (Ferreras et al. 1992, Kramer-Schadt et al 2004). Road mortalities resulted in isolation of habitat patches for Iberian lynx in a fragmented landscape in Germany (Kramer-Schadt et al. 2004). Lynx are also vulnerable to overexploitation from trapping. Access for trapping is increased by the presence of roads and trails.

Roads and trails may facilitate snow compaction, allowing competitors to access lynx habitat, where their mobility would usually be limited. Competition for food may contribute to lynx starvation and reduced recruitment (Ruediger et al., 2000). Coyotes are the most likely carnivore to compete with lynx (Buskirk et al., 2000). Differences in snow column density due to freeze/thaw events across the range of lynx habitat may affect the amount of use of certain habitats for coyotes in the winter. Murray and Boutin (1991) reported that both lynx and coyotes used travel routes with shallow snow, but that coyotes traveled on harder snow more frequently. They also reported that the use of trails in the snow not only reduced the depth to which an animal sinks into the snow, but aided coyotes and lynx in obtaining additional food. Keith et al. (1977) suggested that during peak highs of hares, the density of trails in snow facilitates coyote movement. Murray and Boutin (1991) reported similar results with their study. Kolbe et al. (2007) found that although coyotes remained in their study area throughout the year, compacted snowmobile trails did not appear to facilitate coyote movements, nor did hares provide a large proportion of the coyote's winter diet. In contrast, the distribution of coyotes in Utah and Wyoming appeared to be influenced by proximity to compacted snowmobile trails in deep, powdery snow areas (Bunnell et al. 2006, Burghardt-Dowd 2010).

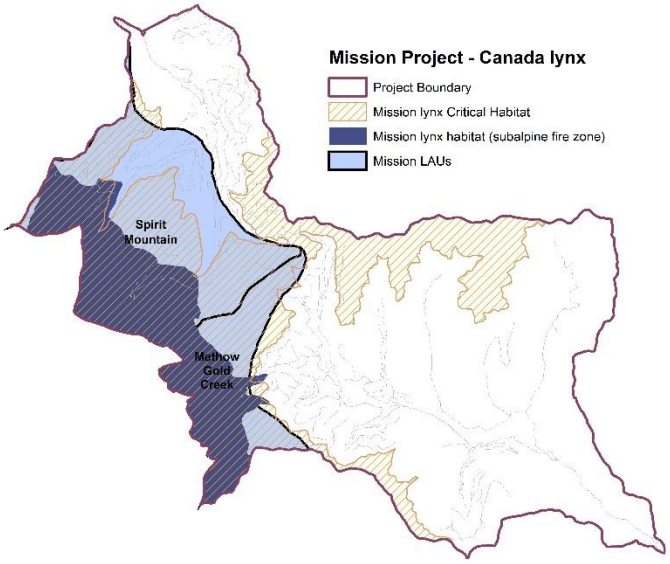
Canada lynx are considered vulnerable to loss of habitat connectivity from all four major connectivity threats: land clearing and vegetation removal, development, roads and traffic, and the presence of people and domestic animals. Human activities and low-elevation forest along the Okanogan River, Upper Columbia River, and Pend Oreille River valleys constitute the main barriers for connectivity (WHCWG,2010). Singleton et al. (2002) identified 3 habitat concentration areas on the Forest, based on dispersal habitat suitability modeling- South Cascade, Central Cascade, and North Cascade range, which were fragmented by "fracture zones", defined as areas of reduced landscape permeability between habitat concentrations for lynx. They concluded that substantial landscapes surrounding the habitat concentration areas were available to lynx movement due to the high mobility of lynx and their relative resilience to human disturbance.

Lynx are generally tolerant of humans (Staples 1995). Other anecdotal reports suggest lynx are not displaced by human presence (Mowat et al. 2000). Ruediger et al. (2000) list a variety of factors that may influence the effects of recreation on lynx including the type and quality of lynx habitat in which an activity occurs, the time of year, time of day, type of activity and pattern of activity, intensity and frequency of activity. Squires et al. (2010) reported lynx denned further from roads than random expectation, but did not think that was related to human disturbance, but rather related to fewer roads in the mature forests.

Analysis Area

The analysis area is the two LAUs that are partially contained within the project area. Only a portion of the LAUs are boreal habitat. The map below shows the relationship between the project area, the LAUs in the project area, the boreal (lynx) habitat within the LAUs, and the designated Critical Habitat.

Wildlife Figure 6. Lynx Habitat, LAUs and Critical Habitat in the Mission Project Area.



Existing Condition

The EMDS model was used to evaluate stand structures and vegetation types in the boreal forest that lynx prefer. In the cold forest areas, the young forest multistoried structure and stem-exclusion single story structure are overrepresented, in comparison to historical levels, resulting in reduced diversity of habitat types across the landscape. Providing a mosaic of stand structures, including dense early-successional stands and mature multi-story coniferous stands that will produce winter snowshoe hare habitat over time, across the landscape, is important for lynx conservation.

Recommendations for the cold forest type from the EMDS analysis include reducing area and patch size in the young forest multi-storied stand type, and to a lesser extent, the stem-exclusion single story type, and reducing the area in subalpine fir types. However, there is limited opportunity to restore stand structures within the lynx habitat, due to topography, elevation, and the existing transportation system.

The project area is in the core area for lynx, where long-term persistence of lynx has been documented. Portions of two lynx analysis units (LAUs) are present in the analysis area, and lynx habitat (subalpine fir zone) is present in the western, higher elevation portion of the LAUs, as shown in the figure above. Habitat in both LAUs is dominated by mid-successional structures, with little stand initiation phase that would provide hare browse. There are approximately 2,274 acres of lynx habitat within the LAUs.

Effects

Wildlife Figure 6. Treatments in LAUs

Treatments in LAUs in Lynx Habitat	
	acres
Aspen	5
Pre-commercial thinning	53
Total	***58***

Silvicultural and fuels treatments: Approximately 1,770 acres of treatment would occur in the LAUs in the analysis area. However, only 58 acres occur within the boreal forest area where lynx are expected to occur. In the Methow Gold LAU (Libby drainage), 53 acres of pre-commercial thinning would occur in plantations that are typed as stand-initiation phase. These stands have grown out of reach of hares and are no longer providing a food resource. Five acres of aspen understory treatment would occur in the Spirit LAU (Buttermilk). This treatment would thin conifers <10" DBH in 15 – 30' circles around aspen trees and girdle conifers 10 – 21" DBH, retaining approximately ten conifers per acre larger than 10 inches DBH following treatment within aspen clones.

All overstory treatments would result in more open habitat that will generate browse for hares, an important prey item for lynx. This effect would occur rapidly after overstory change (1 to 10 years (Pilliod, 2006)), and persist until shrubs and tree limbs grow out of reach of hares. Slash would be hand-piled.

Fisheries and aquatics projects: Several projects aimed at improving aquatic habitat condition are proposed in lynx habitat in the LAUs. Installation of culverts, coarse wood and beaver dam analogs would result in short-term noise and human presence in lynx habitat. Disturbance could occur, but lynx do not appear to be particularly sensitive to human presence (Staples, 1995; Mowat et al. 2000). Minor vegetation effects could occur where heavy equipment is used, but this would be limited in extent and would not reduce vegetation foods for snowshoe hare and other lynx prey species. Timing of the work would prevent disturbance to unidentified den sites.

Road construction and decommissioning: No temporary road construction is proposed in the LAUs. Decommissioning of closed roads would result in temporary noise and human presence in the short-term, during implementation. Disturbance could occur, but lynx do not appear to be particularly sensitive to human presence (Staples, 1995; Mowat et al. 2000), nor to avoid roads (McKelvey et al., 2000, Kolbe et al. 2006, Squires et al. 2010). In the long-term, road decommissioning would result in reduced potential for disturbance to lynx prey.

Determination: The project may affect, but is not likely to adversely affect lynx. Treatments are very limited in the mapped lynx habitat (58 acres), and would increase understory growth that provides cover

and forage for prey species. The project is consistent with the LCAS. Stem densities would not be reduced through thinning until stands no longer provide winter hare habitat.

Critical Habitat for Lynx

The Fish and Wildlife Service designated boreal (northern, high-elevation moist forests) forest landscapes providing a mosaic of forest structures as Critical Habitat. The primary constituent elements (PCEs) for critical lynx habitat are:

- the presence of snowshoe hares and lynx preferred habitat conditions, which include dense understories of young trees, shrubs or overhanging boughs that protrude above the snow, and mature multistoried stands with conifer boughs touching the snow surface;
- winter snow conditions that are generally deep and fluffy for extended periods of time;
- sites for denning that have abundant coarse woody debris, such as downed trees and root wads;
- matrix habitat (e.g., hardwood forest, dry forest, non-forest, or other habitat types that do not support snowshoe hares) that occurs between patches of boreal forest in close juxtaposition (at the scale of a lynx home range) such that lynx are likely to travel through such habitat while accessing patches of boreal forest within a home range (USFWS, 2009).

Critical Habitat consists of areas considered to be essential to the conservation of the species and which may require special management considerations or protection. Critical Habitat receives protection under section 7 of the Endangered Species Act, and agencies must ensure that any actions are not likely to result in destruction or adverse modification of Critical Habitat. Examples of activities that may affect Critical Habitat for lynx include actions that would remove understory vegetation in boreal forest on a large scale, actions that would result in loss or conversion of boreal forest on a large scale, and actions that would increase traffic volume and speed in lynx Critical Habitat. In matrix habitat, activities that change vegetation structure or condition would not be considered an adverse effect to Critical Habitat unless they would create barriers or impede lynx movement between habitat components.

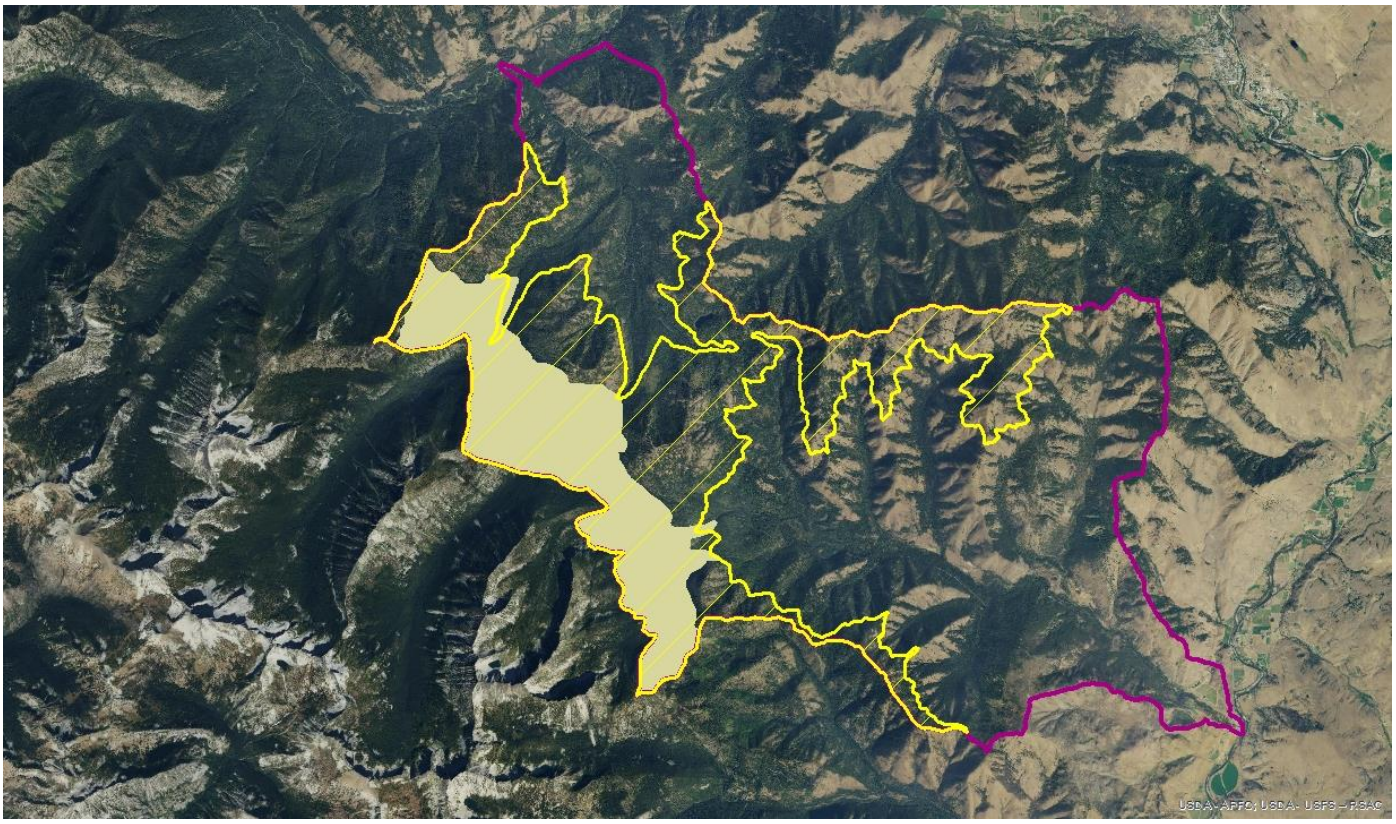
In the North Cascades in Washington, most lynx occur above 4,101 ft. and select Engelmann spruce-subalpine fir forest cover types in winter (Koehler et al. 2008, Maletzke, 2004). Lynx in this area avoid Douglas-fir and ponderosa pine forests, openings, recent burns, open canopy and understory cover, and steep slopes (Koehler et al. 2007).

Boreal forest in the project area is primarily confined to the western half of the LAUs, which has been mapped as lynx habitat. Critical Habitat is also delineated along the northeast and southcentral ridgelines dividing the Libby watershed from watersheds to the north and south. These areas have some cold/cool forest habitat, but are generally warmer drier forest types that aren't providing quality lynx habitat or connections to other LAUs. This is not likely to change, given the warming climate.

In the project area, 12,890 acres are designated Critical Habitat for lynx. Approximately 4,604 acres are within the mapped lynx habitat. Early successional habitat is estimated at 853 acres, 7% of the Critical Habitat in the project area. Approximately 9.9 miles of road are found in Critical Habitat, which could result in disturbance to prey for lynx.

The figure below displays designated Critical Habitat for lynx (cross-hatched), mapped lynx habitat (light green), and the surrounding area.

Wildlife Figure 7. Mission Project, Critical Habitat for Lynx, and Boreal (lynx) habitat.



Approximately 2,132 acres would receive silvicultural or fuels reduction treatments with implementation of the proposed action. Treatments in the Critical Habitat area are in matrix habitats (dry forest, plantations, aspen) or have grown out of hare reach, with the exception of the 58 acres in lynx habitat that are discussed above, in the "Lynx" section.

Silviculture treatments (overstory) in Critical Habitat

Treatment	***acres***
Aspen	59
Conifer girdling for aspen release	37
Dry forest/mistletoe sanitation	112
Dry forest restoration	0.3
Moist forest thin	15
Post/poles	0.4
Regeneration	19
Total	***243***

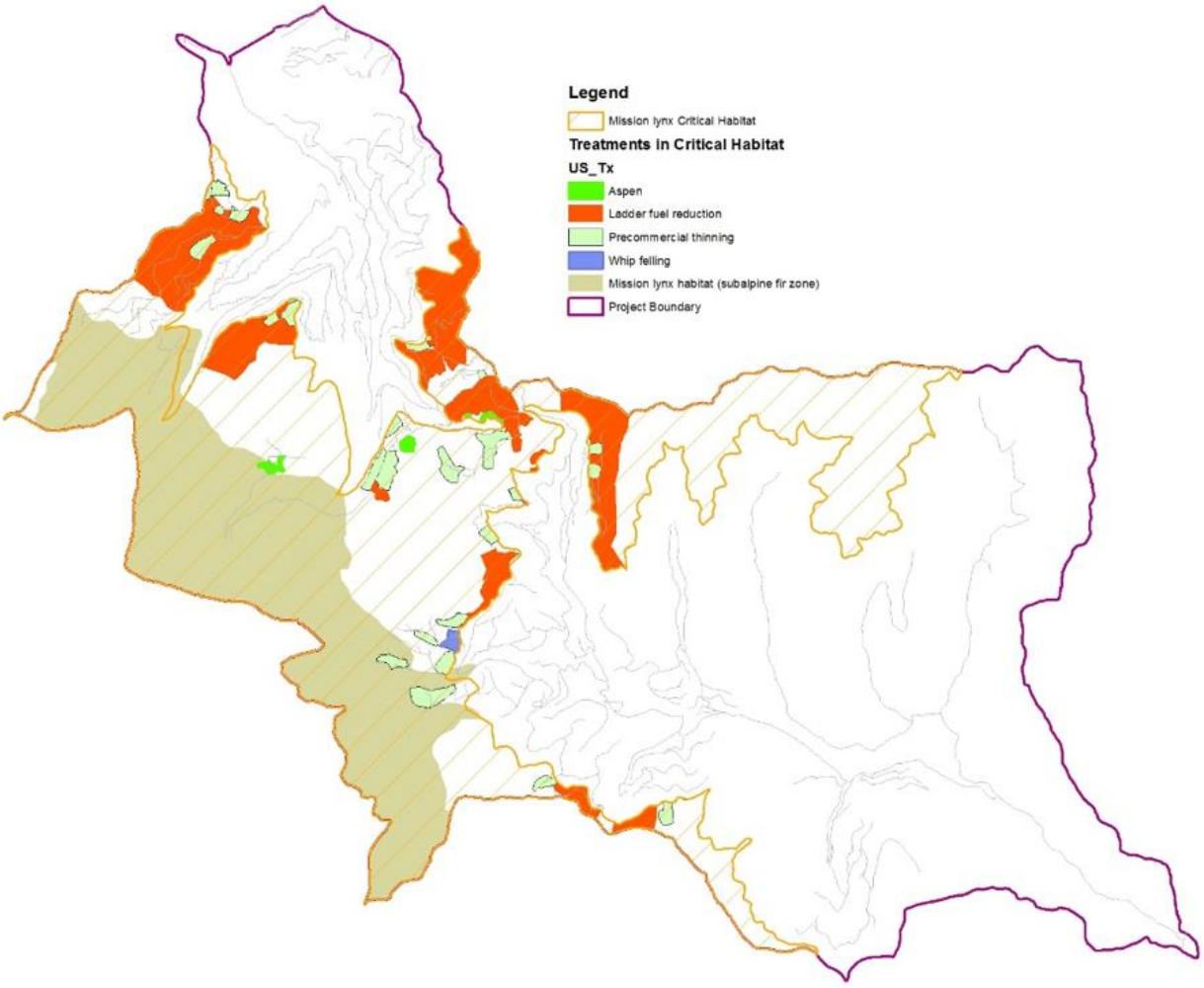
Silvicultural treatments would open the canopy and result in increased understory vegetation, which would be beneficial to hares and other lynx prey. This would continue until the overstory closes again. Depending on how open the stands are, post-treatment, this effect could last for a decade or more.

Fuels and understory treatments

Stand-alone Understory Treatments in Lynx Critical Habitat (no overstory treatments would occur)

Understory Treatments in Critical Habitat	
	acres
Ladder fuel reduction (LFR)	1,468
Timber stand improvement (TSI)	421
Total	***1,889***

Wildlife Figure 8. All fuels treatments in Boreal (lynx) habitat and Critical Habitat for Lynx.



Ladder fuel reduction could affect understory structure and reduce food availability for hares. Shrubs are not cut in LFR treatments, but small trees could provide some food resources for hares and other prey, although many trees are suppressed and lacking branches, or branches are too high for hares to reach. A general mitigation in fuels treatments is to leave 15-20% of the acreage in unthinned patches of trees from 0.1 to multiple acres and to retain the complex patches, clumpiness and gaps retained in the harvest units. This will provide cover and forage for hares. Because understory vegetation is not limited across the Critical Habitat unit and treatments are in matrix or grown out of hare reach, the treatments are not

expected to reduce hare forage or populations. Prey for lynx in the matrix habitat would be maintained. Timber stand improvement units are plantations, generally of ponderosa pine, provide limited cover, and have grown out of reach of hares.

Road actions: Approximately 0.04 miles of temporary road would be built in critical habitat, and result in a minor amount of vegetation loss. Approximately 0.3 miles of open road and 6.6 miles of closed road would be decommissioned. No closed roads would be opened. These actions would have minimal effects on vegetation, depending on how long the roads have been closed and other factors. Decommissioned roads may revegetate in the long-term to provide some habitat for lynx or their prey.

Other actions: No soil treatments or wetland thinning is planned in critical habitat. Fisheries projects-coarse wood placement in streams and culverts of stream crossings, would occur. These projects would not change vegetation or effect critical habitat .

Determination: The proposed action may affect, but is not likely to adversely affect Critical Habitat for lynx. Only 58 acres of treatment would occur within the boreal forest area mapped as lynx habitat. These stands have grown out of reach of hares and are no longer providing a food resource. All overstory treatments would result in more open habitat that will generate browse for hares, an important prey item for lynx.

The proposed action is consistent with the LCAS. In the remainder of the Critical Habitat, treatments would not result in large-scale loss of understory vegetation in boreal forest. The area is mostly not boreal forest, and treatments are in matrix or stands that have grown out of reach of hares.

Northern Spotted Owl and Designated Critical Habitat

The current range of the northern spotted owl extends from southwest British Columbia through the Cascade Mountains, coastal ranges, and intervening forested lands in Washington, Oregon, and California. On the Okanogan-Wenatchee National Forest, it ranges in forested areas from the Chewuch River, west and south to the Forest boundary. An estimated 82,115 acres of spotted owl habitat is present on the Okanogan portion of the Forest, and 631,105 acres on the Wenatchee portion (Youkey, 2011).

The northern spotted owl was listed as threatened under the Endangered Species Act on June 26, 1990 due to widespread loss of habitat across its range and inadequacy of regulatory mechanisms to conserve the spotted owl. It is currently being considered for uplisting to endangered status. An interagency conservation strategy was developed by Thomas et al. (1990), and the Northwest Forest Plan (1994) provided extensive direction to promote the conservation of the northern spotted owl, by use of late-successional reserves (LSRs). A revised recovery plan was released by the USFWS in July, 2011 and builds on the Northwest Forest Plan. Critical Habitat for Northern spotted owls, discussed in the next section, has also been designated and provides protection for spotted owls (USFWS, 2012).

Spotted owls use late/old mixed conifer habitat for nesting, roosting, foraging and dispersal habitat, generally in the more mesic areas of the district, although nest sites in dry Douglas-fir/ponderosa pine stands are also used. Exclusion of fire from dry and mesic forests has increased suitable habitat conditions for spotted owls, but simultaneously resulted in greater risk of habitat loss due to fire (Buchanan et al.1995; Everett et al.,1997). Everett et al. (1997) suggested that while vegetation manipulation to reduce fire hazard may create less optimal habitat for the northern spotted owl, habitat effects from vegetation treatments should be considered against the risk of stand replacement fires and the loss of nesting and roosting habitat over large areas. Over 50% of the northern spotted owl nest-sites in the eastern Cascades of Washington occur within dry and mesic forests (in Gaines, 2010), which are at risk of uncharacteristic fire (Everett et al., 2000; Hessburg et al., 2007). The Recovery Plan (2011) states that, currently, the most important range-wide threats to the spotted owl are competition with barred owls,

ongoing loss of spotted owl habitat as a result of timber harvest, habitat loss or degradation from stand replacing wildfire and other disturbances, and loss of amount and distribution of spotted owl habitat as a result of past activities and disturbances (U.S. Fish and Wildlife Service, 2011).

Climate change combined with effects from past management has exacerbated the change in forest ecosystem process to a greater degree than was predicted by the Northwest Forest Plan, and many researchers believe there is a need to manage forests within an increasingly dynamic and unpredictable future caused by climate change (U.S. Fish and Wildlife Service, 2011). The Recovery Plan suggests that vegetation management of fire-prone forests can retain spotted owl habitat on the landscape by altering fire behavior and severity (Reinhardt et al. 2008, Haugo et al. 2010, Wiedinmyer and Hurteau 2010), while also anticipating likely shifts in future ecosystem processes due to climate change. The Recovery Plan recommends "implementation of landscape-scale, science-based adaptive restoration treatments in disturbance-prone forests that will reconcile the goals of conserving and encouraging spotted owl habitat while better enabling forests to: (1) recover from past management measures, and (2) respond positively to climate change with resilience (Spies et al. 2006, 2010a,b, Millar et al. 2007, Reinhardt et al. 2008, Haugo et al. 2010, Keane et al. 2009, North et al. 2010, Littell et al. 2010). This should provide more high quality spotted owl habitat sooner and for longer into the future which will greatly benefit spotted owl recovery in the long-term".

In the dry forests of the Eastern Washington Cascades, the approach of protecting key areas of closed-canopy forest while managing the remaining landscape to restore and maintain dry site conditions would allow retention of current owl habitat, provide for needs of dry site species that use open forest types, and reduce the threat of wildfire loss of habitat. While there are many recommendations about the kinds of management activities that can reduce fuels and fire risks in dry forests (Agee 2002, Hessburg and Agee 2003, Hessburg et al. 2005, Brown et al. 2004, Agee and Skinner 2005, Peterson et al. 2005, Stephens and Moghaddas 2005). Agee (2002) summarized fuel treatment principles:
1. Reduce surface fuels—especially volume in the 1-hr (herbs, litter, round wood < ¼ " dia.), 10-hr (duff to 4" depth, and round wood ¼ - 1" dia.), 100-hr (round wood 1-3" dia.), and 1000-hr (3-6" dia.) time lag classes, decreases flame lengths and fireline intensity.
2. Increase the height to live crowns—eliminates fuel ladders, which means longer flame lengths are needed to facilitate tree torching. Amounts to removing the lower crown classes—seedlings, saplings, poles, small and sometimes medium sized trees.
3. Decrease crown density—reduces crown fuel continuity, the propensity for canopies to trap heat, and thereby, the likelihood of running crown fires. Decreasing crown density is the least important of all other principles are applied. This principle may be applied variably across the landscape and would appropriately be ignored in owl habitat to maintain prey habitat and provide closed canopy owl habitat.

Other recommendations from the Science Panel (Courtney et al. 2008) for active management in spotted owl habitat include:
1. Favor fire tolerant tree species during treatments, thereby steadily improving the fire tolerance of stands, especially where fires are typically low or mixed severity.
2. Retain the large and very large fire tolerant trees—existing old trees of fire tolerant species (ponderosa pine, western larch, Douglas-fir) should be retained throughout the landscape managed for Northern Spotted Owl habitat. These trees take 150 or more years to grow and are not easily replaced. They are key habitat features that can persist for centuries. Large trees of other species (e.g. grand fir and white fir) and younger, smaller trees (e.g. <20" DBH) of fire tolerant species may be removed outside critical owl habitat to reduce canopy fuels.
3. Apply treatments unevenly within stands--creating fine-scale landscapes within stands. Fuel and other stand-scale restoration treatments should produce a fine-scale mosaic of open patches of large trees, denser patches with mid-canopy trees, and regeneration within a landscape that generally meets fuel treatment principles (above). Creating fine-scale landscapes within stands, provides for species and

processes that operate at a smaller patch scale (range from <0.1 acre to 100+ acres). Many plants, animals, and processes rely on a relatively fine scale pattern of patchiness than occurs at a tree, sub-patch, patch, patch-group, or neighborhood scale.
4. Apply treatments unevenly among stands--creating meso-scale landscape mosaics within regional landscapes.
5. Develop silviculture prescriptions for entire landscapes that integrate the above fuel reduction objectives with those for maintaining or improving habitat for Northern Spotted Owl prey.

Several local studies have characterized nest sites of spotted owls. Buchanan et al. (1995) compared random sites with spotted owl nest sites and found that nest sites had more Douglas-fir trees 35-60 cm diameter at breast height (dbh), greater basal area of Douglas-fir trees, more large ponderosa pine trees (61-84 cm dbh), greater live tree basal area, and greater basal area of Class IV (soft) snags. In addition, nest sites had less basal area of Class I and II (hard) snags, however, volume of coarse woody debris and canopy closure did not differ between sites. Snag classes are from Buchanan (1991). Everett et al. (1997) found that spotted owl nest stands had multi-layered canopies and that the presence of shade-tolerant tree species have increased as a result of reduced fire effects. While spotted owls will nest in a wide variety of habitats within the east Cascades Physiographic Province (Buchanan and Irwin 1998), a general definition of nesting and roosting habitat includes a moderate to high canopy closure (60 to 90 percent); multi-layered, multi-species canopy with a component of Douglas-fir and large overstory trees (dbh greater than 30 inches), a high incidence of large trees with various deformities (large cavities, broken tops, mistletoe infections, and other evidence of decadence); large snags; large accumulations of fallen trees and other woody debris on the ground; and sufficient open space below the canopy for spotted owls to fly (Thomas et al. 1990). Most nests occur in mistletoe platforms and/or abandoned goshawk nests in Douglas-fir. About 10% of the nests are in cavities of large trees (Buchanan, 1991).

Foraging habitat generally has attributes similar to those of nesting and roosting habitat, but may not always support successful nesting pairs (USFWS 1992a). Dispersal habitat has been used to define the conditions necessary for spotted owls to move between patches of nesting, roosting and foraging habitats. Dispersal habitat provides linkages between habitat patches for owl movement, but may not contain the structural attributes, such as canopy closure, large trees, and snags, associated with nesting, roosting and foraging habitats. Little research has been conducted to quantitatively define dispersal habitat for spotted owls. However, Sovern et al. (2015) found that roosting habitat used during natal dispersal included some large trees (>20”) and canopy cover greater than 70%.

The 2011 Recovery Plan (USFWS 2011) identified range-wide threats to the spotted owl as competition with barred owls, ongoing loss of suitable habitat as a result of timber harvest and uncharacteristic wildfire, and loss of amount and distribution of suitable habitat as a result of past activities and disturbances. Habitat effects include loss of habitat quality and quantity as a result of past activities and disturbance, and ongoing and projected loss of habitat as a result of fire, logging and conversion of habitat to other uses. Habitat loss from logging has declined since the Northwest Forest Plan was implemented, however low net rates of loss continue, largely as a result of wildfire (Davis et al. 2011, 2015). Davis et al. (2016) estimated a rangewide net decrease in nesting/roosting habitat of 1.5% on all federal lands since 1993.

Mission Analysis Area
Critical habitat for northern spotted owls was designated and provides protection for northern spotted owls (USFWS, 2012). Unit 7 East Cascades North, subunit ECN1 is west of and adjacent to the Mission project area. There is a slight (2.8 acres) overlap of the subunit with the project area on northwestern boundary.

The Buttermilk Creek and Libby Creek drainages were first surveyed for northern spotted owls in 1987. In that year, one detection was made in Buttermilk Creek near Blackpine Lake. It was recorded as a single male with no detections on follow-up visits. These areas were surveyed again in each year from 1988-1993. In 1990 a single adult was detected again in Buttermilk Creek near Blackpine Lake. There were no detections in 1988, 1989, 1991, 1992 or 1993. The Mission project area was surveyed to the USFWS endorsed 2012 protocol in 2014 and 2015. Six visits were completed on 5 separate routes each year. No northern spotted owls were detected. Other owl species detected were great horned, barred, and flammulated.

The nearest known nest sites are the War Creek site, approximately 4.5 miles west of the Mission project area, and the Foggy Dew site, approximately 4 miles south of the Mission project area. The War Creek site was last known to be active in 1992, the Foggy Dew site in 1995. The western edge of the project area, with its primarily warmer and drier forest types, may be a dispersal route between more mesic habitats in the Twisp River drainage and higher elevations of Gold Creek.

Northern spotted owl habitats as mapped in the Ray Davis 2012 habitat layer show that the Mission project area contains 4,385 acres of highly suitable/suitable nesting/roosting habitat, 13,944 acres of marginal habitat, and 17,792 acres of dispersal habitat. Habitat assessment conducted for the Mission project found a lot less habitat. Using a combination of EMDS modelling, GIS, and field verification it was determined that currently, 1,054 acres have been identified as nesting, roosting, foraging habitat (NRF) and 4,113 acres as dispersal habitat,. This amounts to 3.3% and 13% of the Mission project area, respectively. The NRF habitat is generally marginal and probably better described as foraging habitat with some limited capacity for roosting. These stands are found primarily in riparian stringers and small, isolated patches. It is unlikely that enough NRF habitat is present in the Mission project area to support northern spotted owls, and potential for these vegetation types to produce sustainable owl habitat is extremely limited. In a 1.8 mile buffer from the 1987 and 1990 site near Blackpine Lake there are 194 acres of NRF habitat and 1,295 acres of dispersal. Like the NRF habitat, the dispersal habitat is comprised of denser stands that are at high risk of wildfire and not sustainable.

Late Successional Reserve

Approximately 2,335 acres of the Mission analysis area are designated as late-successional reserve (LSR), to be managed for late-successional habitat for spotted owls and other species. Currently, about 118 acres (5% of the LSR within the project area) of NRF habitat and 306 acres (13% of the LSR within the project area) of dispersal habitat are present in the area.

The proposed action includes 88 acres of TSI activity (thinning of young plantations) and 12 acres of Ladder Fuel Reduction work LSR. Both of these treatments are noncommercial thinning of conifers less than 8” dbh. These would meet Northwest Forest Plan Objectives for Late Successional Reserves (LSRs) in that planned noncommercial treatments open the canopy and reduce potential for crown fire and competition between trees, which would reduce the risk of habitat loss of the late/old habitat. This activity is covered under the Assessment of the Northeastern Cascades Late-Successional Reserves (USDA Forest Service, 1998) and is exempted from further review by the Regional Ecosystem Office (Regional Ecosystem Office 1998). Thinning would accelerate development of small trees into larger trees, and is consistent with direction for LSRs.

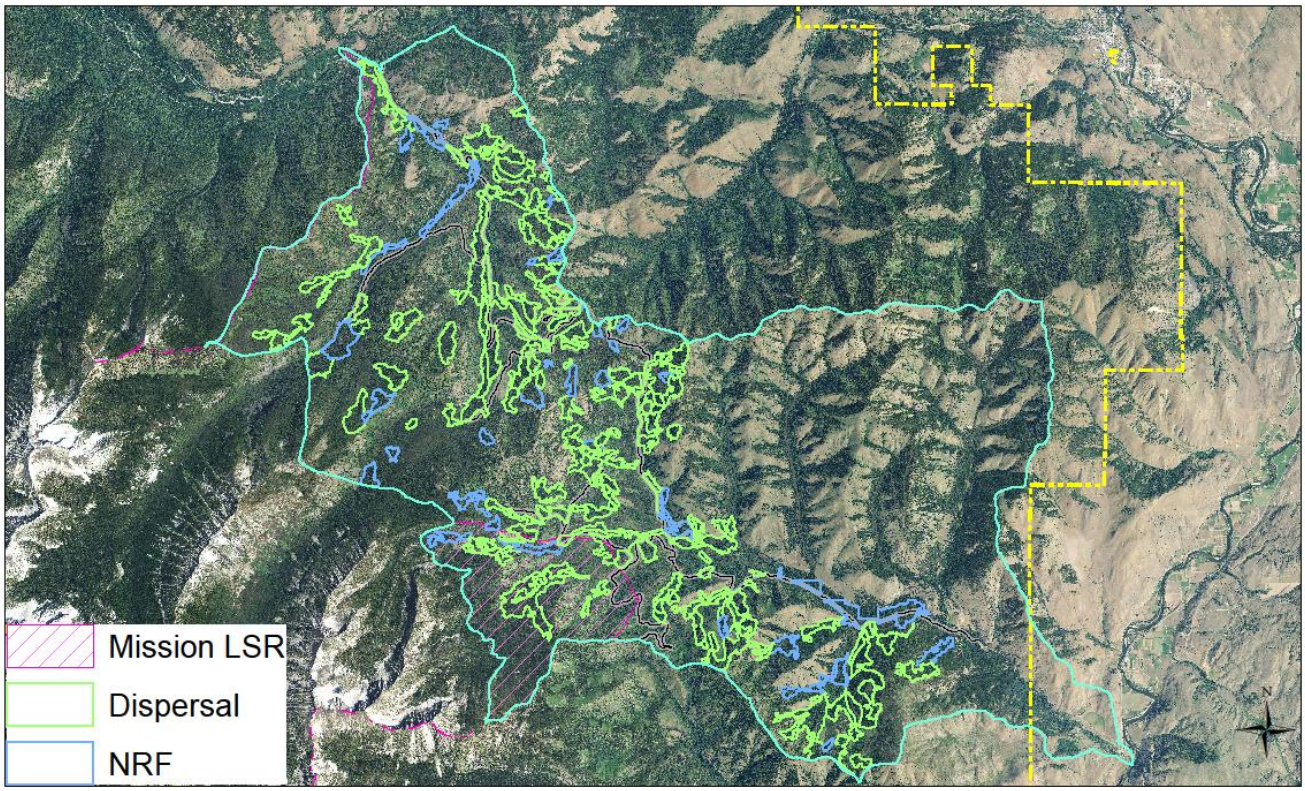
The following table shows how field verified acres of habitat compare to owl habitat acreages as mapped in the regional Ray Davis layer:

Mission Restoration Project		NSO Habitat Mapping Differences Disclosure		
Habitat Type	Mapping Methodology	Acres Pre Project Habitat	Acres of Project Validated Habitat	Acres changed based on Mapping Update
Nesting Roosting	PI Owl Habitat		1054	
	Davis Highly Suitable	244		
	Davis Suitable	4141		-3331
Foraging	PI Potential Habitat		0	
	Davis Marginal	13,944		-13,944
Dispersal	Davis Dispersal	17,792	4113	-13,679

Habitat in the project area has changed due to fire suppression and logging, which have resulted in reduced numbers of large trees, fragmented stands, and forest conditions dominated by dense multilayered stands of smaller trees that are at risk for wildfire, insects and disease, and that also compete with larger trees. Old forest structural attributes (large trees, large snags and down wood) in these dense overstocked stands are at a high fire risk (Everett et. al., 1997).

Approximately 2.2 miles of open road intersect NRF habitat in the analysis area.

Wildlife Figure 9. Mission Spotted Owl Habitat



Potential Effects of the Mission Project to Designated Critical Habitat
Critical habitat subunit ECN1 is west of and adjacent to the Mission project area. There is a slight (2.8 acres) overlap of the subunit with the project area on northwestern boundary. This 2.8 acres is non-habitat, neither NRF or dispersal. It is within a larger unit proposed to be underburned. Underburning is described in more detail on page 26 of this BA, but basically would be a reduction of surface fuels (grass, shrubs, duff, downed branches) and some minor tree scorching.

Determination
The proposed Mission project would not result in the destruction or adverse modification of any habitat in Critical Habitat subunit ECN1. The effect of underburning of 2.8 acres of nonhabitat for northern spotted owls on the edge of this subunit would be insignificant and discountable. The proposed project "may affect, but would not likely adversely affect" critical habitat designated for the northern spotted owl.

Potential Effects of the Mission Project to Northern Spotted Owl
Potential effects of the proposed Mission project to northern spotted owls would be:

- Potential for human disturbance to nesting owls;
- Changes to northern spotted owl habitat;

<u>Disturbance to nesting owls</u>
There are no known nesting sites within the Mission project area. The nearest known northern spotted owl nesting sites are 4-5 miles distant from the analysis area boundary and activity has not been documented at either of them for more than 20 years. Existing habitat suitable for nesting/roosting/foraging within the project area is marginal and consists of numerous small stringers that total 1054 acres which is only 3.3% of the project area. The Mission project area was surveyed to the USFWS endorsed 2012 protocol in 2014 and 2015. Six visits were completed on 5 separate routes each year. No northern spotted owls were detected. It is extremely unlikely that there would be northern spotted owls nesting in the Mission area when the proposed activities are implemented.

<u>Changes to northern spotted owl habitat</u>
Within the Mission project area there are currently 1,054 acres that have been identified as nesting, roosting, foraging habitat (NRF) and 4,113 acres as dispersal habitat. This amounts to 3.3% and 13% of the Mission project area, respectively. These habitats were mapped using EMDS and GIS layers that were then modified through field verification. The NRF habitat is generally marginal, and found primarily in riparian stringers and small, isolated patches.

The following tables summarize effects to Northern Spotted Owl NRF and dispersal habitat based on the Proposed Actions identified in the Mission Restoration project. The first table shows the effects relative to locally mapped or field verified habitats and forms the basis for the effects described on pages 14-31 of this BA. The second and third table are provided to show the relation of effects to the Region 6 baseline layer (Ray Davis Layer) developed for the NWFP monitoring requirements. The second table here shows the acres of "Ray Davis Layer" that coincide/agree with locally mapped habitats, thus the effects to baseline mapping elements that are believe to be an accurate depiction of effects. The third table displays what the effects analysis would show if the District simply used the "Ray Davis layer" without having done the appropriate project level habitat mapping and validation.

Mission Restoration Project			Treatment Effects to Field Verified NSO Habitats												
Habitat Type	Mapping Methodology	Acres of Project Validated Habitat	Acres Degraded w/in 0.7 mi Activity Center	Acres Degrade w/in 1.8 mi Activity Center	Acres Degraded outside of Activity Center	Total Acres Degraded	Acres Downgraded w/in 0.7 mi Activity Center	Acres Downgraded w/in 1.8 mi Activity Center	Acres Downgraded outside of Activity Center	Total Acres Downgraded	Acres Removed w/in 0.7 mi Activity Center	Acres Removed w/in 1.8 mi Activity Center	Acres Removed outside of Activity Center	Total Acres Removed	Post Treatment Acres
Nesting Roostin	PI and Field Verified	1054	NA	NA	296	296	NA	NA	0	0	NA	NA	0	0	1054
Dispersal	PI and Field Verified	4113			1756						NA	NA	35	35	4078

Mission Restoration Project			Treatment Effects To Ray Davis Habitat Field Verified in Mission Project												
Habitat Type	Mapping Methodology	Acres Field Verified	Acres Degraded w/in 0.7 mi Activity Center	Acres Degrade w/in 1.8 mi Activity Center	Acres Degraded outside of Activity Center	Total Acres Degraded	Acres Downgraded w/in 0.7 mi Activity Center	Acres Downgraded w/in 1.8 mi Activity Center	Acres Downgraded outside of Activity Center	Total Acres Downgraded	Acres Removed w/in 0.7 mi Activity Center	Acres Removed w/in 1.8 mi Activity Center	Acres Removed outside of Activity Center	Total Acres Removed	Post Treatment Acres
	Davis Highly Suitable	12													
	Davis Suitable	248	NA	NA	102	102	NA	N A	15	15	NA	NA	0	0	260
	Davis Marginal	374	NA	NA	126	126	NA	NA	12	12	NA	NA	0	0	374
Dispersal	Davis Dispersal	2,672			1185	1185			0	0	NA	NA	28	28	2,644

Mission Restoration Project			Treatment Effects To Ray Davis Habitat Layer												
Habitat Type	Mapping Methodology	Acres Pre Project Habitat	Acres Degraded w/in 0.7 mi Activity Center	Acres Degrade w/in 1.8 mi Activity Center	Acres Degraded outside of Activity Center	Total Acres Degraded	Acres Downgraded w/in 0.7 mi Activity Center	Acres Downgraded w/in 1.8 mi Activity Center	Acres Downgraded outside of Activity Center	Total Acres Downgraded	Acres Removed w/in 0.7 mi Activity Center	Acres Removed w/in 1.8 mi Activity Center	Acres Removed outside of Activity Center	Total Acres Removed	Post Treatment Acres
	Davis Highly Suitable	244													
	Davis Suitable	4141	NA	NA	1697	1697	NA	N A	386	386	NA	NA	12	12	4373
	Davis Marginal	13,944	NA	NA	4635	4635	NA	NA	914	914	NA	NA	33	33	13,911
Dispersal	Davis Dispersal	17,792			5852	5852			0	0	NA	NA	48	48	17,744

Overstory treatments:
Commercial thinning treatments would occur on 2 units totaling 36 acres (3%) of marginal NRF habitat for spotted owls. These treatments would change the overstory in NRF habitat and would open the canopy, and slightly degrade NRF habitat but would not downgrade the function to dispersal habitat. The silvicultural prescriptions for the two units in NRF include mitigations of retaining large trees (≥ 21" dbh), clumps of large trees, snags and defective trees, and maintaining canopy closures of 60% or greater (where it currently exists). Habitat would be slightly degraded for flying squirrels (Lehmkuhl et al. 2006b, Carey, 2001) but habitat for woodrats and other prey (Lehmkuhl et al. 2006a), would be retained or would rapidly recover functionality (in less than 5 years)(Irwin et al. 2012), and would provide a food source for owls. Variable thinning is expected to be favorable compared to even-aged thinning because it creates within stand heterogeneity (Carey 2001, Lehmkuhl et al 2006). Carey found that, post- variable thinning, total biomass of squirrels was enhanced within 5 years.

Approximately 556 acres of dispersal habitat would be commercially thinned (about 14% of the dispersal habitat), which would open the canopy and degrade this habitat type. This includes treatments that remove mistletoe infections, which produce deformed branches often used for nesting. This treatment is planned for 127 acres in dispersal habitat (3% of the dispersal habitat). In the short-term, this would decrease nest site availability in stands that may become habitat in the future, while improving growth on remaining trees in the longer term. Regeneration harvest would occur on 35 acres of dispersal habitat (1%), which would downgrade the habitat to non-habitat (removal of dispersal habitat). Approximately ½ of the treatment in dispersal habitat would occur in the northeastern portion of the analysis area, where dry forest conditions interspersed with non-forest habitat adjacent to private land and the eastern edge of the owl's range, make this area a poor candidate for managing as owl habitat. In the longer term, accelerated growth of large trees would occur more quickly than if left unmanaged, providing better habitat over time for spotted owl and other species using large trees.

Silvicultural treatments would also result in beneficial effects to the habitat, in the short and longer term (immediately to >20 years). Release of large and medium trees would reduce competition on the remaining trees, accelerating their rate of growth into larger trees. It would also reduce the ladder fuels that could carry fire from the ground into the canopy, and reduce risk of losing the stands of large trees. This would improve habitat at the individual stand and at the landscape level for spotted owls. In all prescriptions except regeneration harvest (35 acres of the 4,113 acres of dispersal, <1%), NRF and dispersal stands will retain some habitat function as foraging habitat, post-treatment.

Understory treatments
Ladder fuel treatments: Research suggests that thinning and burning treatments in dry coniferous forests have few detrimental effects on native understory vegetation (USDA, 2012). Ladder fuel thinning that affects the understory would have minor effects on the NRF and dispersal habitat, and would not downgrade habitat.

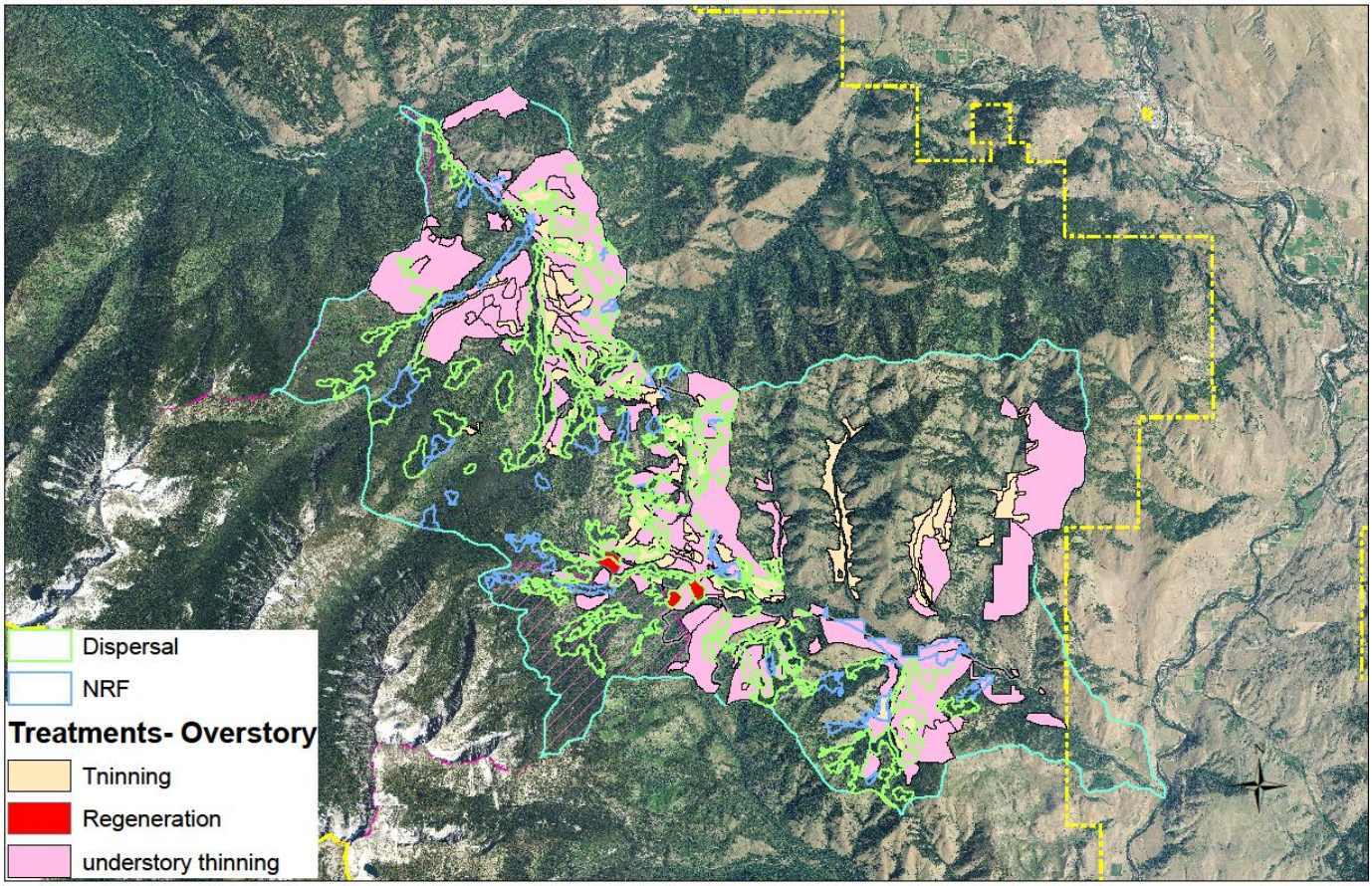
Understory fuels less than 8" dbh would be cut, piled and burned. These contribute little to canopy closures and are too small to provide shading, habitat for prey species or cover from predators. Removal of this component would reduce competition and risk of fire to the larger trees.

Ladder fuel thinning would occur on 260 acres of NRF habitat and about 1,200 acres of dispersal habitat (about 29%). In NRF stands, mitigations to maintain habitat function are:

1. To maintain canopy closures at 60% or greater, and
2. No openings larger than 1/4 acre would be created.

Ladder fuel reduction (LFR) in non-habitat stands would result in reduced risk of crown fire across the landscape, which would protect existing owl habitat, as well.

Wildlife Figure 10. Overstory and Understory Treatments and Field Verified Spotted Owl Habitats



Prescribed burning: Prescribed burning has less effect on overstory than thinning, and usually doesn't reduce tree density or basal area of the dominant overstory (USDA, 2012). Patchiness, structural complexity and habitat heterogeneity increase with prescribed burning, (unless there are multiple entries or burn is large (greater than 1000 hectares) (Pilliod, 2006)). Prescribed burning with low/moderate prescriptions would have minor negative effects on owl habitat. It would result in slightly more open canopies, loss of large, soft snags, and creation of small, hard snags. Beneficial effects would be increased diversity of structures and increased complexity of habitats which would increase foraging opportunities in about 5 years. Proposed prescribed burning would not downgrade or degrade NRF or dispersal habitats where it would occur. Fireline construction by machine and hand would be completed to support burns. None of the machine firelines are in suitable (NRF) habitat.

Other treatments: No temporary roads would be built in suitable (NRF) habitat. Several closed roads (ML 1) would be opened. While 2.4 miles would be opened, only 0.5 would be open to public use. The remainder would be open to administrative use, which is infrequent. Decommissioning of closed and open roads, opening of closed roads for administrative use, and changes in maintenance levels would occur. A long-term benefit would occur, as decommissioned roads would eventually revegetate, possible providing additional habitat in 40 years or more. Minor vegetation changes could occur as a result of the decommissioning or reopening, if small trees and shrubs are removed on the road bed.

Soil treatments would occur in 28 acres of NRF and 21 acres of dispersal habitat. The tree component would not be changed, and this treatment would not change habitat function. Wetland treatments and aquatic

projects would result in no vegetation effects and large trees would not be affected. The Mission project area was surveyed to the USFWS endorsed 2012 protocol in 2014 and 2015. Six visits were completed on 5 separate routes each year. No northern spotted owls were detected. It is extremely unlikely that there would be northern spotted owls nesting in the Mission area when the proposed activities are implemented.

Determination

There are no known nesting sites within the Mission project area. Existing habitat suitable for nesting/roosting/foraging within the project area is marginal and consists of numerous small stringers. The Mission project area was surveyed to the USFWS endorsed 2012 protocol in 2014 and 2015. No northern spotted owls were detected. It is extremely unlikely that there would be northern spotted owls nesting in the Mission area when the proposed activities are implemented. Changes to habitat would be minimal. NRF habitat would be degraded by 296 acres, dispersal by 1756 and an additional 35 acres of dispersal habitat would be removed. None of these treatment units are within designated critical habitat for the northern spotted owl.

In east-side habitats of the Washington and Oregon Cascade Range, the only viable conservation strategy is to actively manage fire-prone forests and landscapes to sustain spotted owl habitat (USDA, 2012). The proposed treatments in the action alternatives would achieve this, and are consistent with the revised recovery plan for northern spotted owls (USFWS, 2011). With the exception of 36 acres, the proposed action treats areas that are not currently providing NRF habitat, in order to protect habitat from large scale, high-severity fires and to set appropriate stands (which are very limited in the analysis area) on a trajectory to become habitat in the future. Suitable habitat in the analysis area is inadequate to support owls, and marginal due to small isolated stands on the edge of the range. Two of those stands (36 acres) would be thinned to retain the large tree component.

The proposed activities of the Mission project "may affect, but would not likely adversely affect the northern spotted owl".

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Status of Listed Fish Species

UCR Spring-run Chinook ESU: UCR Spring-run Chinook salmon were listed as an endangered species on March 24, 1999 (64 FR 14308) and their endangered status was reaffirmed on June 28, 2005 (70 FR 37160).

Upper Columbia River Steelhead DPS: UCR steelhead were listed an endangered species on Aug. 18, 1997; status upgraded to threatened on Jan. 5, 2006; reinstated to endangered status per U.S. District Court decision in June 2007; status upgraded to threatened per U.S. District Court order in June 2009.

Columbia River Bull Trout: The Fish and Wildlife Service (FWS) listed the Columbia River population of bull trout as threatened on 06/10/1998 (63 FR 31647).

Critical Habitat

Critical habitat is defined in Section 3(5)(A) of the ESA as "the specific areas within the geographical area occupied by the species ... on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection." NMFS designated critical habitat for UCR spring-run Chinook and UCR steelhead on September 2, 2005 (70 FR 52630). The FWS designated critical habitat for CR Bull Trout throughout their U.S. range on September 30, 2010 (75 FR 63897). Table 22 lists the designated CH for Chinook, steelhead, and bull trout.

Table 22. Designated Chinook, steelhead, and bull trout CH in the Action Area drainages.

Watershed	Sub-watershed/stream	Species*	Crit. habitat length (mi)
Twisp River	Buttermilk Creek	ST	2.4
		SCH	None
		BT	2.6
	EF Buttermilk Creek	BT	3
	WF Buttermilk Creek	BT	9
Lower Methow River	Libby Creek	ST	3.4
		SCH	None
		BT	None

*ST-Steelhead, SCH-Spring Chinook, BT-Bull trout

Habitat for steelhead and bull trout, to a lesser degree, extends beyond the current distribution of critical habitat in the project area (See Figures 3 and 4). Within the Buttermilk Creek drainage, NMFS did not designate steelhead critical habitat in WF Buttermilk and EF Buttermilk Creeks. Past snorkel surveys in these creeks observed rainbow/steelhead up to the wilderness boundary on WF Libby Creek and to waterfall barrier on EF Libby Creek. During the 2011 snorkel surveys, rainbow/steelhead juveniles were the abundant species with accounting for ~80% of the total individual observed. In 2015, a fish survey conducted on Black Pine Creek identified juvenile rainbow/steelhead up RM 0.62, just above the second road crossing over the creek. Surveys up at RM 1.3 and 1.7 observed only cutthroat trout, suggesting steelhead distribution ends downstream. In the Libby drainage, juvenile rainbow/steelhead is confirmed to up to RM 1.6 and up to RM 1.3 on SF Libby Creek. There is little data on abundance in these streams. A 2010 snorkel survey

observed juvenile rainbow/ steelhead to account for ~4% of the total fish surveyed and a density of 0.04 fish per meter below the 43 road. In SF Libby Creek, juvenile density was 0.11 fish per meter. One juvenile bull trout (129 mm) was documented by USGS in 2005 at RM 6.3 on Libby Creek. Their distribution is unknown, but their abundance assumed to be low numbers. USGS also identified juvenile chinook up to RM 1.6 in Libby Creek.

Essential Fish Habitat for Chinook and Coho

Essential Fish Habitat (EFH) is defined in the Magnuson-Stevens Act as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (16 U.S.C. 1802(10)). EFH regulations further interpret the EFH definition as follows:

Waters include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; **substrate** includes sediment, hard bottom, structures underlying the waters, and associated biological communities; necessary is defined as the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers a species' full life cycle.

The amended Magnuson-Stevens Act requires NOAA to minimize damage to EFH from fishing practices, to the extent practicable. Additionally, the Act requires Federal agencies that authorize, fund, or conduct activities that "may adversely affect" EFH to work with NMFS to develop measures that minimize damage to EFH.

Chinook Salmon and Coho Salmon EFH: the lower portion of Buttermilk Creek and Libby Creek contain suitable existing and historic essential freshwater habitat for Chinook and Coho Salmon. Additionally, the Twisp and Methow River do as well.

Description of Species Baseline

The project fishery biologists evaluated the effects of the proposed actions at the Action Area level, at the HUC12 sub-watershed and HUC10 watershed scales. This allowed the project biologist to make ESA effect determinates at the watershed scale. The BA will discuss habitat baseline indicators of the listed fish habitat in the Action Area by HUC12 sub-watersheds and HUC10 watersheds.

Watershed and subwatersheds assessed include the following:

HUC10 Watershed:	Twisp River
HUC12 Sub-watersheds:	Buttermilk Creek
HUC10 Watershed:	Lower Methow River
HUC12 Sub-watershed:	Libby Creek

Sources of information for the baseline conditions consist of the following: Geographic Information System data and USFS Stream Habitat Surveys (USDA 2010 and 2011). The Functioning Condition ratings for fish, habitat, and watershed indicators are based on the FWS/NOAA Fisheries *Table of Population and Habitat Indicators for use In the Northwest Forest Plan Area* (MPI) (USDA, USDC, and USDI 2004).

Subpopulation Characteristics

Subpopulation Size

Spring-run Chinook

Nearly all spring Chinook salmon passing over Wells Dam are destined for the Methow Sub-basin. A small number of hatchery origin spring Chinook now return to the Okanogan Sub-basin as a result of Chief Joseph Hatchery Program. The adult population, based on counts over Wells Dam, has fluctuated since the high count in 2001 with some high years between 2014-2016. 2017 saw a sharp decline adult and jack returns over Wells (FCP 2018). Spawning escapement has fluctuated around 1,000 fish with a few years where the number approximately doubled. 2016 was an especially low year with an estimated escapement of 636 spawners (Snow et al. 2017). Redd counts for the Methow Sub-basin have fluctuated broadly from a low of 308 redds in 2007 to a high of almost 1,400 in 2010. 2016 also saw a sharp decline in redd counts in the Methow (Snow et al. 2017). Spring Chinook have access to most suitable habitat in the sub-basin and fish passage improvements in the last ten years have restored access to supposed historic range. Overall, spring Chinook in the Methow Sub-basin have low numbers and the hatchery component contributes ~73% of the spawning adult run above Wells Dam between 2010-2016 (Snow et al. 2017). According to the MPI fish numbers developed by the USFWS, spring Chinook are ***functioning at risk*** for subpopulation size throughout Methow Sub-basin.

Steelhead

Nearly all steelhead passing Wells Dam are destined for either the Methow or Okanogan sub-basin. Returns over Wells Dam have increased in this decade compared to low numbers in the 1990s. The lasts Wells monitoring and evaluation report (Snow et al. 2017) estimated the 10-year median wild origin spawner at 896, which is below the target of 1,000 for the Methow Sub-basin (UCSRB 2007). Redd counts do not show clear trends. Wide fluctuations have occurred since surveys began in 2001 and are at least due in part to difficult survey conditions including spawning overlaps with spring runoff. Complete counts are difficult to obtain. Like Chinook, steelhead have access to most suitable habitat in the Methow Sub-basin.

The proportion of the wild fish in the steelhead run, within the Methow Sub-basin over the last 10 years, has been ~22% (Snow et al. 2017). Recent wild spawning escapement estimates are seeing a slight improvement to wild origin spawners; however, the Methow Sub-basin continues to be depressed and therefore, steelhead are ***functioning at risk*** for subpopulation size in the Methow Sub-basin.

Bull trout

There are populations of adfluvial, fluvial, and resident bull trout within the Methow core area. The "Recovery Plan for the Coterminous United States Population of Bull Trout (*Salvelinus confluentus)*" was released in September 2015, along with the "Recovery Unit Implementation Plans for Bull Trout."

The USFWS bull trout recovery plan for the Mid-Columbia Recovery Unit (USFWS 2015) delineated 10 local populations of bull trout in the Methow River Core Area. These include Beaver Creek, Gold Creek, Twisp River, Lake Creek, Chewuch River, Wolf Creek, Early Winters Creek, Upper Methow River, Lost River, and Goat Creek. The largest local populations of fluvial bull trout

occur in the Twisp River, Wolf Creek, and Upper Methow River, and suspected the Lost River. Annual Methow River Sub-basin bull trout redd counts, with some incomplete surveys, have averaged around 187 redds for the years (2001-2015). The Twisp River watershed has consistently had the greatest number of redds with an average of about 90 redds. Annual redd counts in the Chewuch River, Upper Methow, and Wolf Creek have averaged between 19 and 27 redds per year. Populations in Early Winters, Goat, and Gold Creeks are typically less than 15 redds each year (USDA 2015).

The upper Lost River bull trout may an isolated population from the rest of the Methow Sub-basin due to a probable year-around barrier from a large rockfall in the river above the confluence with Monument Creek. Redd surveys in the upper Lost River were done over two years, observing 9 and 16 redds in 2008 and 2009. In 1998, the Washington Department of Fish and Wildlife classified the population status of bull trout in the Lost River as "Healthy" with an estimated population of 1,444 fish. In 2009, WDFW re-surveyed the Lost River from Diamond Creek to Drake Creek and estimated the local population as being 1,646 fish (WDFW 2010). In the lower Lost River, 2 redds were counted in Monument Creek during an incomplete survey in 1992.

Surveyed bull trout redd numbers over the last 9 years do not present a clear trajectory for the Methow Sub-basin population. Between 2001 and 2010, redd count numbers appeared to decline. Based on the fluvial redd counts, the adult bull trout population numbers is estimated to be below 500 fish. Therefore the subpopulation size in the Methow Sub-basin is considered **functioning at risk**.

Growth and Survival

Spring-run Chinook

The 5-year average spring chinook spawning population or abundance within the Methow Sub-basin has centered around 1,000 fish (avg 1,288), which includes both hatchery and wild origin. Considering just wild origin, the 5-year average is 321 and well below the target 2,000 natural origin fish. Productivity is based on ration of natural spawner:spawner of 1.2. According to most recent Montioring and Evaluation report over Wells Dam (Snow et al. 2017), latest complete brood (2010) that estimated this ratio was 0.20 in the Methow and is well below the 1.2 target ration. Based on the natural abundance and productivyt being well below the recovery criteria and the high percentage of hatchery fish. Spring-run Chinook are ***not properly functioning*** for growth and survival.

Steelhead

The 5-year average steelhead spawning population within the Methow Sub-basin averaged about 3,500 fish, which includes both hatchery and wild origin. Considering just wild origin, this average is 959. This value is close to the recovery criteria; however, spawner to spawner ratio last estimated back in 2010 was 0.25 and assumed to remain low. Based on the proportion of wild steelhead returns and other factors, steelhead are ***not properly functioning*** for growth and survival.

Bull trout

Most resident populations within the subpopulation would be expected to recover from disturbance in one generation. However, the persistence of the resident population isolated in Blue Buck Creek is currently unknown following post-fire effects of the Tripod Complex Fire in 2006. Migratory bull

trout are widely distributed throughout the sub-basin; however, numbers are low and habitat is moderately fragmented by low stream flow from natural causes, water diversions, and areas of high water temperatures. Fish passage projects have nearly completely restored fish passage at roads and irrigation diversions. The presence of brook trout in the Twisp, Chewuch, and Middle Methow watersheds threatens the survival of these populations through introgression and competition. Therefore, the Methow Sub-basin bull trout population is ***not properly functioning*** for growth and survival.

Life History Diversity and Isolation

Spring-run Chinook
Current hatcher practices use native broodstock to the Methow. NMFS considers stray rates from hatchery origin fish in the Methow basin are high due to the close proximity of hatcheries to wild spawning areas. Overall, spring-run Chinook are ***not properly functioning*** for life history diversity and isolation.

Steelhead
Wild subpopulations in the Upper Columbia can stray; however, the likelihood of this is unknown. Resident *O. mykiss* of varying levels of genetic purity are present in the sub-basin and can interbreed with anadromous steelhead. Recent fish passage and instream flow projects have opened up several miles of habitat to steelhead; therefore, steelhead are ***functioning at risk*** for life history diversity and isolation.

Bull Trout
Recent restoration efforts removed physical artificial barriers allowing migratory bull trout passage to areas previously isolated, including most, if not all, historically accessible reaches. One exception may be upper Eightmile Creek Valley. Some resident populations remain naturally isolated. Brook trout introgression/competition at lower elevations further fragments the population. Because of these factors, bull trout are ***not properly functioning*** for life history diversity and isolation.

Persistence and Genetic Integrity

Spring-run Chinook
The Upper Columbia ESU was homogenized between 1939 and 1944 during the GCFMP. Genetic impacts resulting from this effort are neither fully understood, nor is the level of subsequent genetic drift that has occurred since. The Methow spring Chinook subpopulation has connectivity between other sub-basins in the ESU, but there is low abundance and possibly only a slight up trend across the ESU. Low population size in the 1990s and past hatchery operations threaten the population's genetic diversity. Methow River run sizes, though largely of hatchery origin, have increased in the last decade. Out-of-basin Carson stock spring Chinook have been phased out of sub-basin hatchery operations. Based on these factors, spring Chinook are ***not properly functioning*** for persistence and genetic integrity.

Steelhead
Connectivity occurs between other sub-basins in the upper Columbia DPS and recent telemetry data shows a proportion of the steelhead that come above Wells Dam are from the Snake River and other river systems lower in the Columbia. The DPS has a homogenized history, resulting from the

GCFMP, which mixed the genetics of all steelhead stocks arriving at Rocky Reach Dam. The extent to which the native Methow stock steelhead's genetics persisted in resident *O. mykiss* and remains today is not understood. Hatchery steelhead account for a large proportion of the Methow Sub-basin steelhead population and they may threaten the native run through genetic introgression and competition. Based on these factors, steelhead are ***not properly functioning*** for persistence and genetic integrity.

Bull trout

Connectivity is possible between other subpopulations in the CR bull trout population but inter-sub-basin spawning has not been documented. However, the USFWS conducted radio telemetry of fluvial bull trout and observed migrations between the Methow and other upper Columbia core areas (Nelson and Nelle. 2008). Finite distribution and origin of each fish is not fully understood, but movements may indicate inter-sub-basin spawning. There are still some isolated resident populations of bull trout in the Methow Sub-basin, but most are due to natural conditions. Habitat in the upper Beaver Creek sub-watershed was reconnected when issues at several irrigation diversions and stream crossings were addressed, but it appears that the bull trout may no longer persist in the headwaters. Brook trout introgression with introduced brook trout is a concern in many local populations. Bull trout are ***functioning at risk*** for persistence and genetic integrity.

Discussion of Habitat Baseline Conditions

The existing condition for the Action Area HUC 10 watersheds was assessed by the FWS/NOAA Fisheries Table of Population and Habitat Indicators For Use In The Northwest Forest Plan Area (MPI) (USDA, USDC, and USDI 2004).

Twisp River Watershed Baseline

The last baseline update for the Twisp Watershed was completed for the Little Bridge – Lookout Mountain Allotment Management Plan (Amp) Renewal project and ongoing activities in 2011 (USDA 2011b). New information included in this document updates the baseline; these include new and ongoing monitoring data for years 2011-2017 (e.g. temperature, off-Forest restoration projects and stream surveys). The most significant restoration project was the conversion of Methow Valley Irrigation District West going to wells and off the Twisp River. Yakama Nation has constructed some logjams on private lands.

Activities and monitoring data updated the indicator between the 2008 assessment are summarized below. The only activity that has changed is the wildfires, which are summarized below. The other changes are reflected in the baseline as monitoring data updates.

.

- Temperature data was collected at a few locations in the watershed
- Sediment data
- Two wildfires occurred in the watershed

Wildfires burned within the Twisp River Watershed in 2014 and 2015. Both fires burned in the Little Bridge Creek sub-watershed and portions of the Lower Twisp River sub-watershed, with a combined area of ~16,200 acres. Both fires burned with mixed severity, but mostly with low to

moderate severity. Post-fire changes within streams included increased sediment levels in Little Bridge Creek and the lower Twisp River. Since then, slopes have mostly stabilized and sediment levels are decreasing. Localized increases in wood loading and some changes to peak/base flows have occurred, but not enough to change the overall watershed ratings for these indicators. See the 2014 and 2015 Emergency Fire BAs for more details.

- Stream surveys on the Twisp River and Buttermilk Creek drainage. Wood and pool counts in Little Bridge Creek.
- Instream restoration work on private lands - unknown how this changed habitat conditions.

Watershed Description - Twisp

The Twisp River Watershed is located on the eastern slope of the Cascade mountain range and is about 157,000 acres in size. The Twisp River is approximately 30 miles long with the lower 15 miles and 15,700 acres on state and private lands. It flows into the Methow River at the town of Twisp, at Methow river mile (RM) 42. It is comprised by eight HUC12 sub-watersheds, including the Upper Twisp River, South Creek, Mainstem Upper Twisp River, War Creek, Eagle Creek, Buttermilk Creek, Little Bridge and Mainstem Lower Twisp River sub-watersheds (Figure 12).

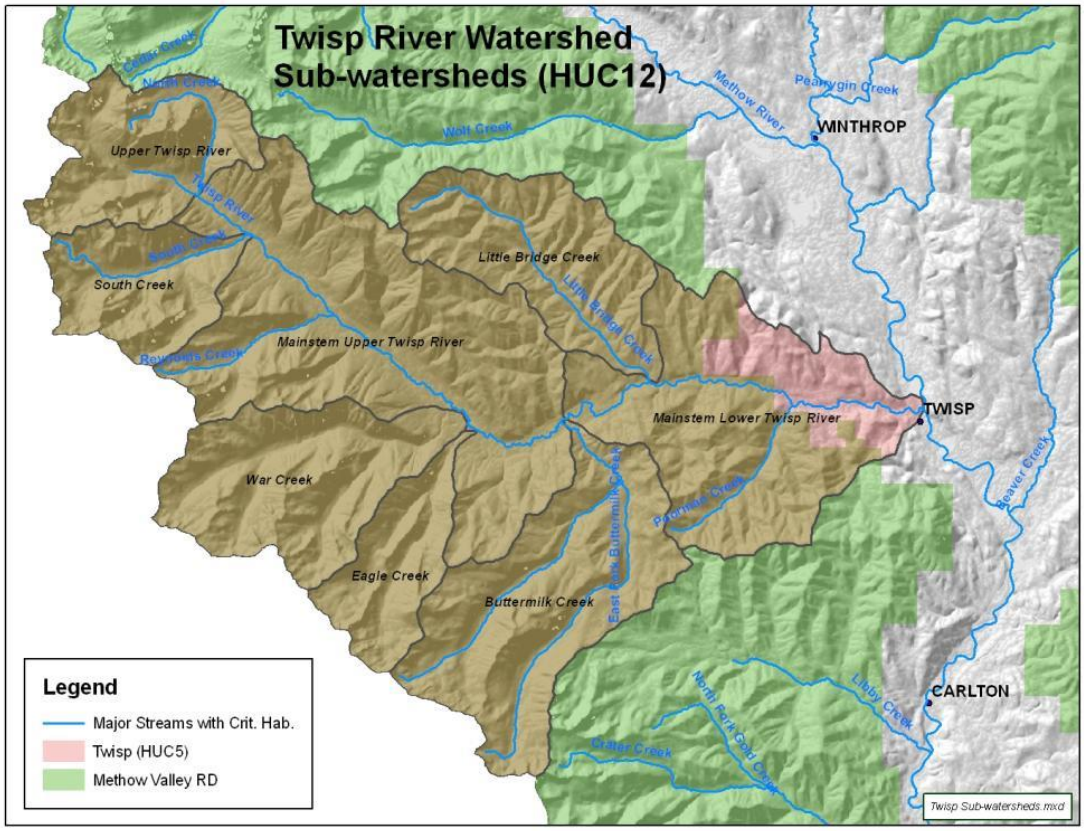

Figure 12. Twisp River Watershed (HUC10) Sub-watersheds (HUC12).

Annual precipitation ranges from 90 inches along the Cascade crest to 20 inches in Twisp; elevation ranges from 8,500 feet at the upper ridges to 1,600 feet at the confluence with the Methow. Over 90% of Twisp watershed is managed under direction of the Okanogan National Forest Land

Resource Management Plan (USDA 1989) as amended by the Northwest Forest Plan (NWFP; USDA and USDI 1994) and PACFISH (NMFS 1995). The Twisp Watershed is a Tier 1 key watershed, identified under the NWFP as important in contributing to the conservation of anadromous salmonids, bull trout, and other resident fish species. About 72,500 acres of the watershed (about 46%) is within the Lake Chelan-Sawtooth Wilderness and an additional 30,000 acres of the watershed are designated Late-Successional Reserve (LSR). Overall, about 70% of the watershed is either Wilderness of LSR. The remaining 40,000 acres consist of multiple use management. A watershed analysis was completed in 1995 (USFS 1995).

Within the Twisp River Watershed, timber harvest and road construction have occurred in the Poorman, Newby, Canyon, Little Bridge and Buttermilk sub-watersheds, leaving a large portion of the upper watershed in a relatively pristine condition. Livestock grazing on National Forest lands occurs within the Lime, Canyon, Little Bridge, Coal, Myers, Poorman, Newby, and Buttermilk Creek drainages.

Spring Chinook salmon, steelhead, and bull trout access the lower 30 miles of the Twisp River, and short (less than 1 mile) segments of Poorman, Eagle, War, Reynolds, South, and North Creeks. Buttermilk and Little Bridge creeks each have several miles of habitat accessible to these species.

Limiting factors for salmonid production for the Twisp River Watershed were identified from several sources including the Upper Columbia Biological Strategy (2014) and the UCR Recovery Plan (UCRSB 2007). These factors include:

- Water Quantity
- Floodplain Connectivity/Habitat
- Channel Complexity
- Sediment
- Temperature
- Introduced Exotic Aquatic Species

Suggested Restoration Actions include:

- Address passage barriers by removing, replacing or fixing artificial barriers (culverts and diversions)
- Reduce sediment recruitment by improving road maintenance
- Reduce the abundance and distribution of brook trout
- Increase habitat diversity, reconnect floodplain and wetlands, restore riparian habitat, increase LWD

The Bull Trout Recovery Plan also identified recovery actions for the bull trout populations on the Forest which are included in the Mid-Columbia Recovery Unit Implementation Plan (USFWS 2015). Applicable recovery actions include:

- Maintain, protect and restore riparian habitats
- Reduce impacts to riparian areas, stream banks, stream flow, and water quality
- Improve habitat complexity, water quality, and connectivity
- Reduce impacts from transportation networks.

Ongoing Actions in the Watershed - Twisp

The following actions are ongoing in the watershed and are discussed at length in previous biological assessments (USDA 2011b). Activities include front country recreation, backcountry recreation, irrigation diversions, and annual road maintenance are ongoing actions in the watershed.

Recreation

Twisp River is renowned for a variety of recreational activities including: skiing, hiking, fishing, hunting, biking, camping, horse-packing, ATV and motorcycling, snowmobiling, swimming and scenic driving. The USFS maintains seven developed campgrounds in the watershed, including five on the banks of the Twisp. The Roads End campground is located adjacent to the Twisp River where bull trout spawn with a user built trail across the creek. To minimize effects to bull trout, the MVRD closes the campground for a month starting early September every year.

Existing dispersed recreation sites across the MVRD were identified and seven sites were inventoried along the Twisp River. There are several others within the subwatersheds, especially within the Little Bridge and Buttermilk drainages.

Back country recreation is trail based and takes place away from roads and in areas not accessible to listed fish. Most back country use is by the general public on foot and horseback. Less than 5% of the use is by commercial outfitter guides using pack stock and operating under special use permit. Front country recreation occurs close to roads and includes developed and dispersed campsites that are accessed by passenger vehicle.

There are roughly 140 miles of trail in the Twisp River watershed. Many of the trails parallel tributaries and meander in and out of riparian reserves. Trails are two or three feet wide and use can cause trampling of vegetation and soil compaction, which can accelerate run off and erosion. Most trails in the Twisp River Watershed are in the Wilderness. In 2007, Twisp River Trail was relocated off the North Creek alluvial fan where it affected natural fan process and bull trout habitat. Now the trail crosses the creek on Twisp River road. Based on field observations, sediment delivery from trails and trail crossings generally have minor effects to stream sediment levels and do not affect habitat indicators at the reach or watershed scale.

Outfitter Guide

For the past 50 years or more, outfitter guide companies have used horses, mules, and llamas to take people into the Lake Chelan Wildernesses. The majority of disturbances are along streams and lakes are localized where camps and day use areas are close to lakes and streams and stream crossings. Trail crossings typically create localized disturbances to stream banks of about 10 feet on each side of the crossing. Streamside campsites are present at low densities. Projects to reduce water routing down trails sediment delivery to adjacent streams have been implemented on all trails across the MVRD. For example, water bars are a standard practice during trail design and are maintained through trail maintenance.

Water Diversions and Irrigation Ditches

The Aspen Meadows and Buttermilk Ditches and six water transmission lines begin on USFS land. Transmission lines are small water diversions generally from springs and less than 2 cfs. Updates to the irrigation diversions in the Twisp River watershed include:

Aspen Meadows Ditch - The diversion is located at RM 2.1 on Little Bridge Creek. The ditch currently can remove up to 0.48 cfs throughout the irrigation season. Fish passage was improved in 2006.

Buttermilk Ditch - The diversion is located at RM 0.71 on Buttermilk Creek. The ditch currently can remove up to 4 cfs throughout the year.

Water Transmission Lines - The Twisp watershed has six permitted water transmission lines. All six lines utilize groundwater sources, none of which have surface water connections to perennial streams.

Annual Road Maintenance

The MVRD completes about 140 miles of road maintenance for the District per year. In the Twisp, this accounts for an estimated 30 miles per year. Activities include surface blading, ditch cleaning, culvert flushing, dust abatement (watering roads), and roadside brushing.

Grazing Allotments

Cattle allotments occur on both sides of the Twisp River. On the north side, the Little Bridge allotment in the Little Bridge Creek area and upper half of the Lookout Mountain allotment in the Buttermilk Creek area are the only two allotments in the watershed. Both allotments were renewed for a 10-year period in 2011 with a LAA effects determination for the presence of livestock in Little Bridge Creek and Buttermilk Creek within occupied critical habitat. It was determined, through consultation that the direct and indirect effects to listed fish were likely to injure or kill ESA-listed fish.

Baseline Habitat Indicators - Twisp

The existing condition for the Action Area watersheds was assessed by using the FWS/NOAA Fisheries Table of Population and Habitat Indicators for Use In The Northwest Forest Plan Area (MPI) (USDA, USDC, and USDI 2004).

Water Quality

Temperature

Natural temperature drivers in the Methow in general include solar radiation, heat exchange between the atmosphere and river channel, ground water input, and the internal structure of a stream channel (Tague et al. 2007; Poole and Berman 2001). Solar energy is the largest component of heat energy available to a stream in the summer (Meehan 1991) and can have a major effect to stream temperature in forested landscapes, especially small streams (Poole and Berman 2001). Management actions that influence water temperature include: riparian vegetation removal next to streams, which increases solar radiation reaching the water surface; ground based yarding which can both compact soil and develop additional drainage features which, singly, or in combination accelerate water transport and reduce storage; and road construction, which can create unnatural streamside canopy openings, increase drainage networks, simplify channel characteristics, and reduce a watershed's ability to retain water in late summer. We focus on vegetation removal for this indicator as the Washington Department of Ecology (DOE) emphasizes effective shade as the driver

for effects to stream temperature, and because road and soil conditions are pertinent and addressed elsewhere in the baseline such as stream sediment levels.

Climate change is a topic of increasing importance at numerous scales. It is now accepted that air and water temperatures are increasing globally. Cool water temperatures, which are critical for our local fish species, are a concern locally regarding the potential for future temperature increases.

Neither the Twisp River nor any tributaries are on the 2016 303(d) list for temperature. However, data from the mouth and near the War Creek Campground suggest that temperatures in late summer may exceed DOE standards. The Twisp River is considered by DOE to be a stream of concern in need of additional monitoring and study to determine if listing is warranted. The following table displays the highest 7-day average maximum temperatures available (7DADM) for the Twisp River and various tributaries since 2001 (USFS 2015).

Table 23. Highest 7-Day Average Maximum Temperature Recorded by Year

Stream	2001	2002	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Twisp River (Methow RM 42.3)													
-RM 0.2 (Hwy bridge)													22.1
- RM 1.8 (USGS gage)	21.8		22.7	19.9	18.8	19.6	20.2	18	15.6	18.1	19.7	19.2	21.1
- RM 3.2 (below C Lk)				19.8	18.5								
- RM 3.8 (above Ch Lk)				19.6									
- RM 4.5 (at diversion				19.8	18.7								
- RM 5 (cut-off bridge		19.4			18.6						18.9		
- RM 6 (Elbow Coulee)								17.8					
- RM 9.6 (Little Bridge)											19.2		
- RM 11 (Jennings)				18.3									
- RM 13 (below Bmilk)		16.9											
RM 15 (above Bmilk)							17.1	15.4	14.4	16.2	17.2		
- RM 18 (War Bridge)	16.1							14.8	13.4	15	15.8		
- RM 22 (Mystery CG)	12.7										13		
- RM 26 (abv South Cr)							13.7	12.3	10.8		13.2		
- RM 29 (Roads End)	12.1												
Little Bridge Cr (Twisp RM 10)													
- Mouth			17.3	17.6		15.7	17.4	15.3	13.6	15.4	16.5	16.8	18.5
- RM 2 (below 030 Rd)			16.3	15.9									
- RM 2.2 below divers				15.9	15.1			14.2	12.5	14.2	14.7		17.5
- RM 2.3 abv diversion			15.8	15.4	14.9			13.9	12.4	13.7	14.7	14.8	17.2
- RM 3 (above 100 rd)			15.1	14.9									
- RM 5 (Vetch Cr)				13.6				13.2		13.4	13.9		16.5
- RM 6.5 (end of Rd).				12.2						10.9	12		

Stream	2001	2002	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Buttermilk Creek													
-Below diversion (RM .2							17.6	13.7	12.8	14.9	15.7		
-Above Diversion (RM 1)								13.2		14.2	15		
W Fork Buttermilk Creek													
-Mouth									11.3				
-at Road 550 x-ing (RM 2)								10.7					
E Fork Buttermilk Creek (RM 1.5)													
-Mouth									11.8				
-at Road 500 x-ing (RM 1.5)								11.3					
Elbow Coulee Side Channel													
Twisp River side channel RM 6							11.4						
North Creek RM 0.3								11.3	10.3	11.8	12		
South Creek RM 0.2								13.2	12	13.8	14.4		
War Creek RM 0.7								12.8	11.8	13.6	14.2		
Poorman Cr													
-Below ponds (RM 0.2)								19.2	16.4		18.5	19.3	
-Above Road 360 (RM 1.7)								13.1	12.1				

Irrigation withdrawals reduce summer base flows when air and water temperatures are highest. Water temperature models have demonstrated that low flow conditions reduce thermal mass and increase instream temperatures (Bartholow, 1991). There are two ditches and six water transmission lines on Forest Service lands and at least one private ditch in the watershed that reduce summer base flows and likely have some effect to water temperature.

Water temperature exceeded the DOE standard of 16°C in the lower two miles of Little Bridge Creek on six years since 2005. Water temperatures are functioning at risk for steelhead rearing (NMFS; 14°C) in the lower three miles of Little Bridge Creek and exceeded the standard for properly functioning steelhead rearing habitat for 59 days at the mouth and six days at RM 3.0 in 2006.

While there are exceedences of recommended water quality standards for salmonid spawning and rearing during the summer, we hypothesize the existing temperatures are at least partially natural. Temperatures (7DADM) recorded at War Creek in 2001 slightly exceeded the 15°C standard for

bull trout summer rearing; however, the Twisp River and tributaries upstream are primarily LSR or Wilderness. Past management activities in some sub-watersheds including Buttermilk Creek and Little Bridge likely have reduced some canopy cover and increased solar exposure, but it can also be argued that fire suppression has increased stream cover in other reaches. Temperatures (7DADM) in Little Bridge Creek were similar ranging from about 12°C to nearly 18°C at the mouth (USFS 2006) and 7DADM temperature at Buttermilk Creek's mouth in 2009 was recorded at 18°C. Water temperatures can be very warm at the mouth that are likely the result of cumulative effects of land use changes mostly along private land along the mainstem. There are certainly some improperly functioning reaches in terms of preferred temperature ranges of sensitive salmonids; however there are many more reaches with intact riparian reserves and adequate shading and corresponding properly functioning temperature regimes. Most of the riparian areas in the watershed, with the exception of the lower reaches of the mainstem, are providing adequate shade. Some sensitive species that use the Twisp utilize migration timings that occur around the warmest parts of the year. Thus, we consider the Twisp River Watershed to be generally **functioning at risk** for water temperature.

Suspended Sediment Intergravel DO/Turbidity & Substrate Character and Embeddedness
These two indicators have similar causal mechanisms of fine sediment entering streams from erosion or runoff. They are considered together for the analysis because we lack intragravel DO measurements and Nephelometric Turbidity Units readings.

Sub-watersheds (12th HUC) in the mid- to upper portion of the Twisp Watershed (10th HUC) contain highly erosive soils, including the Buttermilk Creek and Poorman subwatersheds. Most of the Little Bridge Creek and Newby Creek drainages contain moderate or low erosion potential. Sub watersheds across the HUC10 watershed are susceptible to high intensity summer rain squalls and can erode, which can result in rapid sediment delivery to valley bottoms and the mainstem Twisp River. Natural sediment sources in the watershed include debris torrent activity from the Reynolds Fire, scour from anchor ice, mass wasting of alluvial deposits along the Twisp River, and episodic events in tributaries.

Past management practices associated with activities such as timber harvest, road development, road management, and grazing in the Twisp watershed are suspected to have altered sediment routing and increased fine sediment percentages in the Twisp River. We have not collected turbidity or intragravel dissolved oxygen (IGDO) measurements; however, we do collect Wolman pebble count data in the Twisp River and tributaries and McNeil Core sampling data in spawning gravels in the Twisp. These measurements are used as a surrogate for evaluating turbidity, IGDO, and embeddedness. We assume percent fine levels found from pebble counts and McNeil Core sediment data would be representative of turbidity or IGDO levels and of gravel embeddedness.

Since 2001, MVRD and Bureau of Reclamation has annually monitored fine sediments in known spring Chinook spawning gravel in the Twisp watershed by conducting sediment sampling surveys with a McNeil Core Sampler (Figure 13). McNeil Core Sampling results indicate fine sediment values in spawning habitat in the Twisp River are relatively low. Management activities such as logging, road building and grazing in Buttermilk Creek, Little Bridge Creek, Poorman Creek, and Canyon Creek have contributed sediment to Twisp River over the years. Fine sediment levels in the river peaked in 2006 then decreased, indicating a positive trend in sediment levels. There has been no change in management activities in the Twisp River since what occurred before the 2011

baseline BA was completed. It's unknown at this time what caused the large increase at Reach 1 in 2006. It should also be noted that all values for 2006 appear to be higher and not necessarily following adjacent year trends.

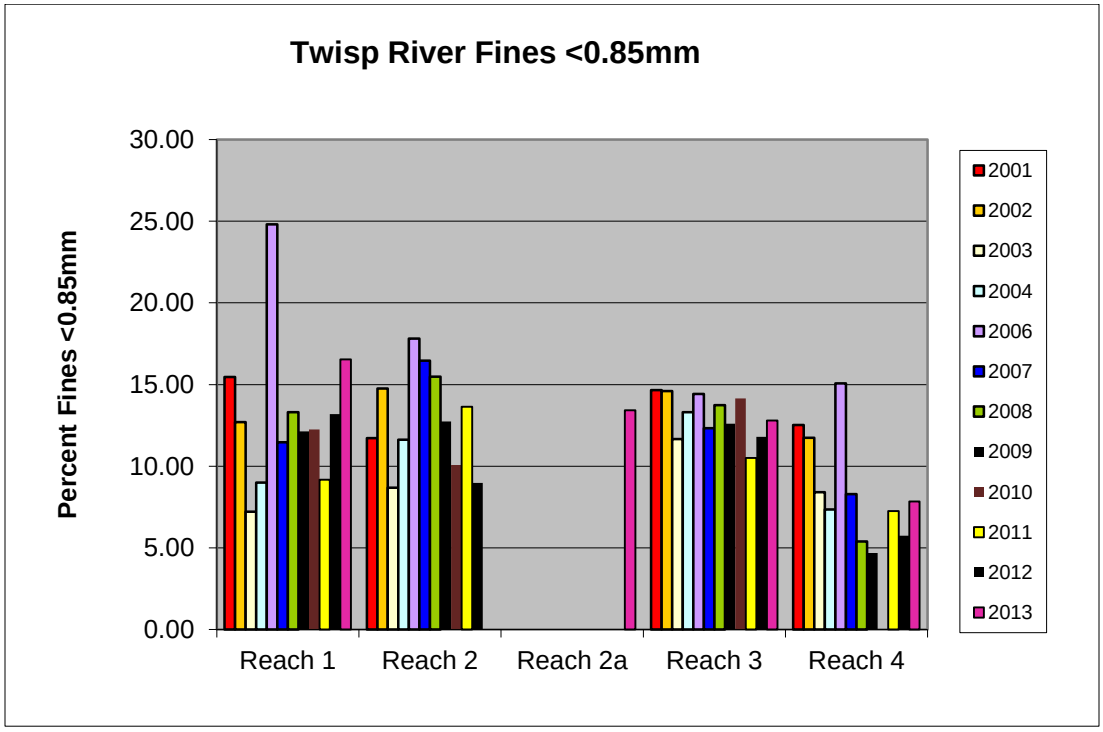

Figure 13. Fine sediment levels in spawning habitat on the Twisp River.

Most tributary streams in the Twisp River watershed are high gradient, transport streams. One exception is Little Bridge Creek, which has some low gradient, deposition reaches where sediment deposits occur. The Twisp River Watershed Analysis (USDA 1995a) identified Little Bridge as a noticeable contributor of sediment to the Twisp River due to its abundance of riparian roads. Pebble counts in 2006 measured surfaces fines <6mm at 13% and 18% in every reach, indicating surface fines were functioning at risk. The amount of surface fines in the two lower gradient reaches (RM 0.7 to 5.0) were about 16% to 17%. From RM 5 to 8.1 surface fines were measured at about 18%. Estimated road densities are 2.7 miles per square mile with most roads parallel to streams. Wildfires burned in the sub-watershed in 2014 and 2015 that generated some post-fire debris flows and sedimentation in Little Bridge Creek. Five pebble counts were done in 2017 and they measured surface fines <6mm as 11.5 to 13% over three reaches. Collectively, the riparian roads, livestock grazing, and recent fire activity add excess sediment to the system and results in a functioning at risk rating for amounts of surface fine sediments, based on the Services guidelines.

Buttermilk Creek is a high gradient, high energy channel that appears to easily transport fines to the Twisp River. The 1995 stream survey identified several large slope failures that reportedly added large amounts of sediment to the creek. During that era, the Forest Service was harvesting timber and constructing roads. These activities were cited as likely causes for the slope failures and caused sediment deposition in the Twisp River. The Forest Service resurveyed the stream in 2011 (USDA 2011c) and several eroding slopes were identified as well. However, these areas did not appear to contribute much sediment to the stream, suggesting conditions have healed somewhat since 1995.

Pebble counts during the 2011 survey were low (<12%) suggesting fine sediment delivery and loading are low, but that could be due to the high transport capacity.

Yakama Nation conducted pebble counts in six tributaries in the Twisp River watershed in 2016 (Table 24) (Yakama Nation Fisheries 2017). Percent fines were low and properly functioning in each of the surveys. These streams drain roadless areas except for Canyon Creek which has roads and livestock grazing. These activities are likely the reason the sediment is higher than other tributaries, but it remains properly functioning (<20% fines of <6mm).

Table 24. Pebble counts on Twisp River tributaries (2016).

Stream	**% Surfance Fines < 6mm (Avg)**
Canyon Cr	7.95
Eagle Cr	0
North Cr	0
Reynolds Cr	5.5
South Cr	05
War Cr	1.5

Overall, the Twisp River Watershed is **functioning at risk** for the sediment indicators for reaches in the Twisp River, Little Bridge Creek, and the presence of artificial sediment sources.

Chemical Contamination and Nutrients

The Twisp River is not on the state 303(d) list for chemical or nutrient contamination. Possible chemical contamination sources include inactive mining areas in the upper watershed, but there are no tailing piles and no chemical contamination has been detected to date.

During the 2015 Twisp River Fire, the Washington State DNR relied heavily on aerial fire retardant to suppress the fire and to protect homes. On two occasions, fire retardant was dropped directly over the Twisp River while protecting adjacent homes. One drop occurred near Newby Creek and the other near the bottom of Poorman Creek road. Both drops occurred on private land. Forest Service fish biologists collected some pH and ammonia data following the drops within a few days of the drops. Spot temperatures ranged from 12-17C, pH levels ranged from 6-9, and Ammonia concentrations ranged from 0-0.5. The pH and ammonia levels were elevated a few days after the retardant drops and ammonia has been found to be elevated a year after a retardant drop on a stream (USDA 2015c). After three years, we expect the conditions have returned to pre-retardant drop conditions for these water quality parameters.

Other possible nutrient contamination could also come from livestock use in riparian areas in Buttermilk and Little Bridge Creek, but it has never been documented and believed to be minimal. Livestock have minimal access to these streams. Any effect of fecal contamination by livestock in this watershed is probably small and would likely not have a negative effect on fish. The Twisp watershed is **functioning appropriately** for the indicator.

Habitat Access

Physical Barriers

On the mainstem Twisp River there is a channel-spanning diversion dam on non-federal land at river mile 7. This dam is used by the Twisp Power Irrigation ditch and WDFW for adult Chinook brood stock collection and steelhead biological sampling. Spring Chinook, steelhead, bull trout and other species are intercepted at this weir while it is operational, and passage above it must be facilitated by WDFW staff. Only fish that volunteer into the trapbox are able to pass above the structure, thus it could alter migration patterns of anadromous/migratory fish.

Most of the major tributaries of Twisp River have natural barriers within the first mile because of glacial hanging valleys. Exceptions are Little Bridge Creek and Buttermilk Creek, which both provide >5 miles of anadromous fish habitat.

The USFS has replaced three culverts and two irrigation diversion barriers on Little Bridge Creek since 2002 and a partial barrier culvert on east fork Buttermilk Creek in 2002. Culverts have also been replaced in the lower stretches of Reynolds, Williams, North and Scatter creeks since 2002. The ditch diversion on Buttermilk Creek takes a majority of the water at low flow and may present a problem for downstream-migrating fish and possibly inhibits fish migrating upstream at low flows. During the Mission Project development, four culverts were identified in the Buttermilk Creek drainage that partially or fully block fish movement. Several small tributaries may have fish passage barriers. Rainbow trout are the only known fish present in Canyon Creek above a likely fish passage barrier culvert at the Twisp River Road (RM 0.1). Steelhead may be able to ascend this culvert under some conditions but the project fish biologists made a cursory assessment and determined it at least a partial barrier to some species and some life stages of O. mykiss.

Because of a potential partial upstream/downstream problem on Buttermilk Creek and a probable fish passage barrier in Canyon Creek, the Twisp River Watershed is **functioning at risk** for physical barriers.

Habitat Elements

Large Woody Debris

Large wood (LW) plays important roles in aquatic ecosystems, especially in streams in the Twisp River drainage. Instream wood influences channel shape and form that leads to increased diversity and favorable fish habitat conditions. Since European settlement, the amount and size of large wood in stream systems has decreased as a result of human activities. A reduction in wood quantities has resulted in adjustments to channel maintenance processes, a loss of complex pool habitats, and a loss of high quality spawning areas.

Substantial efforts to remove instream large wood complexes occurred following the 1948 flood, which cause extensive damage to private property, primarily along the Methow River. It is not known how much wood was removed from the Twisp River following the 1948 flood (USDA 1995a). Following the 1972 flood, the Army Corps of Engineers removed extensive amounts of LWD along the Twisp River between War Creek (RM 17) and North Creek (RM 28), plus additional amount of wood removed from the lower river, below the National Forest boundary.

The MVRD inventoried LWD levels in the Twisp River in 1993, 2001, and 2013. In 2001, the Twisp River, above RM 16.7, had about 42.4 large pieces of wood per mile in the channel and good to excellent recruitment potential (USFS 2001). The 2013 wood inventory counted 50.5 pieces per mile, an increase in wood by almost 20%. Similarly, log jams numbers increased since 2001. Surveyors counted 53 log jams, many creating deep pools, within the upper 17 miles of the Twisp River. During the 2013 survey, we counted 94 jams in this section of the river (Table 25). By comparison, large wood was scarce in the lower 14 miles due to private lands being developed, loss of riparian trees, and past wood removal in the channel. Less than 8 pieces of wood were counted in 2001 and recruitment potential was poor in this reach. In 2007, the BOR surveyed the private reach of the Twisp River from RM 1.7 to 4.9 and found LWD data similar to the 2001 results. Only 18 pieces of wood >35 feet long and >12 inches in diameter (5.5 per mile) were counted in the reach (USDI 2008).

Table 25: 2001 Twisp River LWD by reach (USFS 2001)

	Reach 1	**Reach 2**	**Reach 3**	**Reach 4**	**Reach 5**	**Reach 6**	**Reach 7**	**Reach 8**
River Mile Begin	9.55	13.37	17.3	20.28	22.76	26.25	27.27	28.86
River Mile End	13.37	17.3	20.28	22.76	26.25	27.27	28.86	29.73
Reach Length – Miles	3.82	3.93	2.98	2.48	3.49	1.02	1.59	0.87
Total Medium and Large/mile	**8.2**	**25.3**	**50.5**	**17.4**	**55.2**	**36.8**	**52.2**	**41.8**
Log Jams/mile	**1.1**	**3.6**	**8.4**	**2.4**	**8.3**	**4.9**	**6.9**	**4.6**

Large wood recruitment potential is poor to fair in the lower 13.7 due to the removal of trees from the banks and riparian areas for agriculture and houses. The streamside recruitment potential is poor in a two mile stream segment above Buttermilk Creek (RM 13.7) due to the lack of conifers growing in the floodplain. The floodplain vegetation consists mainly of seedling/sapling size deciduous trees, as frequent flooding does not allow for the establishment of conifers in this area. The recruitment potential varies from fair to good between War Creek (RM 17.6) and Poplar Flats Campground (RM 24.2), and is excellent in the upper 6 miles of the river. A major large wood recruitment source is from tributary streams and landslides in the Reynolds Creek area.

Recent wood counts in the Buttermilk Creek drainage (USDA 2011c) observed low to moderate wood levels. Total wood pieces per mile in the mainstem Buttermilk Creek were 44.6, which is well below the desired 273 pieces per mile for pieces ranging from small diameter up to large, key log sized pieces (Fox and Bolton 2007). East and West Fork Buttermilk had more wood loading with ranges from 126-141 and 103-221 pieces per mile. These are still below desired conditions, but conditions are not as departed as the mainstem. This project proposes to add more wood that will increase these volumes.

Amounts of LWD in Little Bridge Creek are below desired conditions. About 15 pieces of large wood per mile were counted in lower Little Bridge Creek (below FS Road 4415-100 culvert). Upstream of the culvert, most of which is in the LSR, LWD standards are being exceeded. In Canyon and Buttermilk Creeks, the amounts of LWD were within guidelines for most reaches. In several reaches, wood volumes fell short of Forest Plan and MPI guidelines; however amounts of small wood were generally adequate, which appear to create high quality habitat in the small, steep, v-shaped stream channels.

Table 26. Little Bridge Creek LWD level comparison.

	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5
2006	13	16	26	31	89
2016	56	33	36	34	
% Change	+330.8	+106.2	+38.5	+9.7	N/A

Yakama Nation surveyed the lowest reach of six other tributaries in 2016 to assist in identifying restoration opportunities. They completed Forest Service Level 2 Surveys that included LWD counts (Yakama Nation Fisheries 2016).

Table 27. Twisp River tributary LWD level comparison.

Stream	Surveyed Reach Length	LWD/Mi
Canyon Cr	0.5	36
Eagle Cr	0.5	80
North Cr	0.6	67
Reynolds Cr	0.6	23
South Cr	0.6	45
War Cr	0.9	79

Based on newer science for functioning wood levels in Douglas fir/ponderosa pine vegetation zones (Fox and Bolton 2007), the Methow Valley Ranger District (MVRD) considers higher wood levels to characterize functioning habitat conditions in which salmonids are known to have adapted. From these data sources, the desired density of wood greater than 12 inches diameter is in the range of 105 to 172 pieces per mile, which is a sub-set of the 273 pieces per mile recommended by Fox and Bolton (200&). The Forest Service stream survey protocol does not currently count small diameter pieces. For larger wood pieces, with diameters greater than 20 inches and 35 feet long, our desired density ranges is > 33 pieces per mile. This would include the largest diameter wood pieces that fit the key log size category. The desired log jam density is between 10 and 19 jams per mile.

Stream size can limit wood movement downstream. According to May and Gresswell (2003), chronic fluvial processes in small headwater streams have long periods of storage of sediment and wood that can be transported downstream episodically by debris flows. The intermittent streams present in the Buttermilk Creek drainage are first and second order channels with widths generally 2-4 feet wide. Streams of this size do not have the capacity to move medium or large sized wood downstream except during infrequent debris flow events. These events are rare and are extremely unlikely to occur in the project area.

Tributaries in the Twisp River are mostly functioning at risk for the indicator with several reaches and sections of the Twisp River well below desired conditions. Overall, the watershed is considered **not properly functioning** for the LWD indicator.

<u>Pool Frequency/Quality and Large Pools</u>
These indicators were lumped together because each is affected by similar mechanisms.

Pool habitats in alluvial type rivers form mostly as a result of the interaction between the stream and large woody debris accumulations (Beechie and Sibley, 1997). Wood and sediment deposition patterns function as primary factors in pool formation in the mainstem Twisp River. Past LWD removal resulted in loss of channel complexity and pool forming agents (USDA 1995a). The lack of wood has led to pool frequencies and deep, complex pools being rare.

The BOR conducted a habitat survey from RM 1.7 to 4.9 in 2007 (USDI 2008). Results from the BOR survey found pools to be scarce in the lower reaches of the river. Only 15 pools counted in the 3.2 mile stream segment (4.6 pools/mile). About 10% of the total habitat area in the reach consisted of pool habitat. Three deep holding pools (>5') were observed in the reach. Adult spring Chinook were observed in the holding pools during snorkel surveys conducted by PWI in 2001. Pools were formed primarily at the bends in the river (deepened by rip-rap) and by bedrock. Although large wood was not a primary pool scouring agent, a few pieces of wood in the channel did provide some rearing habitat, creating small pockets of scour and hiding cover along the stream margins.

The Forest Service surveyed their section of river in 1996, 2001, and 2013. Results from the 2001 survey found pool quantities and deep, complex pools be below desired conditions. Pool frequencies (pools/mile) ranged from 4.4 to 28.3 with three reaches below desired quantities (Desired 19-31). Additionally, the lack of wood and deep pools has diminished deep, complex pool features to below desired levels on all but one reach. The range is 3.5 to 12.6 deep, complex pools per mile (Desired 12-15).

Little Bridge Creek had below desired pool habitat conditions in 2006 and Very little deep pool habitat exists in Little Bridge Creek due partly to the small size of the stream and partly to the infilling of pools with sediment in the lower five miles of the stream (Table 28). An average of only 1 pool/mile >3' deep was counted in the 8.1 miles of surveyed stream. Although pool habitat is not deep, large woody debris, boulders and overhanging vegetation provide habitat complexity in some stream segments. Fish hiding cover was considered fair throughout most of the stream segments. Wood and stream bends created most pool habitat in the lower gradient, sinuous reaches located between RM 0.7 and RM 5. Large substrate and wood created most pool habitat in the lower 0.7 miles and in high gradient areas between RM 5 and RM 8.1. Good steelhead spawning habitat was observed at pool crests in the lower gradient area between RM 0.7 and RM 5.0. Overall, Little Bridge Creek has adequate number of pools but is considered functioning at risk due to some sedimentation of pool bottoms and depressed LWD values in the creek, which reduces pool habitat complexity.

Table 28. Pool habitat and MPI functional rating in Little Bridge Creek (USDA 2006 and Yakama 2016).

River Mile	% Pool Habitat	Pools/ Mile	Pools >3' Deep/Mile	Avg. Max/Residual Pool Depth	Avg. wetted width/ MPI pool std.	**2016 Pools/ Mile**	**% change**	MPI functional rating[1]
0.0-0.7	77.4%	47.5	2.8	2.0' / 1.3'	13.3 / 48	**61**	**+28**	PF
0.7-3.0	73.7%	46.4	0.8	1.9' / 1.3'	12.8 / 48	**72**	**+55**	PF
3.0-5.1	75.0%	50.2	0.8	1.8' /1.3'	12.2 / 48	**61**	**+21**	PF
5.1-7.2	80.6%	51.8	1.4	1.7' / 1.3'	9.5 / 60	**54**	**+4**	FAR
7.2-8.1	75.2%	77.1	1.0	1.5' / 1.3'	7.8 / 60			PF

The Buttermilk Creek drainage was last surveyed in 1995 and then more recently in 2011. The survey protocol for counting pools was changed in 1996. Prior to 1996, no pools were counted

where the width of the habitat unit exceeded the length of the unit. In 1996 the protocol was changed to count plunge pools where the habitat width exceeded the length. Table 29 below compares 2011 pool habitat data with pool data collected in 1995. Plunge pools with a width greater than the length were subtracted from the 2011 pool count in order to be comparable to the 1995 pool count.

The number of pools per mile counted in 2011 has increased since 1995 in the Main Stem and in the East Fork. The number of pools per mile counted in 2011 in the West Fork is about the same as 1995. The increase in pool habitat in the Main Stem and in the East Fork corresponds with the increased amount of large wood in those two streams. The amount of wood and pools counted in the West Fork is about the same in the two survey years. The average residual depth of the pools is the same in every reach except for East Fork Buttermilk Reach 2, where there was a decrease in the average residual depth. The decrease in residual depth in this reach is attributed to a large increase (50%) in the total number of pools. The additional pools were formed by wood; these pools are shallower than the deep bedrock/boulder pools that were counted in both survey years, lowering the average pool depth in this reach.

TABLE 29: Pool Habitat Comparison in Buttermilk Creek: 2011 vs. 1995

	Main Stem	East Fork		West Fork		
	Reach 1	**Reach 1**	**Reach 2**	**Reach 1**	**Reach 2**	**Reach 3**
River Mile Location:	RM 0 – 2.6	RM 0 - 2.5	RM 2.5-3.3	RM 0 – 1.8	RM 1.8-2.3	RM 2.3-3.7
Measured Length	2.97 mi.	2.98 mi.	0.80 mi.	2.29 mi.	0.58 mi.	1.54 mi.
Pools per Mile:						
-2011 Survey Pools/Mile	28.1	43.6	76.5	35.0	61.8	45.5
-2011 Pools Length > Width[1]	2.4	6.0	15.0	4.8	12.1	4.5
-2011 Comparable Pools	25.7	37.6	61.5	30.2	49.7	41.0
-1995 Survey Pools/Mile	23.7	17.6	40.9	30.2	43.6	44.3
% Increase (Decrease)	8%	114%	50%	-	14%	(7%)
Pools Residual Depth						
-2011 Survey	1.8’	1.7’	1.8’	1.7’	1.9’	1.7’
-1995 Survey	1.8’	1.7’	2.3’	1.7’	1.9’	1.7’
% Increase (Decrease)	-	-	(22%)	-	-	-

[1]Plunge pools with widths > lengths were not counted under the 1995 survey protocol. These pools have been subtracted from the 2011 pool count in order to compare the 2011 pool data with the 1995 pool data.

Yakama Nation surveys on seven tributaries found pool frequencies to range from desirable to below desired conditions. South Creek and War Creek both had low pool frequencies based on their bankfull widths (Yakama Nation Fisheries 2016).

Table 30. Twisp River tributary pool habitat comparison.

Stream	Pools/Mi	Deep, Complex Pools/Mi
Canyon Cr	56	2
Eagle Cr	52	4
North Cr	60	6.7
Reynolds Cr	53	8.3
South Cr	18	3.3
War Cr	26	5

The lower Twisp River has pool frequencies and quality well below the target range. We hypothesize the lack of pools is from the low levels of large wood. Above RM 13.7, pools conditions are more abundant with adequate instream wood and recruitment levels. Most tributary

streams have adequate pool frequencies and quality. An exception is Little Bridge Creek, which lacks adequate wood due to past logging. Overall, the lower Twisp River is considered **functioning at risk**.

Off-Channel Habitat

Off-channel wetland habitat is abundant in many segments of the Twisp River, particularly the upper reaches on Forest Service lands. Large wetland areas are found in many areas outside the Spokane Grade reach (~RM 2), particularly upstream of RM 5. Numerous off-channel beaver pond complexes are present in low-lying bench areas adjacent to the main channel. Unfortunately, many of these provide high quality habitat exclusively for introduced brook trout.

Side channel habitat in the surveyed segment of Twisp River has increased since 2001 (Table 31). Side channel and off-channel habitat is abundant in all of the unconfined reaches surveyed in 2013 except for reach 1. Channel confinement from rip-rap/levees is much less prevalent in the Twisp River above the confluence with Little Bridge Creek (RM 9.5) than in the downstream reaches. Some bank hardening resulting in confinement and channel incision was observed on private land below the confluence with Eagle Creek.

Beaver are active throughout much of the 20 mile segment surveyed in 2013. Many of the side channels originate from springs/upwellings in the floodplain and provide colder water habitat for rearing fish. Excellent rearing habitat and abundant numbers of juvenile fish were observed in most of the side channels during the survey.

Table 31: Side Channel Habitat by Reach in Twisp River, 2013.

	Reach 1	**Reach 2**	**Reach 3**	**Reach 4**	**Reach 5**	**Reach 6**	**Reach 7**	**Reach 8**
Stream Segment (from RM to RM)	9.5 to 13.4	13.4 to 17.3	17.3 to 20.3	20.3 to 22.8	22.8 to 26.2	26.2 to 27.3	27.3 to 28.9	28.9 to 29.7
Channel Gradient	0.6%	0.6%	1.3%	1.8%	1.6%	3.7%	2.4%	7.3%
Average Floodprone Width[1]	89’	77’	64’	57’	58’	36’	42’	26’
Entrenchment Ratio[2]	2.79	5.22	5.06	1.85	5.50	2.40	2.58	1.41
Total # of Side Channels	8	24	28	3	19	4	8	3
Side Channels per Mile	2.1	6.2	9.3	1.2	4.8	3.8	5.0	3.3
% Side Channel Habitat	3.2%	17.4%	10.6%	0.2%	11.9%	4.1%	7.9%	1.7%

[1]Average measured value during 2013 survey.
[2]Floodprone width divided by bankfull width.

A comparison of the total side channel/off-channel habitat in the two survey years is shown in Table 32 below:

% Side Channel Habitat Area

Reach and RM	2013	2001	+ or -
Reach 1: RM 9.5 to 13.4	3.2%	3.0%	+ 0.2%
Reach 2: RM 13.4 to 17.3	17.4%	10.9%	+ 6.5%
Reach 3: RM 17.3 to 20.3	10.6%	10.7%	- 0.1%
Reach 4: RM 20.3 to 22.8	0.2%	0.1%	+ 0.1%
Reach 5: RM 22.8 to 26.2	11.9%	8.6%	+ 3.3%
Reach 6: RM 26.2 to 27.3	4.1%	1.5%	+ 2.6%
Reach 7: RM 27.3 to 28.9	7.9%	6.9%	+ 1.0%
Reach 8: RM 28.9 to 29.7*	1.7%	1.3%	+ 0.4%
Weighted avg. w/o reach 8	**8.9%**	**6.7%**	**+ 2.2%**

*Reach 8 ended at the confluence of North and South Fork Twisp River in 2001.

The % side channel habitat to the total habitat area was higher in every reach in 2013 except for reaches 3 and 4 (side channel habitat was the same in the two survey years in reaches 3 and 4). The flow in Twisp River at the USGS gaging station at RM 1.8 at the beginning of the two surveys was approximately the same (87 cfs in 2001 compared to 80 cfs in 2013). Several side channels have recently avulsed into the floodplain since 2001. A higher amount of beaver activity was observed in 2013, possibly due to the USFS beaver reintroduction program in the watershed. Juvenile fish were abundant in many of the side channels.

The 2007 BOR survey of the lower three miles of the Twisp River found limited in off-channel/side-channel habitat. All of the survey reach is on private land where landowners removed in-channel wood, constructed levees, and rip rap that have cut off the rivers ability to access the floodplain (USDI 2008).

About 1% of the total habitat area in Little Bridge Creek at low flow consists of side channel habitat. The lower gradient segment of the creek between RM 0.7 to RM 5.0 had the highest amount of side channel habitat, with about 2% to 3% of the habitat area consisting of side channels. Some slow water habitat was observed in this area, good habitat for steelhead rearing. Upstream of Vetch Creek (RM 4.9) the valley narrows and naturally precludes connectivity with the floodplain. Beaver dams and activity are scarce in Little Bridge Creek, though there is sign of historic dams. Cattle damage was observed in many of the wet meadows along the stream banks and may be associated with reduction in success of beaver reintroduction efforts. Increased beaver dam density in the sub-watershed would yield positive hydrologic and ecological benefits. Overall, the Little Bridge Creek sub-watershed is functioning at risk for off-channel habitat.

Buttermilk Creek and its forks are likely properly functioning for side channel habitat. Most of the length of stream is steep, with minimal developed floodplain and classified as a Rosgen B channel. Side channel habitat consists of around 3-6% across all reaches. Beaver activity has been documented in the past but there are no known beaver dams on the mainstem or East or West forks. Side channel habitat is limited in the Buttermilk Creek drainage, but is likely within historic expected range.

Overall, most of the Twisp River Watershed is properly functioning for side channel habitat, though is considered **functioning at risk** due to a relatively small (by stream length) amount of areas that are disconnected from the floodplain/channelized.

Refugia

The Twisp River is an important stronghold and refugia for steelhead, spring Chinook salmon, and bull trout. Overall, habitat is largely intact in the Twisp Watershed. Connectivity and access between the varieties of habitats required by migratory fishes is mostly good, and riparian habitat in the watershed is generally in good condition on Federal lands.

Some challenges remain such as high density of riparian roads, water withdrawals, past timber harvest in riparian areas, high summer temperatures, and reduced large wood recruitment potential in the lower portion of the watershed, specifically in the Little Bridge, Poorman, and the portions of the Buttermilk subwatersheds. Road related sediment loads have affected the refugia indicator in Little Bridge Creek, Poorman, and Buttermilk Creek drainages. Summer low flows are functioning at risk with several water withdrawals across the watershed, but instream flows in the lower part of the river are improving with flow modifications to ditches on federal and private lands. High summer temperatures exist that reduce habitat quality for salmonids, but to some extent, it is natural.

Some off-channel habitat is likely reduced but physical connectivity between all areas historically accessible is currently maintained, with the exception of Canyon Creek and possibly limited lengths of several smaller tributaries. Some limitation in refugia may be limited by warm summer temperatures may restrict some migrations, but this extent is unknown, and steelhead, spring Chinook, and bull trout migration timings account for high stream temperatures in August by ascending the stream prior to warm temperatures being reached. As an example, we are not aware of summer Chinook, which migrate up the Methow River after spring Chinook, using the Twisp River mainstem, presumably due to warm summer temperatures.

Overall, coldwater refugia, feeding, spawning, and rearing habitats are largely accessible to salmonids. Fish passage at road crossing structures and into historically utilized tributaries is almost complete, with the last potential artificial barrier being on Williams Creek. Data suggest that quality and access to off-channel habitat is reduced on private land but close to natural levels on federal lands. Therefore, the watershed is ***functioning at risk*** for refugia.

Channel Conditions and Characteristics

Width/Depth Ratio

No data are available for wetted width:wetted depth ratio for the watershed; however the R6 stream survey protocol includes data for bankfull width:depth ratios (Table 33). These data are compared against expected ranges based on Rosgen (1996) channel types.

Table 33. Width:depth ratios for streams in the Twisp Watershed. Bold denotes 2013 survey reaches.

River Mile	Bankfull W/D	Channel Type (Rosgen 1996)	Expected width:depth ratio based on Rosgen (1996)	Within expected range?
Twisp River				
0 – 1.9	28-35	C3	> 12	Yes
1.7 – 5.0	22-35	C3, some B3c	> 12	Yes
5.4 – 5.7	31.1	F3	> 12 (range 12.3-95.0)	Yes
5.7 – 8.0	25.5	C3	> 12	Yes
8.0 – 10.0	25.6	F3	> 12 (range 12.3-95.0)	Yes
10.0 – 13.7	**46.0**	**C3**	**> 12**	**Wider**
13.7 – 17.6	**45.4**	**C4**	**> 12**	**Wider**

River Mile	Bankfull W/D	Channel Type (Rosgen 1996)	Expected width:depth ratio based on Rosgen (1996)	Within expected range?
17.6 – 20.4	**37.4**	**C3**	**> 12**	**Wider**
20.4 – 22.7	**31.6**	B3	> 12 (range 11.7-38.0)	Yes
22.7 – 26.2	**32.5**	C3	> 12	Yes
26.2 – 27.3	**20.5**	B3	> 12 (range 11.7-38.0)	Yes
27.3 – 29.0	**27.7**	C3b	> 12	Yes
29.0 – 30.4	**17.3**	B3a	> 12 (range 11.7-38.0)	Yes
Little Bridge Creek				
0.0 – 0.7	10.0	B3	>12	Narrower
0.7 – 3.0	18.0	B3, C3	> 12	Yes
3.0 – 5.1	14.8	B3, C4	>12	Yes
5.1 – 7.2	11.1	A3, B3a	A: < 12 (range 2.7-12.2) B: > 12	Yes
7.2 – 8.0	8.0	A3, B3a	A: < 12 (range 2.7-12.2)	Yes
Buttermilk Creek				
0 – 2.7	**19.6**	**B2a**	**A: < 12 (range 2.7-12.2)** **B: > 12**	**Yes**
West Fork Buttermilk				
0 – 1.84	**16.4**	**B3a**	**A: < 12 (range 2.7-12.2)** **B: > 12**	**Yes**
1.84-2.34	**13.7**	**A2**	**< 12 (range 2.7-12.2)**	**Wider**
2.34-3.65	**16.2**	**B2a**	**A: < 12 (range 2.7-12.2)** **B: > 12**	**Yes**
4.9 – 5.3	11.5	B4a	A: < 12 (range 2.7-12.2) B: > 12	Yes
5.3 – 6.2	11.9	B2a	A: < 12 (range 2.7-12.2) B: > 12	Yes
6.2 – 7.2	9.2	B3a	A: < 12 (range 2.7-12.2) B: > 12	Yes
East Fork Buttermilk				
0 – 2.7	**16.4**	**A**	**< 12 (range 2.7-12.2)**	**Wider**
2.7 – 3.6	**13.9**	**A**	**< 12 (range 2.7-12.2)**	**Wider**
3.6 – 3.9	8.5	A	< 12 (range 2.7-12.2)	Yes
3.9 – 5.6	13.0	A	< 12 (range 2.7-12.2)	Wider

Width-to-depth ratios correlate to channel gradient and type (Rosgen 1996). High gradient channels (>4%; A channels) are typically narrow, with width:depth ratios <12; moderate gradient channels (2-4%) typically have width:depth >12 for B channels and ratios as high as 35 are not uncommon in B channels. Low gradient channels (<2%) depend on the specific channel type. Rosgen C-Type channels (low gradient mainstems) typically have width:depth ratios >12. Where high sediment loading is not expected based on natural geomorphology, ratios > 40 can indicate a perturbed (aggraded) system.

Generally, the Twisp River mainstem has width:depth ratios within expected ranges for respective channel types. A reach between RM 13.7 and RM 20.4 has wider-than-expected width:depth ratios, perhaps indicating some cause of channel aggradation. This reach also has some of the higher wood counts for the river, and it is relatively close to the unmanaged wilderness area talked about earlier, perhaps this is a natural accumulation that started after floods in 96. The above reach in the Twisp River has collected gravel and wood, which over time will break down and maintain reaches below as sediment and wood is routed out of the system.

Lower Little Bridge Creek is slightly narrow, and may be downcutting as a result of low instream LWD levels (USDA 2006). The mainstem and West Fork of Buttermilk Creek are within expected ranges for channel types. The East Fork has several areas where the stream is wider than expected

for its steep, narrow Rosgen A channel. These reaches are mostly within wilderness boundaries with minimal management activities, thus the condition is presumed to be natural.

Yakama Nation width:depth measurments on six tributaries found pool frequencies to range from desirable to below desired conditions. South Creek and War Creek both had low pool frequencies based on their bankfull widths (Yakama Nation Fisheries 2016).

Table 34. Twisp River tributary Width;Depth comparison.

Stream	W:D	Within Expected Range
Canyon Cr	7	Yes
Eagle Cr	6	Yes
North Cr	25	Wider
Reynolds Cr	15	Wider
South Cr	13	Wider
War Cr	15	Wider

Several streams and reaches exceed expected or desired W:D ratios. This is possibly due to lower wood levels, increased stream drainage networks. Overall, the Twisp River Watershed is considered **functioning at risk** for width:depth ratio.

Streambank Condition

The 2001 Twisp River Survey report shows that 93.6% of the banks of Twisp River were stable. This also includes private reaches along the lower river where streambank stability was impacted by vegetation removal, yet still >91%. Overall, the streambanks in the watershed are very stable, with properly functioning conditions in all surveyed reaches, with two exceptions along the Twisp River.

The lower reaches of the Buttermilk watershed have low amounts of bank erosion (ranging from 1.5 to 9%). Buttermilk Creek has several large areas of mass wasting along the mainstem and lower reaches of both forks. Most of these sites are from natural causes; however a few of these places appear to have been aggravated by past logging activities (timber harvest and road construction). Restoration projects to stabilize these areas have not been proposed because of the cost and probable ineffectiveness of stabilization. Although high, erosion rates seem to be close to natural condition.

Little Bridge Creek is has stable banks based on the 2006 stream survey report (USDA 2006). Average percent bank erosion by reach, ranged from 0.2% up to 1.8%. Field observations on a few of the tributaries on the east side, in 2009 and 2010, found bank stability to be fair to good.

More recent surveys on the Twisp River, Buttermilk Creek and tribs, and the six other tributaries Yakama Nation surveyed had similar high stability values. One reache on the Twisp River had 89.7 percent bank stability, while all other reaches were greater than 90%. Therefore, streambanks in the watershed are considered **properly functioning** for this indicator because of a small number of above-standard reaches.

Floodplain Connectivity

Floodplain connectivity is at risk in many segments of the lower Twisp River on private lands, rip rap has affected the lateral migration of the river many reaches below the Forest boundary. Off-channel habitat is often disconnected from the main channel in the lower 5 miles of the stream due to floodplain development and road location (Yakama Nation Fisheries 2010). Off-channel habitat is disconnected in places between RM 5 and 13.7 by floodplain dikes. Good floodplain connectivity exists above RM 13.7 in the Twisp River.

On National Forest lands, the Twisp River has well connected floodplains and side channels. Roads, agriculture, rural development, removal of riparian vegetation, and other floodplain effects on private land in lower Twisp watershed have reduced floodplain connectivity and possibly placed the system at risk.

In Little Bridge Creek the channel has been cut off from historic side channels, beaver ponds, and riparian wetlands. About 1% of the total habitat area in Little Bridge Creek at low flow consists of side channel habitat. The lower gradient segment of the creek between RM 0.7 to RM 5.0 had the highest amount of side channel habitat, with about 2% to 3% of the habitat area consisting of side channels. Some slow water habitat was observed in this area, good habitat for steelhead rearing. Entrenchment ratios ranged from 1.9 to 2.4, suggesting the stream has moderate to low entrenchment.

Buttermilk Creek is a confined, high gradient system with limited floodplain development and is close to natural condition. North Creek is on an alluvial fan and the presence of side channels indicate the area is well connected to the floodplain.

Overall, the Twisp watershed above Little Bridge creek is considered **functioning at risk** for floodplain connectivity; however the Twisp River above Little Bridge Creek has many reaches that have good floodplain connection with very wide floodplains, active channel migration, many off-channel wetlands and oxbows and roads are up and out of the floodplain.

Flow/Hydrology

Change in Peak/Base Flows

Hydrology and water yield in the Twisp Watershed is largely driven by annual precipitation in the form of snow pack. For example, when moisture availability is limited by climatic conditions, instream flows become reduced resulting in low base flows. Catastrophic disturbances, such as wildfires, are also a natural component of this ecosystem and change water yield. Water yield in a watershed can increase when vegetation cover, and sometimes soil properties are dramatically altered by a wildfire (Gresswell 1999, Chanasyk et al. 2003). In the nearby Chewuch River watershed, modeling predicted storm runoff following the 2006 Tripod Fire could increase by 242 to 311% during a 25-year 1-hour storm event when compared to pre-fire levels (Higgenson 2006). A major fire in the Twisp Watershed would undoubtedly cause an additional increase in water yield and channel response to increased stream flow is expected.

Human water uses in the Twisp River include domestic, livestock watering, recreation, and irrigation. There are two irrigation ditches and seven water transmission lines on Forest Service land in Twisp watershed. The combined withdrawal of the two ditches comes to about 5.3 cfs. The water transmission lines all combined probably takes less than 1 cfs. Consultation on these

irrigation ditches and water transmission lines was last completed in 1999 and 2000 (USFWS ref # 1-3-99-F-1321 through 1323; NMFS March 7, 2000 WSB-98-054 and June 16, 2000 WSB-98-060). Additionally, the Twisp Valley Irrigation District diverts an unknown amount from the river.

Other anthropogenic factors affecting streams flow include past timber harvest, the current road network, and the loss of beavers. Some drainages in the Twisp River Watershed (including Little Bridge Creek, Poorman Creek, Newby Creek, Buttermilk Creek, and along the lower mainstem below War Creek) experienced extensive harvesting and roading in past decades, which artificially increased the drainage network in the watershed and increased the rate at which water is routed out of tributary sub-watersheds and into the mainstem. These factors, coupled with the extensive irrigation diversions in the watershed, have contributed to lower base flows in summer and winter.

Wildfire activity in the Twisp River Watershed has been somewhat minor compared to other watersheds in the Methow Valley. In 2014, the Little Bridge Fire burned about 4,960 acres of the Little Bridge Creek drainage and the Twisp River Fire burned about 10,400 acres in 2015. Combined, these fires burned about 9% of the watershed of which over half was sagebrush shrub habitat. We do not expect the magnitude of these changes to be measurable in terms of changes to peak/base flow conditions in the Twisp River. However, BAER analysis modeled a significant change in peak flow in LBC subwatershed. According to their model, pre-fire peak stream flow was modeled to increase 102 percent to the mouth of the watershed in post-fire conditions. Therefore, potential risk remains, specifically in the two affected subwatersheds but not at a magnitude that would shift the indicator from *FAR* at the watershed scale.

Subsurface and low base flow stream conditions in late summer and winter are considered to limit rearing area and spawning habitat for listed fish species in the upper mainstem and bull trout have been documented seasonally trapped above naturally de-watered reaches around Poplar Flat Campground as well as being trapped in isolated pools over the winter where they sometimes die by a range of causes (RM 24; Nelson 2004).

The Twisp River Watershed has a wide ranging hydrograph and reaches naturally dewater during low flow periods. These conditions are likely exacerbated in some locations of the watershed by irrigation diversions and the road network. Because of these factors, the watershed is **functioning at risk** for the change in peak/base flows indicator.

<u>Drainage Network Increase and Road Density and Location</u>

These indicators are grouped together as road network and stream crossings are the primary agent of hydrologic change altering drainage patterns in the watershed. As road density increase and connectivity between roadways and the stream network becomes more efficient and the hydrograph can become flashier as surface waters are more quickly routed from roadways and ditches into streams.

Almost half (46%) of the Twisp Watershed is within the boundaries of the Chelan-Sawtooth Wilderness Area and is roadless. GIS analysis of Twisp River sub-watershed roads reveals that extensive road systems are present in the Little Bridge Creek, lower Buttermilk Creek, Poorman Creek, and Newby Creek drainages, as well as along the valley bottom of the mainstem Twisp River. There are about 220 miles of road in the Twisp River watershed with an estimated 530 stream crossings. Many of the roads constructed on Forest Service land parallel streams but are generally located outside of the floodplain and riparian reserves. For example, roads run parallel to

the Twisp River up to RM 26 and there are approximately 20.6 miles of valley bottom roads in the Little Bridge Creek drainage. Some of these roads interrupt stream function such as limiting the recruitment of large wood, providing excess sources for fine sediment, lead to increases in solar input, and can prevent natural channel migration. Additionally, the road network has undersized stream crossings at risk of failure.

Overall road density across the watershed is relatively low at 1.4 miles per square mile. Subwatersheds with higher road densities are Little Bridge Creek and Mainstem Lower Twisp (Table 35). At smaller scales, higher road densities exist in the Newby Creek, the upper portion of Poorman Creek, around Canyon Creek, and along the Twisp River valley floor.

Forest roads artificially increase the drainage network in a watershed. Wemple et al. (1996) documented up to 50% of the roads were connected to a stream network in the central Oregon Cascade Mountains, effectively increasing the drainage network. The increase in effective drainage network can increase peak flows through rerouting precipitation runoff generated from compacted road surfaces and interception of shallow subsurface water from road cuts (Jones et al., 2000). Road densities in their study equaled 3.0 miles per square mile and the average annual precipitation was 88 inches that comes primarily as rain. Whereas the project area has an estimated road density if 1.4 mi/mi^2 and ~ annual precipitation of 10 inches in the lower elevations and 40 in the higher elevation that comes primarily as snow. Rather than assuming similar road drainage percentages in the Buttermilk Creek drainage, the project team assessed the amount of roads with potential to drain into streams using the WWRP procedures (USDA 2015b). GIS analysis, using 10m DEM, provided estimations of drainage points along existing road gradients. These points provided locations where roads are predicted to drain and the points also estimate the length of road draining to that point. Then the points were clipped to 300-foot buffers of the project area streams to identify an estimated road drainage network that is additive to the natural stream network. Based on this analysis, the existing roads increased the drainage network by an estimated 10.4 miles or by about 15%.

The Buttermilk Creek drainage is part of the Twisp River Key Watershed, which is a Tier 1 level watershed. Under the Northwest Forest Plan, it says no net increase in roads. Since the Norwest Forest Plan was signed, there has been ~14 miles of road decommissioning total from two periods of roadwork. In 1996, ~2.5 miles were decommissioned and ~11.5 miles were removed between 2009-2010.

Although the road density for the watershed is relatively low, we have higher road densities in areas with potential to influence stream function such as valley bottoms next to occupied fish habitat. As one example, the Twisp River Watershed Analysis (USDA 1995a) suggests that up to 40% of the transported sediment to the Twisp River is delivered via Buttermilk Creek. Therefore we find that the Drainage Network Increase and Road Density and Location indicators are **functioning at risk** for both bull trout and steelhead/salmon for the watershed.

Table 35. Twisp River Watershed sub-drainage road density, Riparian Reserve road density, and MPI functional ratings.

Drainage Name	**Hydrologic Class**	**Acres**	**Mi²**	**Roads[1] (mi)**	**Road Density Mi/Mi²**	**NWFP Riparian Reserves and Riparian Road Density[1]**				**Road-Stream crossings[1]**		Functional Rating for Twisp River Watershed (MPI)[2]
						Acres	**Mi²**	**Roads (mi)**	**Mi/mi²**	**Total**	**# / mi²**	
Upper Twisp River	HUC12	12,864	20.1	1.9	0.1	1,295	2.0	0.7	0.3	4	0.2	FAR – Bull Trout FAR – Steelhead/ Chinook[3]
South Creek	HUC12	10,113	15.8	0.4	<0.1	1,085	1.7	0.3	0.2	0	0.0	
Mainst. Upp. Twisp	HUC12	40,352	63.1	68.6	1.1	4,040	6.3	11.6	1.8	61	1.0	
Little Bridge Cr.	HUC12	15,628	24.4	66.7	2.7	1,533	2.4	19.0	7.9	67	2.7	
War Creek	HUC12	17,537	27.4	3.4	0.1	1,602	2.5	0.5	0.2	1	0.0	
Eagle Creek	HUC12	8,601	13.4	1.3	0.1	1,034	1.6	0.3	0.2	1	0.1	
Buttermilk Creek	**HUC12**	**23,783**	**37.2**	**53.5**	**1.4**	**2,392**	**3.7**	**6.8**	**1.8**	**39**	**1.0**	
Mainst. Low. Twisp	HUC12	28,138	44.0	91.7	2.1	2,822	4.4	19.5	4.4	79	1.8	
Poorman Creek	<HUC12	7,940	12.4	16.2	1.3	834	1.3	6.1	4.7	22	1.8	
Newby Creek	<HUC12	2,933	4.6	15.5	3.4	214	0.3	2.4	7.2	10	1.8	
Twisp River WA	HUC10	157,016	245.3	299.2	1.2	15,803	24.7	58.7	2.4	252	1.0	

[1] GIS exercise using OWNF current road layer (3-10-10). Data from state, county, private, other road jurisdictions may be under-represented.
[2] PF – Properly Functioning; FAR – Functioning at Risk; NPF – Not Properly Functioning
[3] The estimated road density is below the PFC threshold, but due to the volume of roads paralleling streams, especially the Twisp River, we gave a FAR rating.

WATERSHED CONDITIONS

Human Disturbance History

The lower Twisp River watershed's floodplain has been developed for housing, agriculture, and flood control. This has altered floodplain function, vegetation, and hydrology. Channel straightening and road placement on private land in the lower Twisp has disconnected the channel from flood energy dissipation areas such as side channels and wetlands. However, acquisition and conservation easements for properties with off-channel wetlands and side channels along the lower Twisp River are helping to reduce the anthropogenic effects to this indicator. A recent example in the Twisp River Watershed is a cooperative effort between a landowner, the Methow Conservancy, and the Forest Service, which culminated in the attainment by the Forest Service of a 16.5 acre parcel at the upstream extend of private land, just below Eagle Creek at about RM 16.5. This parcel includes about one-half of an extensive off-channel wetland complex with beaver dams and, an oxbow lake, and valuable, intact riparian habitat.

Cattle grazing occurs in portions of the riparian in several tributaries, including Little Bridge Creek. Changes in grazing strategies under the Little Bridge AMP renewal involves fencing off the remaining 2 miles of known steelhead spawning habitat and an area with the most cattle access on Little Bride Creek. Across the watershed, other fencing has been ongoing in the watershed and conditions are improving. Other tributaries affected by cattle include Poorman Creek, Newby Creek, and tributaries to the East Fork of Buttermilk Creek. The wilderness portion of the Twisp watershed has had little alteration from its historic condition except for effects from fire suppression.

Most of the land in the higher elevations of the Twisp River watershed is wilderness or roadless, which precludes traditional road base timber harvest. Lower elevation land above the confluence with Buttermilk Creek has been allocated as LSR under the Northwest Forest Plan (managed to benefit species associated with late successional forest). USFS land below the confluence with East and West Buttermilk Creeks have been allocated as matrix under the Northwest Forest Plan. Most timber harvesting will be on land allocated as matrix. Timber harvests have occurred in about 25% of the Twisp River watershed, mainly in the subwatersheds east of and including Buttermilk Creek. Recruitment potential for large woody debris is good above the confluence with Eagle Creek (RM 16.7) since there has been little harvesting of the riparian area in this stream segment. Trees have been removed in the riparian area on private land for agriculture and development in the lower half of the Twisp River (USFS, 2007).

The overall call for the Twisp River watershed is **functioning at risk** for this indicator; however much of the watershed is wilderness or LSR and has minimal to no disturbance history.

Riparian Reserves

Land allocations where Riparian Reserves lay across the Twisp River drainage range from wilderness, LSR, to Matrix lands. Most of the land in the higher elevations of the Twisp River drainage on National Forest is wilderness or roadless, while lower elevation land above the confluence with Buttermilk Creek has been allocated as LSR. National Forest land below the confluence of and including Buttermilk Creek has been allocated as matrix, which allows for timber harvest.

There has been little harvest in the riparian area above Eagle Creek (RM 16.7) and there is good recruitment potential for large woody debris. Riparian conditions along important spring Chinook and bull trout spawning areas are in good to excellent condition and provide a good source of LWD. Similarly, most riparian damage to high lakes in higher elevations is due to dispersed recreation and commercial outfitter guide trips. Impacts to riparian areas of these high mountain lakes are from trampling of vegetation and soil compaction. Because access is limited at the high lakes, most effects to the Riparian Reserves are minimal. Recreation effects to the lakeshores and streambanks are typically above barriers to migratory fish, affect a proportionately small area, and do not affect listed species.

On the lower half of Twisp River, trees were historically removed in the riparian area for logging, agriculture, and development on private land. Lands in the Buttermilk Creek, Little Bridge Creek, and portions of Poorman Creek have been managed for timber production along with grazing and recreation uses. Subsequently, past timber harvest along many streams including the Twisp River resulted in stream wood loading falling below desired wood loading compared to current standards. The most recent wood inventories in Little Bridge Creek and Buttermilk Creek show levels below those recommended by Fox and Bolton (2007).

Vegetation and fuels conditions found in Riparian Reserves are similar to prevailing conditions found throughout the project area. Management activities during the twentieth century have altered the species composition, structural diversity, and natural disturbance patterns of plant communities found within the project area Riparian Reserves. Fire exclusion, timber harvest, and widespread removal of beavers within the Buttermilk Creek, Little Bridge Creek, and other areas within Matrix lands have altered tree species composition, tree stocking levels, and size class distribution of many Riparian Reserve dry forest stands. Douglas-fir forest cover has expanded, tree stocking levels have increased, forest canopy layering has increased, and average tree size has decreased throughout Riparian Reserves in response to these management practices. Aspen dominated stands in Riparian Reserves are in decline compared to conditions that were prevalent at the turn of the twentieth century.

Large trees currently are less common compared to historical levels and existing conditions are unlikely to increase the number of large trees in dry forest stands. Douglas-fir dwarf mistletoe infection and insect defoliation levels have increased due to the expanded area of Douglas-fir cover, increased canopy layering, and increased contiguity (connectivity) of host patches. Existing large ponderosa pines and Douglas-firs are vulnerable to fatal bark beetle attacks due to elevated tree stocking levels and competition among trees for water, nutrients, and growing space within dry forest zone Riparian Reserves. Tree stocking levels are too high to promote the growth and development of additional large trees to provide a sustained supply of large conifers, coarse woody debris, and in-stream wood in the future. Aspen dominated stands have declined as a consequence of increased levels of conifer stocking and canopy closure which have become established in Riparian Reserves. Conifer competition has decreased sunlight and soil moisture availability and created unfavorable site conditions for the maintenance or expansion of existing aspen stands.

These conditions are compounded by an increased risk of uncharacteristic high severity wildfire within Riparian Reserves and adjacent upland forest areas caused by high levels of surface, ladder, and canopy fuel loading that have developed over the past century.

Recreation impacts in the Twisp River watershed tends to concentrate in RRs from dispersed campsites, to designated campgrounds, and hiking trails. Compared to other watersheds across the MVRD, recreation impacts in the Twisp tend to be lower and less impact. Very few sites exist in the Mission Project area.

Riparian corridors along streams within the Little Bridge Creek Fire and Twisp River Fire experienced low burn intensity with few exceptions. These isolated areas are relatively small compared to the size of the fire and subwatersheds. Fire suppression impacts were relatively minimal in RR and >95% rehabilitated. We do not expect any element of the fires to have impacted RR at a magnitude that would change the indicator.

The overall condition of riparian reserves in the Twisp Watershed is considered **functioning at risk**; however, there are many wide, functioning riparian buffers above Little Bridge Creek, as well as among the tributaries.

Disturbance Regime

Environmental disturbances are short lived, and the hydrograph is predictable with low flows in the late summer and winter and peak flows in the spring. The habitat quality is high above RM 16 on the Twisp River, where there is spawning and rearing habitat for spring Chinook and steelhead, and rearing and migration habitat for bull trout. Fire activity has been minimal in the Twisp Watershed with only a few sizable fires >500 acres burning in the drainages of Poorman Creek, War Creek, Reynolds Creek, and Williams Creek in the last 15 years. Due to high fuel loading and the absence of significant fires in the recent past, the watershed is at risk for a large fire (Meg Trebon personal communication).

Natural processes such as sediment delivery and LWD routing are stable for much of the watershed because the amount of roadless area. The abundance of roads located on valley bottoms, often paralleling streams, interrupts natural stream processes like sediment and LWD routing along many occupied fish streams. Past timber harvest and ongoing grazing has resulted in some habitat degradation in some subwatersheds.

With the forest condition across the watershed overstocked and at heighted risk to a major wildfire, due in part to fire suppression, and the presence of several miles of valley bottom roads, we consider the Twisp Watershed to be **functioning at risk** for disturbance regime.

Summary/Integration of all Species and Habitat Indicators - Twisp

Bull Trout

Of the three listed salmonids, bull trout are most likely to persist in higher elevation, cold-water watersheds with low road densities (Rieman et al, 1997). Higher stream temperatures, minimal refugia, lost off-channel habitat, low LWD levels, road constriction along the river, and simplified channels synergistically reduce the quantity and quality of habitat in the middle and lower reaches of the Twisp for use by bull trout. Buttermilk Creek and to a lesser degree Little Bridge Creek have suitable habitat at higher elevations in the lower watershed. The most important areas for bull trout are the upper Twisp River, North Creek, and Reynolds Creek. Most of all other tributaries not previously mentioned in this summary have natural barriers near the mouth or are not suitable habitat. Habitat conditions are not expected to improve dramatically in the next 5 to 10 years,

therefore bull trout in the Twisp and the Methow sub-basin are **Not Properly Functioning** when population characteristics are integrated with habitat conditions.

Steelhead and Spring Chinook Salmon

About 24% of the spring Chinook and steelhead (~30%) that return to the Methow Sub-basin spawn and rear in the Twisp River. Access by anadromous fish up river and to tributaries has improved over the past 10 years due to removal of fish barriers (culverts and irrigation diversion). In the past decade, culvert and irrigation diversion fish barriers on Little Bridge Creek and the Twisp River were replaced. Summer water temperatures may be problematic for rearing steelhead and rearing and spawning Chinook as well as migration in the lower Twisp River. Off-channel habitat is lacking in the lower river from being disconnected from side-channels in many areas and from bank armoring. Summer irrigation withdrawals reduce summer flows down to about 20 cfs, limiting migration and rearing and spawning habitat. These habitat conditions are not expected to improve dramatically in the next 5 to 10 years, therefore steelhead and spring Chinook in the Twisp and the Methow subbasin are **Not Properly Functioning** when population characteristics are integrated with habitat conditions.

Lower Methow River Watershed Baseline

The last baseline update for the Lower Methow Watershed was completed for the Little Bridge/Lookout Mountain AMP BA and ongoing activities in 2011 (USDA 2011b). New information included in this document updates the baseline established in 2011, which is limited to just temperature data. Since 2011, the 2014 Carlton Complex Fire and 2015 Black Canyon Fire burned substantial portions of this watershed.

Watershed Description – Lower Methow

The Lower Methow River Watershed is a HUC10 composite watershed containing approximately 243,000 acres (Figure 14). It stretches from the town of Carlton to the confluence with the Columbia River at Pateros. About 146,000 acres within the watershed are National Forest. The remaining 97,000 acres consist of mixed ownership including private, state, and BLM lands. Private and state-owned lands are primarily located on valley bottoms and next to major streams. State Highway 153 parallels the Methow River along its entire reach within the watershed with approximately a dozen bridge crossings.

Elevation ranges from 8,464 feet at Hoodoo Peak in the northwestern corner (Libby Creek sub-watershed) to 779 feet, the normal pool elevation of Lake Pateros (Columbia River) at the mouth of the Methow River. Annual precipitation ranges from 50 inches in the highest reaches of Libby and Gold Creek drainages to 10 inches at the mouth of the Methow River (Richardson 1976). The Lower Methow Watershed contains highly erosive soils and has had generations of human use including vegetation management, road construction, grazing, fire suppression, and urban development. Much of the lands are susceptible to high intensity summer rain squalls, which can result in erosion and rapid sediment delivery to valley bottoms and the mainstem Methow River. Snow melt can also cause erosion of disturbed soils if it occurs more rapidly than infiltration, such as with rain-on-snow events, making overland flow.

Figure 14. Lower Methow River (HUC10) Sub-watersheds (HUC12).

Significant sub-watersheds in the Lower Methow are Libby Creek and Gold Creek 12fth fields. All of the streams that enter west of the Methow River are managed under the terms of the Northwest Forest Plan (USDA, 1994). There are three sub-watersheds that drain from the east into the mainstem of the Methow River that are included as part of Lower Methow 6th field watershed. The upper reaches of Texas and French Creeks are all managed under PACFISH (USDA & USDI, 1995). Land management designations for the western side of the lower Methow watershed include Late Successional Reserves and matrix. Watershed analysis for the area was completed in 2001. Land allocations on National Forest lands include MA 25, managed for commodity output, MA 14, wildlife habitat, MA 5, scenery resources, MA 26, mule deer winter range, and MA 15, wilderness.

The lower Methow River is a migratory corridor for all anadromous salmonids and fluvial bull trout that spawn and rear in the Methow watershed. It also serves as rearing habitat for all salmonid species. Summer Chinook salmon and summer steelhead are known to spawn in the lower Methow River; spring Chinook salmon do not spawn this far downstream in the mainstem. Coho salmon originating from Yakama Nation recovery efforts, as well as out-of-basin strays, utilize much of the mainstem Methow River (R. Alford, pers. comm. 2010). Bull trout, steelhead, spring Chinook have been documented in Libby Creek and Gold Creek and steelhead use lower Black Canyon Creek.

Limiting factors for salmonid production for the Lower Methow River Watershed were identified from several sources including the Upper Columbia Biological Strategy (2007) and the NMFS approved UCRSSRP (2007). These factors include:

- Water Quantity
- Road related sediment and stream encroachment

Ongoing Actions in the Watershed – Lower Methow

The following actions are ongoing in the watershed and include recreation, backcountry recreation, water transmission lines, and road management.

Recreation

Recreation is the primary use of roads in the watershed; including the roads along streams in the Gold, Libby, McFarland, French, Texas, and Black Canyon creek drainages. The USFS maintains one developed campground in the watershed, Foggy Dew Campground, which is located along Foggy Dew Creek, near the confluence with the North Fork of Gold Creek. Numerous dispersed campsites, many of which are in close proximity to streams, occur on National Forest lands in the watershed. These sites are used primarily during holiday weekends and the fall hunting season.

Backcountry recreation is trail based and takes place away from roads and mostly in areas not accessible to listed fish. Most backcountry use is restricted to the Sawtooth Backcountry area in the Gold Creek drainage. It consists primarily of foot, horseback, and motorcycle. Several commercial outfitter guides operate in this area, using pack stock and operating under special use permit.

There are winter recreation sites located in the South Fork Gold Creek drainage (T31N, R21E, Sec. 25) and in the Black Canyon Creek drainage (T30N, R22E, Sec. 25). Snowmobiling in the watershed takes place on groomed designated routes on existing roads. The South Fork Gold Creek sno-park is located on the opposite side of the road from the South Fork of Gold Creek and appears it has not affected the channel or streambanks to the South Fork of Gold Creek. The Black Canyon recreation site is a grassy area approximately 200 feet by 100 feet. The “sno-park” area is located on both sides of Forest Road 4010, with the majority of the area located on the opposite side of the road from Black Canyon Creek.

Water Transmission Lines

There are four permits for water transmission lines in the Lower Methow watershed. Water transmission lines in the Libby Creek sub-watershed may slightly degrade the temperature indicator. Small amounts of water are removed from the Libby Creek drainage via permitted waterlines in Chicamun Creek, and Smith Canyon Creek. There is a waterline from a seep in

Middle Fork of Gold Creek subwatershed, though the line does not remove water in surface continuity with the Middle Fork of Gold Creek. Black Canyon Creek has an 8" water line that could possibly degrade water temperatures due to the size of pipe (8") in the small stream and casual observation indicates that up to 1/3rd of the flow is removed, though flow data have not been collected.

Roads

There are approximately 380 miles of county, state, and federal roads within the 308 square mile Lower Methow watershed. An assessment of road conditions, specific effects on stream channels, and restoration needs has not been conducted for the lower Methow watershed. Use on the roads is shared between recreation, logging, and access to range areas. The miles of road to be maintained and type of maintenance will vary from year to year. Routine road maintenance includes grading roads and cleaning ditch lines with heavy equipment, unplugging culverts, and removing brush and downed logs. Maintenance also includes road cut or fill slope stabilization, cutting hazard trees within one tree length of the road surface, and repair or installation of barricades (earthen barriers or gates) to restrict traffic movement. Routine road maintenance is addressed under the programmatic Biological Assessment.

Grazing Allotments

Cattle allotments occur on both sides of the Methow River in the Lower Methow watershed. On the west side, the Lookout Mountain allotment in Libby Creek area is the only active allotment currently. The Lookout Mountain Allotment was renewed for a 10-year period in 2011 with a LAA effects determination for the presence of livestock in Libby Creek within occupied critical habitat. It was determined, through consultation that the direct and indirect effects to listed fish in the Libby Creek watershed were of a magnitude to result in injury or death of ESA-listed fish..

Baseline Habitat Indicators – Lower Methow

The existing condition for the Action Area watersheds was assessed by the FWS/NOAA Fisheries Table of Population and Habitat Indicators For Use In The Northwest Forest Plan Area (MPI) (USDA, USDC, and USDI 2004). The discussion of baseline conditions below will include updates from changes from the Carlton Complex and Black Canyon Fires. Due to post fire debris flows and the large influx of fine sediment, many indicator conditions were predicted to degrade in the short-term of 3-5 years. This includes the lower Methow River, Gold Creek, and Black Canyon Creek drainages. The Libby Creek sub-watershed was not burned as part of those fires except for a small 600 acres portion of the 2014 CCF fire did burn at low severity. As a result, the dramatic changes that occurred in the heavily burned areas and the Methow River did not occur in the Libby Creek drainage. Where indicators were deemed to degrade and change functioning condition because of the fires, does not apply to the Libby Creek HUC 12 sub-watershed.

Water Quality

Temperature

Natural drivers of stream temperatures generally include solar radiation, heat exchange between the atmosphere and the channel, ground water input, and the internal structure of a stream channel (Tague et al. 2007 and Poole and Berman 2001). Solar energy is the largest component of heat energy available to a stream in the summer (Meehan 1991) and can have a major effect to stream

temperature in forested landscapes, especially small streams (Poole and Berman 2001). The Lower Methow River is the collector for all streams in the Methow Sub-basin and combined effects and natural characteristics culminate in this section of the river. We hypothesize direct solar radiation and warm temperature tributaries upstream are the primary factors influencing summer temperatures in the mainstem.

Management actions that influence water temperature include riparian tree removal; ground based yarding which can both compact soil and develop additional drainage features which singly or in combination accelerate water transport and reduce storage; and road construction which can create unnatural streamside canopy openings, increase drainage networks, simplify channel characteristics, and reduce a watershed's ability to retain water in late summer. In the past, OWNF harvested timber along tributary streams, often up to streambanks, that resulted substantially reduced shade levels.

Additionally, irrigation withdrawals reduce summer base flows when air and water temperatures are highest. Water temperature models have demonstrated that low flow conditions reduce thermal mass and increase instream temperatures (Bartholow, 1991; Conner et al., 2003). The lower Methow River, below Carlton, is affected by all the irrigation withdrawals in the subbasin above. We hypothesize the multiple water withdrawals throughout the subbasin that reduce summer baser flows, would negatively affect summer temperatures.

Climate change is a topic of increasing importance at numerous scales. It is now accepted that air and water temperatures are increasing globally. Cool water temperatures, which are critical for our local fish species, are a concern locally regarding the potential for future temperature increases.

The lower Methow River mainstem, near the mouth, is listed by the Washington Department of Ecology (DOE) 303(d) list where 7-day average daily max (7DADM) temperatures reached approximately 23°C. Further up the sub-basin, the Chewuch River also has a reach identified as on the 303(d) list water for temperature.

Within the Lower Methow River Watershed, steelhead spawning occurs in the spring with peak spawning around mid-April. Spring Chinook and bull trout do not spawn in the mainstem but migrate through each spring with most fish migrating past Wells Dam by mid to late-June, prior to occurrence of the warmest temperatures (Fish Passage Center website). The only bull trout spawning in the watershed occurs in the Gold Creek drainage, in September and October. Based on bull trout passage data at a weir in the Twisp River being in mid-June through the end of July, we assume migrations occur prior to the warmest temperatures in the lower Methow River.

Water temperatures in the mainstem Methow River have been monitored by the BOR since 2005 and OWNF has monitored temperatures in rotating Methow Sub-basin tributaries since 1995. The majority of temperature monitoring is conducted higher in the sub-basin, though some data are available in the Lower Methow River Watershed. Summary 7DADM data are presented in Table 27. Limited temperature data are also available from DOE (Figure 15).

Table 36. MVRD 7-day average maximum temperature data for Lower Methow River Watershed streams available, 1996-2015.

SUB-WATERSHED/Stream	1996	1998	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
METHOW RIVER													
RM 1.6 – abv. Pateros			24										
RM 5.3 – blw Black Cyn			24.5										
RM 8.6 – blw Squaw Cr.			23.8										
RM 13.8 – abv Methow			23.2										
RM 18.7 – blw McFarland Cr			22.4										
RM 21.7 - blw Gold Cr.			22.9										
RM 24.2 – abv Gold Cr.			22.7										
RM 28.9 - abv Libby Cr			22.6										
RM 34.8 - blw Beaver Cr			21.7										
GOLD CREEK													
RM 0.5	16.8			18.6	16.3	18	19.6	16.5	15.3	17.4	18.3	19.2	
RM 3.1 - blw Middle Fork							18.2	14.8					
South Fork Gold Cr													
RM 0.3							18.5	15.4		15.6	16.3	17.3	18.6
RM 3.8	16.3						17.6	14.7	13				
Rainy Creek													
RM 0.0 – at mouth							17.2	14.8	13.3				
North Fork Gold Cr													
RM 1.9 - abv Crater Cr.	11.8						17.6	12.5					
Foggy Dew Creek													
RM 0.0 – at mouth	14.1						16.6	13.7		14.6	15.2	16.1	16.6
Crater Creek													
RM 0.0 – at mouth							18	14.7	13.6	15.7	16.4	16.6	17.8
LIBBY CREEK													
RM 0.0 – at mouth		16.5	17.2	17.1	15.8	17.2	18.7	16.1	13.7	15.6	16.3		
RM 6.4 – at FS Rd 100		14.9		15.1				13		13.7	14.1	14.5	15.2

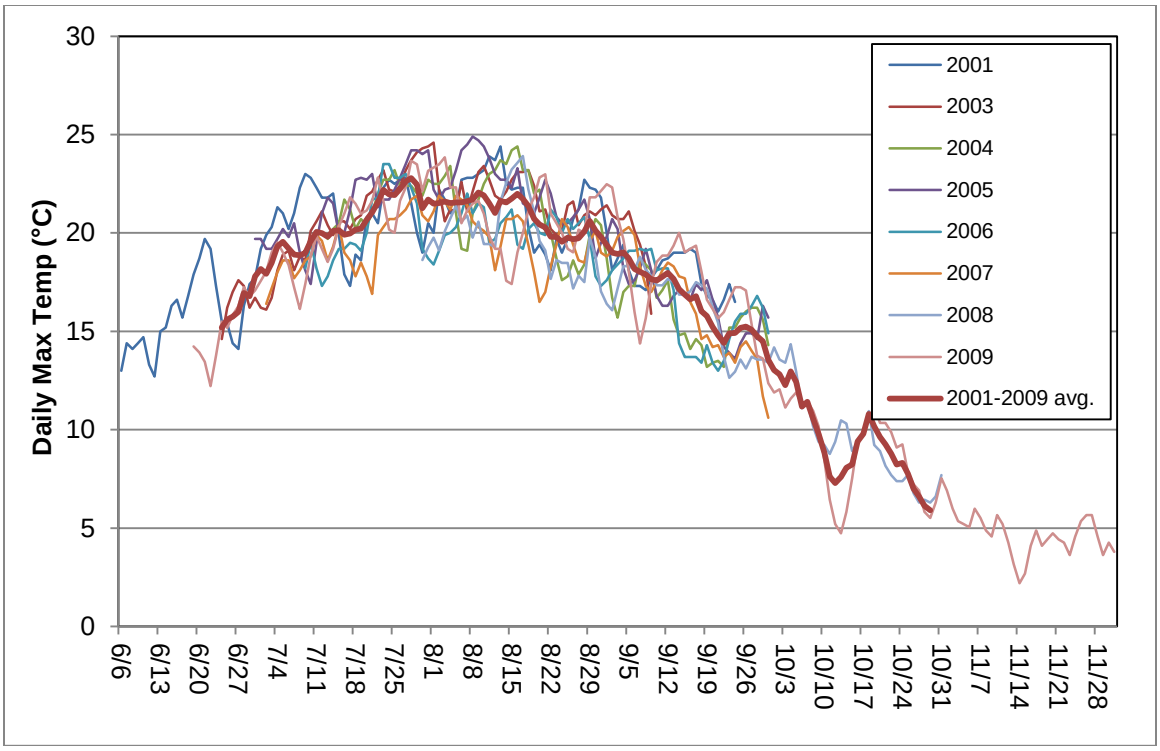

Figure 15. Daily maximum temperatures, Lower Methow River, near Pateros. DOE temperature monitoring site #48A070.

Department of Ecology monitoring data show that temperatures regularly exceed 16°C and 18°C temperature standards in the mainstem Methow River from July through September; however, steelhead, spring Chinook, and bull trout primarily negotiate this reach outside of the time period between early July and September based on hatchery collection encounters (WDFW, unpublished bull trout encounter data), USFWS radio telemetry studies (Nelson and Nelle 2007) and Wells Dam fish passage data (fpc.org) that indicate that bull trout and spring Chinook have completed most of upstream migration and entered the Methow River by July. Data and professional observations indicate that the majority of the adult listed fish are not present in the lower Methow during the hottest period of the summer, but rather are up in colder tributary streams. To some extent these behaviors/migrations are natural with the runs having evolved to coincide with preferred temperature windows; however the temporal windows may have been affected by anthropogenic changes in the sub-basin.

Wildfires often increase stream temperatures from direct heating that can increase water temperatures to lethal levels during burning. The loss of riparian and upland vegetation from a fire can cause an elevation in stream temperatures for several years following a fire. It us unknown what the effect of the Goat, CCF, and Black Canyon Fires had on stream temperature in the Lower Methow River Watershed. According to the BARC modeling, most of the Lower Methow River Watershed burned with low severity. Similarly, most riparian areas across the watershed burned with low severity. This suggests many areas burned did not result in overstory canopy loss.

Table 37. RR acres of burn severity by 6th HUC.

Sub-Watershed	High		Moderate		Low		Total Burned Area		Unburned	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
Alta Coulee-Methow River	222	10.4	392	18.4	879	41.3	1522	71.5	606	28.5
Black Canyon Creek	205	14.9	332	24.1	629	45.6	1205	87.5	173	12.5
French Creek	5	5.0	25	23.0	27	25.1	85	79.4	22	20.6
Gold Creek	41	1.0	47	1.1	337	7.8	426	9.9	3893	90.1
Libby Creek	0	0.0	4	0.2	10	0.4	15	0.6	2472	99.4
McFarland Creek-Methow River	18	2.8	172	27.8	250	40.5	470	76.1	148	23.9
South Fork Gold Creek	49	2.8	312	17.6	257	14.5	638	36.1	1130	63.9
Squaw Creek	83	10.1	180	21.9	383	46.7	677	82.6	142	17.4
Texas Creek-Methow River	42	7.1	73	12.4	216	36.6	350	59.4	239	40.6
Grand Total	665	4.7	1536	10.8	2987	21.0	5204	36.6	9010	63.4

Perennial stream temperatures likely increased when the fire blow through RRs. Burn severity was generally low across most RRs, suggesting many streams likely did not experience severe increases from radiant head. However, some localized heating likely occurred. Shade loss can affect more long-term temperatures after the fire burns through, depending on burn severity. No estimate on shade loss has occurred, but based on the generally small amount of moderate and high burn severity in RRs, shade loss does not appear substantial. Many intact RRs remain, suggesting there would not be much long-term shade loss or increased solar radiation. Of all the sub-watersheds, Black Canyon has the greatest likelihood of increased stream temperatures because ~40 of the total RRs burned at moderate to high severity. Lower Black Canyon is designated critical habitat for steelhead. Although some increased water temperature is expected, they will likely return close to pre fire conditions within a year in most areas.

Based on established MPI standards and summer 7DADM temperatures, the Lower Methow River, lower Gold Creek, SF Gold Creek, lower Crater Creek, and lower Libby Creek each exceed 18°C during the summer and are not properly functioning for bull trout, steelhead and spring Chinook migration, rearing, and spawning; however, these species each migrate during parts of the year when temperatures are much cooler. Production of rearing juveniles in some lower reaches of these waters may be diminished due to a temperature bottleneck during the summer, which effectively reduces rearing habitat and displaces temperature-sensitive juvenile salmonids.

Overall, the Lower Methow River Watershed is considered **not properly functioning** for the temperature indicator because some reaches of the mainstem and tributaries exceed MPI and DOE standards during parts of the year and for some loss of riparian overstory from the fires.

<u>Suspended Sediment, Intragravel DO/Turbidity, Substrate Character and Embeddedness</u>
These two indicators have similar causal mechanisms of fine sediment entering streams from erosion or runoff. They are considered together for the analysis because we lack intragravel DO measurements and Nephelometric Turbidity Units readings.

Sub-watersheds (12th HUC) in the Lower Methow Watershed (10th HUC) contain highly erosive

soils and have had generations of human use including vegetation management, road construction, flood control, grazing and urban development. Sub watersheds are susceptible to high intensity summer rain squalls and can erode, which can result in rapid sediment delivery to valley bottoms and the mainstem Methow River. Sediment tends to pulse through the drainage network and is carried through the drainage system on spring freshets; some of this material is stored and some is delivered to the Methow River. The lower Methow River has a higher gradient than the middle and upper Methow and much of the fine sediment is probably transported to the Columbia River. Some of the fine sediment would settle out on channel margins, the floodplain, and side channel habitat in lower gradient sections of the lower Methow; this would occur as the snow melt resides and flows begin to drop in June.

Past management practices associated with activities such as timber harvest, road development, road management, and grazing in the Lower Methow watershed are suspected to have altered sediment routing and increased fine sediment percentages in the Methow River. Currently, roads that often parallel or cross streams are the primary sources for artificial sediment.

MVRD has not collected turbidity (NTU) or intra-gravel dissolved oxygen (IGDO) measurements; however, Wolman pebble count data are collected in tributaries to the lower Methow River. These measurements are used as a surrogate for evaluating turbidity, IGDO, and embeddedness. We assume fine sediment levels in pebble count data are representative of NTU or IGDO levels and of gravel embeddedness. Habitat data, including sediment levels, on the lower Methow River mainstem is lacking and considered a data gap. We are not aware of any habitat survey that has been complete on the mainstem below the town of Carlton. New data has been collected in the Gold Creek (USDA 2009) drainage during the stream surveys. For all other streams, no new data has been collected since 2002 in any of the stream reaches in the Lower Methow Watershed. Available pebble count data is listed in Table 38

Fine sediment data from the available pebble counts ranges from not properly functioning to properly functioning. Most of the upper reaches have low sediment levels and also correlate with fewer roads. Subwatershed road densities do not exceed 2.1 miles per square mile but when considering the densities within Riparian Reserves and Riparian Habitat Conservation Areas (RRs; east side of Methow River), they are higher. Additionally, many roads run parallel to streams.

Table 38. Substrate characteristics of surveyed streams in the Lower Methow River Watershed USDA 1997; USDA 2010).

Trib.	RM	D50 (mm)	Surface Fines (<6mm)	Sand (<2mm)	Gravel	Cobble	Boulder	Bedrock	Functional Rating (MPI)[1]
Libby	0-2.9	Private – No data collected							
	2.9-4.6	52.5	31%	24%	32%	37%	7%	-	NPF
	4.6-6.0	28.4	30%	23%	45%	26%	6%	-	NPF
	6.0-7.1	98.4	13%	12%	28%	48%	12%	-	FAR
NF Libby	0-4.6	102	19%	12%	27%	37%	24%	-	PF

Trib.	RM	D50 (mm)	Surface Fines (<6mm)	Sand (<2mm)	Gravel	Cobble	Boulder	Bedrock	Functional Rating (MPI)[1]
SF Libby	0-1.4	60	20%	16%	38%	33%	13%	-	FAR
	1.4-2.6	51	25%	16%	39%	30%	15%	-	NPF
Gold	0-3.1	Private – No data collected							
	3.1-3.4	116	12%	6%	27%	42%	25%	-	PF
NF Gold	0-1.1	133	9%	6%	25%	43%	27%	-	PF
	1.1-1.8	146	7%	5%	23%	44%	28%	-	PF
	1.8-3.0	109	8%	7%	27%	41%	25%	-	PF
SF Gold	0-2.3	Private – No data collected							
	2.3-3.8	116	16%	12%	24%	44%	20%	-	PF
	3.8-5.9	62	17%	13%	29%	39%	9%	-	FAR
Foggy Dew	0-4.4	158	8%	6%	20%	42%	32%	0%	PF
	4.4-4.7	135	4%	3%	13%	35%	46%	3%	PF
Crater[2]	0-1.7	128	9%	8%	20%	48%	24%	-	PF
	1.7-2.9	160	6%	5%	18%	42%	35%	-	PF
Rainy[2]	0-1.1	56	21%	12%	46%	30%	12%	-	FAR

[1]PF – Properly Functioning; FAR – Functioning at Risk; NPF – Not Properly Functioning
[2]Not surveyed in 2009; data from 1996 stream survey report (USDA 1997).

Wildfires have burned over half of the of the Lower Methow River watershed since 2012 from the Goat (2012), Carlton Complex (2014), and Black Canyon Fires (2015). Soil burn severity analyses were completed on the fires and most of the burned area had low severity. High severity was estimated at 8.8%, moderate severity at 25%, and low severity at 66%. A heavy rain storm in 2014 dropped over an inch of rain across the burned area resulting in a major increase in fine sediment to the Methow River and tributaries. A similar one occurred in 2015 around Black Canyon. Both of these storms generated large volumes of sediment to enter the lower Methow River. Fire suppression and BAER treatments contributed only minor sediment to the system because Best Management Practices were applied. Overall, the increased sediment from the fires, post fire storm events and debris flows, and the continued risk of more surface erosion over the next few years, is sufficient to have shifted the sediment-related indicators from FAR in the Lower Methow Watershed to NPF for surface fines and in-gravel fines. Therefore, we expect that the indicator may have shifted/degraded for a period of 3-5 years, subject to precipitation events, riparian vegetation recovery, banks stabilization rates and the rate that fine sediments are flushed from low gradient streams. We consider the Lower Methow Watershed as **Not Properly Functioning** for surface fines and in-gravel fines. The recent fires burned less than 600 acres of the Libby Creek drainage with low severity and post fire sediment effects across the larger watershed did not occur within this

drainage. The Libby Creek drainage is considered functioning at risk due to riparian roads and livestock grazing.

Chemical Contamination/Nutrients

The USFS has not sampled for chemical contaminants or nutrients within the Lower Methow River Watershed. DOE monitors water quality statewide for Clean Water Act compliance, generating the 303(d) list of impaired waters. The lower Methow River currently has no category 5 reaches (polluted waters that require a TMDL) but has a category 2 reach (water of concern) between RM 4.5 and 85.8, where excursions for pH values were detected in 5-10% of samples taken in 2004 and 2006. High pH values were detected in these sampling efforts, though the number or magnitude of exceedances was not sufficient to warrant addition as category 5 water.

Alder Creek, which enters the Methow River mainstem several miles upstream of the watershed break point near Carlton, has long history of mining activities in its drainage. A study found heavy metal contamination of ground water and sediments in the Redshirt Mine and Alder Creek area (Peplow 2002). The study compared the tissues of hatchery juvenile trout reared for 34 days in a pen in wetlands adjacent to the Twisp River (control group) with the tissues of fish reared in wetlands adjacent to the Methow River that are fed by Alder Creek. The Alder Creek fish had accumulated heavy metal granules in mitochondrial structures and may have had reduced growth rates. The mine sites are identified as EPA cleanup sites. Washington DOE considers the Alder Creek as a water of concern (Category 2) for cadmium, pH, and zinc; this stream may contribute pollutants to the Methow River mainstem.

Reduction of historic salmon returns is believed to have considerably reduced delivery of marine derived nutrients to the Methow Sub-basin. The Yakama Nation is currently conducting research on this issue.

A fire retardant misapplication occurred over Gold Creek on July 30th, 2014. Outside of this, there are no reports of other retardant, foam, or fuel spills in the watershed from the fire suppression or suppression rehab activities. We anticipate some accelerated nutrient runoff associated with the Goat, CCF, and Black Canyon Fires because of the large scale of the areas burned. However, given most of the fire area burned at a low intensity or was unburned, we do not expect there to be long-term term negative consequences to aquatic systems. Some relatively minor, short-term (<3 years) impacts are likely to occur but we wouldn't consider those to have occurred at a magnitude that would alter the baseline from FAR.

The Lower Methow River Watershed is considered **functioning at risk** for chemical contaminants/nutrients, given identification of several 'at risk' reaches identified in the watershed or immediately upstream. The mainstem is also identified as impaired in terms of instream flow and temperature, which could have concentrating effects and increased stress and susceptibility of aquatic organisms. The Libby Creek, Gold Creek, and Black Canyon Creek sub-watershed are all assumed to be properly functioning for the chemical contamination/ nutrients indicator. Each of their drainages has minimal management activities that would add nutrients or contaminants. The impacts from the fires are expected to be below a magnitude of degrading the overall condition of this indicator.

Habitat Access

Physical Barriers

There are no physical barriers on the Lower Methow River. On National Forest land, three culverts were identified in the Libby Creek drainage that partially or fully block fish movement. These are proposed for replacement under this project. No other known human caused barriers exist on National Forest lands. The current status of the private irrigation diversion on lower Gold Cree is unknown, but steelhead and migratory bull trout do navigate on to Forest Service lands. We believe the private section of Libby Creek is now fully passable for fish. However, given the elevated temperature regime and associated unknowns in terms of thermal barriers to some species and lifestages, we consider the Lower Methow Watershed to be **functioning at risk** for fish passage barriers.

Habitat Elements

Large Woody Debris (LWD)

For the east side of the Cascades, large woody debris is defined as a downed tree, or portion of a tree, within the bankfull channel that is >35 feet long and >12 inches in diameter. In order for a stream to be functioning appropriately, there must be >20 pieces of LWD per mile and adequate sources of woody debris for recruitment in riparian areas (USFWS, 1998).

The lower Methow River has not been surveyed for habitat conditions but there have been several observations on wood levels. During a 2008 fish survey of the river from Carlton to the mouth, very little wood was observed throughout this reach with an estimated range of 0-2 pieces per mile (G Shull personnel communication). Large-scale stream cleaning activities removed large woody debris from many of the stream systems in the Methow Subbasin that included the lower Methow. The extensive parallel roads on Forest Service lands have removed much of the wood recruitment opportunities. On private lands, property owners have reduced the woody debris levels. We expect wood levels to be lower than what occurred naturally, we also believe natural wood levels were not likely high in this area due to the steeper gradient, more constrained river, and higher energy flows.

Most Lower Methow Watershed tributaries range from not properly functioning to functioning at risk for wood levels. Past timber harvest, stream cleanouts, and parallel roads have limited the amount of wood and recruitment on many reaches. Current management practices in riparian reserves and RRs now protect trees along streams and are assumed to do so in the future. Recent surveys in Gold Creek and Libby Creek drainages observed slight increases in Libby Creek (USDA 2010). Table 39 below lists the current LW pieces per mile.

Table 39. LWD in the Lower Methow River watershed. Bold data is from 2010 stream survey.

Sub-watershed	Stream	RMs	Large Wood (#/mi)[1]	LWD Source?[2]	MPI Functional Rating[3]
Low. Methow	Methow River	0-29.1	Low	Limited	NPF-A
Libby Creek	Libby Cr.	0-2.9	Unknown	Unknown	FAR-A

Sub-watershed	Stream	RMs	Large Wood (#/mi)[1]	LWD Source?[2]	MPI Functional Rating[3]
	Libby Cr.	2.9-4.6	22.8	Limited	PF
	Libby Cr.	4.6-6.0	36	Yes	PF
	Libby Cr.	6.0-7.1	27.2	Yes	PF
	NF Libby Cr.	0-4.6	38	Yes	PF
	NF Libby Cr	**0.0-0.85**	**41.6**	**Yes**	**PF**
	SF Libby Cr	**0-0.54**	**40**	**Yes**	**PF**
	SF Libby Cr.	0-1.4	35	Limited	FAR
	SF Libby Cr.	1.4-2.6	43	Limited	FAR
Gold Creek	Gold Cr	0-3.1	3-A	Limited	NPF-A
	Gold Cr	3.1-3.4	3.4	Limited	NPF
	NF Gold Cr	0-1.8	9-10	Yes	FAR
	NF Gold Cr	**1.8-3.02**	**9.6**	**Yes**	**FAR**
	SF Gold Cr	**2.3-5.9**	**11-13**	**Yes**	**FAR**
	Crater Cr.	0-1.7	2	Limited	NPF
	Crater Cr.	1.7-2.9	17	Yes	PF/FAR
	Foggy Dew Cr	0-4.7	12-18	Yes	PF
Black Canyon	Black Cyn. Cr.	0-7.7	7-28	Limited	FAR

[1]MPI Standard for large wood - >12" diameter & > 35' long.
[2]Determination based on aerial photos/connectivity with floodplain/channelization
[3]PF – Properly Functioning; FAR – Functioning at Risk; NPF – Not Properly Functioning; -A – data assumed.

The CCF and Black Canyon Fire burned along the mainstem of Gold Creek, SF Gold Creek, and Black Canyon Creek. With the exception of some intermittent headwater drainages, burn severities were low in riparian areas. Following these fires, large vegetated buffers and local topography were intact in most areas below high/Moderate burn severity, which, are capable of buffering essential fish habitat from intense and potential post fire effects such as debris torrents and loss of riparian vegetation that may cause changes to LWD recruitment. Most moderate and high intensity burns occurred in upper and mid slopes and will result in higher amounts of wood recruitment to small order stream channels. Much of the wood will be mobilized during intense precipitation events and may settle out in lower gradient reaches, however, the majority of the wood will remain in these headwater reaches. Wood recruitment in the Methow would benefit channel conditions creating channel complexity, adding nutrients, and providing habitat and cover for aquatic organisms. Overall, wood levels in tributaries to the Methow River are expected to increase due to the fire. Long-term, recruitment may be negatively impacted in Black Canyon Creek and a few areas where the fire burned hot.

Chicamun Creek is being analyzed for commercial thinning to increase hardwood production and, ultimately, to improve habitat for future beaver release. To help in assessing short-term impacts, we collected current wood loading in Chicamun Creek. Over 100 pieces of wood per mile, 6 inch dbh

or greater, were counted. This approximately meets our desired condition for wood quantity in small headwater streams.

Stream size can limit wood movement downstream. According to May and Gresswell (2003), chronic fluvial processes in small headwater streams have long periods of storage of sediment and wood that can be transported downstream episodically by debris flows. The intermittent streams present in the Libby Creek drainage are first and second order channels with widths generally 2-4 feet wide. Streams of this size do not have the capacity to move medium or large sized wood downstream except during infrequent debris flow events. These events are rare and are extremely unlikely to occur in the project area.

Large wood volumes in streams and recruitment continue to be limited riparian roads, past riparian harvest, and other elements. Therefore, the Lower Methow Watershed is **functioning at risk** for large woody.

Pool Frequency/Quality and Large Pools

These indicators were lumped together because similar mechanisms influence their formation and quality. These include large wood quantity, sediment load, channel geometry, bedrock, and bed material size (Buffington et al. 2002).

Pool habitat frequency and complexity is assumed to be limited in many segments of the lower Methow River and tributaries. Table 40 summarizes the available pool data by reach. In 1991 surveys done by the Pacific Northwest Research Station found 4.8 pools/mile, which is considered within the normal range if a river with wetted width >100-feet. During a recent fish survey of the lower Methow River, biologists observed many of the pools to have depths over 6 feet and nearly all pools lacked wood and were associated with bedrock or rip rap. Other than casual observations, no recent habitat data has been collected on the mainstem Methow River below Carlton.

The 1999 and 2010 stream surveys in Libby Creek indicated that pool frequency and quality was low. The 2009 survey of Gold Creek found adequate numbers of pools. Pool habitat in both of these streams lack adequate complexity and quality primarily from lower instream wood levels. NF and SF Libby Creeks had good quantities of pools and their complexity was considered good.
The 1995 stream survey of Black Canyon Creek indicates that pool habitat is very scarce and quality was low in the creek.

The recent fires delivered large volumes of fine sediment to the stream network including CH streams. The effect of this is often a reduction in pool depth and frequency. No attempt has been made to inventory the effect, but the high fine sediment loading likely reduced pool habitat in the Gold Creek drainage and Black Canyon. The Methow River also experienced a sudden, large increase in fine sediment. Pool habitat in the river was likely degraded. Fire effects, and post fire flooding and debris flows, have likely degraded the indicator from Functioning At Risk to Not Properly Functioning in several sub-watersheds: Gold, SF Gold, McFarland Creek-Methow River (Methow River), Squaw Creek and Black Canyon. Given those effects and the continued level of elevated risk via vegetation loss and future storm events, impacts have likely shifted the indicators short-term (3-5 years) **Not Properly Functioning** until vegetative recovery occurs, banks stabilize and sediments are flushed through the system.

Table 40. Lower Methow River Watershed pool indicators data and MPI functional ratings. Bold reflects 2009 survey data.

Sub-watershed	Tributary	River Miles	% Pool Area	Avg. wetted width	Pools/ mile	Pools > 5' deep/ mile	Pools > 3' (1m) deep/mile	Avg. Pool Residual Depth	MPI stand. (pools/mi)	MPI Funct. Rating[1]
Lower Methow	Methow R	0-29.1	No data	No data	No data	No data	No data	No data	-	FAR-A
Libby Creek	Libby Cr.	2.9-4.6	12.9	15.8'	**35.1**	0.6	**3.2**	**1.4'**	51	**FAR**
	Libby Cr.	4.6-6.0	19.7	16.4'	**44.2**	0	**2.6**	**1.4'**	45	**FAR**
	Libby Cr.	6.0-7.1	19.8	14.2'	**47.4**	0	**3.7**	**1.4'**	53	**FAR**
	NF Libby Cr.	0-4.6	18.4	11.7'	66	0	3.5	1.7'	48	PF
	NF Libby Cr	**0-0.85**			**68.7**		**3.1**	**2.0'**	**48**	**PF**
	SF Libby Cr	**0-0.54**			**53**		**1.7**	**1.75'**	**48**	**PF**
	SF Libby Cr.	0-1.4	21.7	13'	68	0	7.3	1.6'	48	PF
	SF Libby Cr.	1.4-2.6	24.2	13'	85	0	7.4	1.6'	48	PF
Gold Creek	Gold Cr	0-3.1	No data	No data	No data	No data	No data	No data	-	FAR-A
	Gold Cr	**3.1-3.4**	**10.1**	**21'**	**24**	**0**	**0**	**1.2'**	**23**	**FAR**
	NF Gold Cr	**0-1.8**	**24.7**	**21'**	**39**	**0**	**5.6**	**2.4'**	**23**	**PF**
	SF Gold Cr	**2.3-5.9**	**11.7**	**11.1'**	**34**	**0**	**0.3**	**1.1'**	**48**	**FAR**
	Crater Cr	0-1.7	20.6	17'	48	0.6	11.8	1.8'	39	PF
	Crater Cr.	1.7-2.9	28.1	15.5'	68	2.5	28.3	2.3'	39	PF
	Foggy Dew	0-4.7	17.7	16.0'	42	0.2	7.5	1.8'	39	PF
Black Canyon	Black Cyn	0-3.8	4.6	9.8'	15	0	0.8	1.1'	60	NPF

1PF – Properly Functioning; FAR – Functioning at Risk; NPF – Not Properly Functioning; - – data assumed

Off-Channel Habitat

The lower part of the Methow River is naturally confined by steep valley walls and bedrock canyons; off-channel habitat likely naturally limited. Development of private land as well as road and bridge protection are likely further constraining the channel and reducing large wood recruitment that is important to side channel habitat and pool formation. Analysis of 2006 aerial photos shows a small number of low-lying riparian areas where homes have been constructed and stream armoring has likely occurred in some of these locations to restrict the active channel in place.

Off-channel habitat is very limited in the most tributary streams (<5%) in the watershed because most streams are Rosgen (1996) A- or steeper B-type streams. The area with the most of the potential off-channel habitat on tributary streams is in the lowest gradient sections of Gold Creek on private lands, but the area is likely modified. Roads encroach along Gold Creek, limiting the amount of habitat as well.

Post fire debris flows delivered large volumes of fine sediment to the Methow River and some major tributaries. Off channel habitat likely is substantially reduced as result. Due to influx of sediment and duration for hillslopes to stabilize post fire, we anticipate that Off Channel Habitat conditions may have shifted to **Not Properly Functioning** in the short-term (3-5 years).

Refugia

The Methow Subbasin is an important stronghold and refugia for steelhead, spring and summer Chinook salmon, coho, bull trout, and westslope cutthroat trout, and the primary production area above Wells Dam. The Lower Methow Watershed functions largely as a migratory corridor for spawning habitat higher in the subbasin. Libby and Gold Creek subwatersheds do provide important spawning and rearing habitat as well as the lower Methow for steelhead. Overall, habitat is largely intact in the Lower Methow Watershed. Connectivity and access between the naturally limited habitats available required by migratory fishes is mostly good, and riparian habitat in the watershed is generally in good condition on Federal lands.

Some challenges remain such as high density of riparian roads along the lower Methow River and tributaries, water withdrawals, past timber harvest in riparian areas, high summer temperatures, and reduced large wood recruitment potential in the lower portions of tributary streams such as Libby Creek and Gold Creek subwatersheds. Roads related sediment loads have affected the refugia indicator mostly in the Libby Creek drainage. Summer low flows are functioning at risk with a few water withdrawals across the watershed and several higher up in the subbasin. Some improvement to summer flows has occurred over the years with some ditches converting to wells, some abandoned, and ditch efficiencies. High summer temperatures exist that reduce habitat quality for salmonids, but to some extent, it is natural.

Some off-channel habitat is likely reduced but physical connectivity between all areas historically accessible is currently maintained. Some limitation in refugia may be limited by warm summer temperatures may restrict some migrations, but this extent is unknown.

Libby Creek may have historically provided quality refugia for spring Chinook, steelhead, and bull trout. Recent data and reports indicates Libby Creek provides spawning habitat for steelhead and is used on a limited basis by juvenile Chinook and bull trout. High road densities contribute to higher

fine sediment levels and several parallel roads encroach on the creeks migration zone. Gold Creek has been an important sub-watershed for providing refugia for steelhead and bull trout. Most, if not all, irrigation diversions and other barriers have been repaired and migratory fish have access to nearly all of their historic range in the sub-watershed. A legacy of past management activities including timber harvest, in-channel LWD removal, and extensive road networks, tempered the value of refugia before the recent fires hit. Since the fires and resulting debris flows, the Gold Creek drainage not functioning for many indicators and would provide low quality refugia in the short-term.

Prior to the fires, Black Canyon Creek provided some refugia habitat for steelhead as they regularly spawn and rear in the lower mile of the creek but it is assumed that the creek is not capable of supporting a large population of steelhead.

Habitat features such as pool habitat, hiding cover, spawning habitat, and off channel habitat would be degraded with a sudden, large increase in fine sediment from the fires. Conditions in the Methow River are expected to be short-lived before sediment gets redistributed to natural depositional places. Tributaries may experience post fire effects longer. Some habitat components may benefit from the fire including replenishment of spawning gravels, fine sediment deposition in floodplains, and LWD recruitment (USDA Forest Service, 2012). Overall, given the immediate impacts and continued risk, we expect that this indicator has shifted **Not Properly Functioning** in the short-term (3-5 years).

Channel Conditions and Dynamics

Width/Depth Ratio

In general, a channel's width:depth ratio fluctuates in response to changes in sediment transport rates, stability of streambank, changes in the drainage network and resulting changes in stream power, and quantity of instream LWD. Data on wetted width/depth ratios have not been collected because they are dependent on stream flow and river stage. Table 41 displays the width:depth data available for the major tributaries.

The lower part of the Methow River is naturally confined by steep valley walls and bedrock canyons. There is no data available for the width:depth ratio for the Methow River. Most of the reaches surveyed in the Libby Creek, Gold Creek, and Black Canyon subwatersheds were within the expected ratios based on Rosgen stream types. One section on Foggy Dew and Black Canyon Creek were wider.

Table 41. Lower Methow River Watershed tributary width/depth ratios.

River Mile	Bankfull W/D	Average gradient (%)	Channel Type (Rosgen 1996)	Expected w:d ratio (Rosgen 1996)	Within expected range?
Libby Creek					
2.9 – 4.6	8.8	4.3%	B3a	> 12 (range 11.7-38.0) a: < 12 (range 2.7-11.2)	Yes
4.6 – 6.0	14.3	3.2%	B4	> 12 (range 11.7-38.0)	Yes

River Mile	Bankfull W/D	Average gradient (%)	Channel Type (Rosgen 1996)	Expected w:d ratio (Rosgen 1996)	Within expected range?
6.0 – 7.0	11.6	4.2%	B3	> 12 (range 11.7-38.0)	Yes
North Fork Libby Creek					
0 – 4.6	7.6	12.9%	A3, B4	A: < 12 (range 2.7-11.2) B: > 12 (range 11.7-38.0)	Yes
South Fork Libby Creek					
0 – 1.4	11.9	11%	A3, B4	A: < 12 (range 2.7-11.2) B: > 12 (range 11.7-38.0)	Yes
1.4 – 2.6	9.4	17.7%	A3, B4	A: < 12 (range 2.7-11.2) B: > 12 (range 11.7-38.0)	Yes
Gold Creek					
3.1 – 3.4	23.6	2.6%	B3	> 12 (range 11.7-38.0)	Yes
North Fork Gold Creek					
0 – 1.1	16.6	2.6%	B3	> 12 (range 11.7-38.0)	Yes
1.1 – 1.8	21.2	4.4%	B3	> 12 (range 11.7-38.0)	Yes
1.8 – 3.0	16.2	5.0%	B3a	> 12 (range 11.7-38.0)	Yes
South Fork Gold Creek					
0 – 2.3		4.8%			
2.3 – 3.8	12.5	4.5%	B3	> 12 (range 11.7-38.0)	Yes
3.8 – 5.9	12.3	4.8%	B4, B3	> 12 (range 11.7-38.0)	Yes
Foggy Dew Creek					
0 – 2.6	17.2	6.3%	B3a, A3	A: < 12 (range 2.7-11.2) B: > 12 (range 11.7-38.0)	Yes
2.6 – 4.4	17.3	7.8%	B3a, A3	A: < 12 (range 2.7-11.2) B: > 12 (range 11.7-38.0)	Yes
4.4 – 4.7	13.8	10.3%	A4	< 12 (range 2.7-11.2)	Wider
Crater Creek					
0 – 1.7	12.5	7%	B3	> 12 (range 11.7-38.0)	Yes
1.7 – 2.9	10.4	10%	A3	< 12 (range 2.7-11.2)	Yes
Black Canyon Creek					
0 – 1.5	12.5	6.6%	A3	< 12 (range 2.7-11.2)	Wider

River Mile	Bankfull W/D	Average gradient (%)	Channel Type (Rosgen 1996)	Expected w:d ratio (Rosgen 1996)	Within expected range?
1.5 – 2.6	8.0	6.9%	A4,5	< 12 (range 2.7-11.2)	Yes
2.6 – 3.8	10.4	8.0%	A3	< 12 (range 2.7-11.2)	Yes

Fire suppression activities and BAER treatments in RR are not expected to have measurably affected the indicator. However, the fires and post fire debris flows added a high volume of fine sediment to the Methow River and tributary streams including those with CH. No measurements have been taken, but we anticipate the increased sediment loads observed in Gold Creek, SF Gold Creek, Black Canyon and Methow River to have likely altered W/D ratios. Though changes in W/D ratios are anticipated to be short-term, post fire effects were significant across the watershed including likely within Methow River itself. Therefore, this indicator has likely degraded to **Not Properly Functioning** short-term (<5 years) until risks are reduced, scoured banks stabilize and sediments are flushed out.

Streambank Condition

Most of the headwater streams in the Lower Methow Watershed are Rosgen A-type streams. Couple these stream types with a conifer forested landscape and stream bank stability is generally high. Recent habitat surveys (2010) compared to surveys in 1999 in Libby Creek found that streambank stability increased over the last decade. Small order, higher elevation perennial tributaries with narrow stream channels are typically characterized by larger substrate size, well-armored banks, and higher energy flows. The larger HUC 12 drainage streams are commonly B-type channels with large substrates and dense streambank vegetation. Most riparian areas are well vegetated, providing great protection to streambanks.

Activities that can affect streambanks are grazing, roads, and timber harvest both directly and by altering hydrologic and sediment processes upstream. Management objectives in riparian areas provide good protection of streambanks, but there is room to improve areas and be diligent in continuing protection. Table 42 displays the streambank stability data available for the major tributaries.

The fires consumed some vegetation along riparian areas, but generally, fire intensities were low along most streams with the exception of headwater drainages. Riparian vegetation tends to rebound fairly quickly and bank stability will likely be close to pre-fire conditions in several years. In Black Canyon Creek and Gold Creek, where a post-fire storm event initiated a debris torrent, channel scour likely left stream banks raw and unstable and recovery will be prolonged. The magnitude of impacts from the limited fire suppression activities and BAER treatments in RR are not expected to have measurably affected the indicator.

Though changes in streambank condition are anticipated to be short-term, post fire effects were significant across the watershed including major tributaries but thought to be limited along the Methow River itself. Therefore, this indicator has likely degraded from FAR to **Not Properly Functioning** short-term (<5 years) until risks (future debris flows), riparian vegetation recovery

occurs and scoured banks stabilize. Table 42 below shows pre-fire bank stability ratings for National Forest streams.

Table 42. Stream bank stability for tributary streams.

River mile	Bank erosion (eroded ft/mi)	% Eroding banks (total both banks)	MPI Functional Rating[1]
Libby Creek			
2.9 – 4.6	400	3.8%	PF
4.6 – 6.0	555	5.2%	PF
6.0 – 7.0	240	2.3%	PF
North Fork Libby Creek			
0 – 4.6	110	1.1%	PF
South Fork Libby Creek			
0 – 1.4	145	1.4%	PF
1.4 – 2.6	25	0.2%	PF
Gold Creek			
3.1 – 3.4	873	8.3%	PF
North Fork Gold Creek			
0 – 1.1	1,054	10%	PF
1.1 – 1.8	1,054	10%	PF
1.8 – 3.0	514	4.9%	PF
South Fork Gold Creek			
0 – 2.3	Not surveyed	Not surveyed	-
2.3 – 3.8	148	1.4%	PF
3.8 – 5.9	322	3%	PF
Foggy Dew Creek			
0 – 2.6	219	2.1%	PF
2.6 – 4.4	384	3.6%	PF
4.4 – 4.7	182	1.7%	PF
Crater Creek			
0 – 1.7	88	1%	PF
1.7 – 2.9	72	<1%	PF
Black Canyon Creek			
0 – 1.5	649	6.1%	PF
1.5 – 2.6	314	3.0%	PF
2.6 – 3.8	129	1.2%	PF

[1]Properly Functioning; FAR – Functioning at Risk; NPF – Not Properly Functioning; -A – data assumed.

Floodplain Connectivity

Natural connectivity to the floodplain is limited along the lower Methow River mainstem due to a relatively narrow valley below Carlton and natural confinement by steep valley walls and bedrock canyons. Nonetheless, development of agricultural and residential lands, as well as road and bridge protection have likely reduced connectivity with the historic floodplain, wetlands further constraining the channel and reducing large wood recruitment that is important to side channel

habitat and pool formation. Analysis of aerial photos shows a small number of low-lying riparian areas, evidence by signs of historic flowpaths, where homes and apple orchards have been constructed. These areas have likely been cut off by dikes and riprap to restrict the active channel in place.

Little floodplain habitat exists in the tributary streams to the lower Methow River due to the steeper gradients and V-shaped valleys. In the few areas with floodplain, roads encroach most listed fish streams in the Libby, Gold, and Black Canyon Creek drainages, Libby Creek sub-watersheds. Also private land development occurs right along Libby and Gold Creeks that modified the little floodplain habitat available.

Fire suppression activities and BAER treatments are not expected to have affected the indicator. The post-fire flooding likely resulted in the building of some floodplain habitat in some stream reaches and some floodplain connection loss in other reaches where streams downcut. Overall, the Lower Methow River Watershed k is **functioning at risk** for floodplain.

Flow/Hydrology

Change in Peak/Base Flows

Hydrology and water yield in the Lower Methow Watershed is largely driven by annual precipitation in the form of snow pack. Flows in the lower Methow River are largely driven by precipitation and human alterations in the Methow Subbasin above. Anthropogenic influences, such as road networks, timber harvest, agriculture, and water use (domestic and irrigation), and natural disturbances, such as wildfires, influence flows in the river. Water yield in a watershed can increase when vegetation cover, and sometimes soil properties are dramatically altered by a wildfire (Gresswell 1999, Chanasyk et al. 2003). Wildfires have burned about 20% of the entire Methow Sub-basin over the last 10 years and the remaining forest is mostly in various stages of mid- to late-seral vegetation conditions with a portion of the Libby Creek drainage at an early seral stage from the last wildfire. Most of the bottom lands are private with private residences with domestic wells and agriculture with irrigation systems. We expect a continued increase in demand for groundwater via domestic wells would contribute to a decrease in base flows.

The USGS has operated a stream gaging station near the mouth of the Methow River since 1960. Peak annual flows typically occur from May to June. Mean annual low flows typically occur from in September. The timing and magnitude of flows appear to be relatively unchanged from historic records. Peak flow discharge for the lower Methow River is assumed to relatively natural and close to properly functioning if not already.

Per the fire's BAER reports, the increase in stream flows may continue for about 2-3 years or until vegetation is re-established with shrubs and grasses. The increase in sediment delivery may also continue for about 2-3 years as well, however, a significant reduction can be expected after the first growing season as a result of natural vegetative recovery in the areas burned at low to moderate severity. Given the continued risk, predicted outcomes, and relatively large size of impacted area (amount of bare ground, riparian degradation), we expect the indicator to have shifted from FAR to **Not Properly Functioning** short-term (3-5 years) until the area revegetates and stream bank stability increases.

Drainage Network Increase and Road Density & Location

These indicators are grouped together as road network and stream crossings are the primary agent of hydrologic change altering drainage patterns in the watershed. As road density increase and connectivity between roadways and the stream network becomes more efficient and the hydrograph can become flashier as surface waters are more quickly routed from roadways and ditches into streams.

Forest roads artificially increase the drainage network in a watershed. The Libby Creek drainage area has an estimated road density if 1.9 mi/mi^2 and ~ annual precipitation of 10 inches in the lower elevations and 40 in the higher elevation that comes primarily as snow. Using the WWRP procedures for estimating drainage points within 300 feet of streams, the project fish biologist estimates the existing roads increased the drainage network by 25.5 miles or by 44%. The higher number is due to there being several parallel roads to streams with close proximity. The increase in effective drainage network is expected to more efficiently drain the sub-watershed and have an impact to peak and base flows.

High road densities in some of the upland sub-watersheds likely have altered natural runoff patterns. Areas of very high road density include upper French Creek, Upper North Fork Libby Creek, North Fork Gold Creek, the divide between McFarland and Squaw creeks, and upper Black Canyon Creek.

Overall road density across the watershed is relatively low at 1.4 miles per square mile. Smaller drainages with higher road densities are French Creek, Upper North Fork Libby Creek, North Fork Gold Creek, the divide between McFarland and Squaw creeks, and upper Black Canyon Creek (Table 43). Although the road density for the watershed is relatively low, we have higher road densities in areas with potential to influence stream function such as valley bottoms next to occupied fish habitat.

Per the post-fire storm updates, there were several roads within the fire perimeters that created some erosion problems during the post-fire rain storm event. In most cases, this caused culverts to plug and road crossings to fail. BAER treatments re-established drainage on some damaged roads. In summary, several stream crossings were blown out and drainage was temporarily increased due to the fires likely causing a short-term degradation of the indicators. Long term, we expect suppression rehab and BAER treatments to very slightly improve the indicators e.g., closure of two ML2 roads. We expected a 1-year short-term degrade to this indicator, ending in 2016. Currently, this indicator has returned back to pre-fire conditions. Therefore we find that the Drainage Network Increase and Road Density and Location indicators are **functioning at risk** for both bull trout and steelhead/salmon for the watershed.

Table 43. Lower Methow River Watershed sub-drainage road density, Riparian Reserve (and RR) road density, and MPI functional ratings.

Drainage Name	Hydrologic Class	Acres	Mi^2	Roads (mi)[1]	Road Density Mi/Mi^2	Riparian Res. (RR on eastside)				Functional Rating for LWR Methow River Watershed (MPI)[2]
						Acres	Mi^2	Roads (mi)	Mi/Mi^2	
Libby	**HUC12**	**25724**	**40.2**	**75.9**	**1.9**	**2684**	**4.2**	**20.7**	**4.9**	FAR – Bull Trout FAR – Steelhead/ Chinook[3]
Gold	HUC12	38915	60.8	57.5	0.9	3822	6.0	16.2	2.7	
SF Gold	HUC12	18009	28.1	22.3	0.8	1807	2.8	7.4	2.6	
Combined Gold	>HUC12	56924	88.9	79.9	0.9	5629	8.8	23.6	2.7	
Texas	<HUC12	7079	11.1	14.7	1.3	385	0.6	3.3	5.5	
McFarland	<HUC12	8368	13.1	41.6	3.2	619	1.0	4.5	4.7	
French	<HUC12	19700	30.8	42.8	1.4	1173	1.8	2.8	1.5	
Squaw	HUC12	10204	15.9	32.8	2.1	953	1.5	6.4	4.3	
Mainst. L Methow	HUC12	47070	73.5	108.8	1.5	3370	5.3	16.5	3.1	
Mouth of Methow	HUC12	21297	33.3	14.0	0.4	1249	2.0	3.1	1.6	
Black Canyon	HUC12	15824	24.7	30.0	1.2	1384	2.2	4.9	2.3	
Lower Methow	**HUC10**	**197302**	**308.3**	**373.0**	**1.2**	**20898**	**32.7**	**82.9**	**2.5**	

[1] GIS exercise using OWNF current road layer (3-10-10). Data from state, county, private, other road jurisdictions may be under-represented.
[2] PF – Properly Functioning; FAR – Functioning at Risk; NPF – Not Properly Functioning
[3] The estimated road density is below the PFC threshold, but due to the volume of roads paralleling streams, especially the Twisp River, we gave a FAR rating.

Watershed Conditions

Disturbance History

Historic disturbances within the Lower Methow Watershed are many and extend over at least a century of human occupation. Disturbances include natural and human caused fires, intensive grazing throughout the late 19th and early 20th century, localized mining, timber harvest, road construction, human settlement on private lands and leased lands within the National Forest, and development of the limited natural floodplain of the Methow River.

There has been extensive harvest and road construction in the Libby Creek, McFarland Creek, Squaw Creek, portions of Black Canyon Creek, and the French Creek drainages. Some harvest and road construction has occurred in the Gold Creek drainage but to a lesser degree. Post fire debris flows caused extensive sediment delivery to the creek following the Black Canyon Fire of 2015.

No data are available for the watershed's equivalent clear-cut area (ECA), though based on listed criteria, concentration of disturbance (irrespective of natural fire disturbance) and prevalence of late successional reserve area within the watershed, we consider the watershed is **functioning at risk** and improving. The fires burned over half of the watershed, but it was due to natural starts. Fire suppression, repair and BAER treatments resulted in minor impacts across the watershed that would not change the WC rating.

Riparian Reserves

The riparian area along the lower Methow River is mostly private. Low lying land along the river is limited below Gold Creek where the river is mostly hillslope or high terrace constrained. Where private development occurs on the few low lying areas, the riparian vegetation has be altered and often removed for rip rap. Many areas on high terraces are developed and similarly the vegetation in these areas has been heavily altered. The lower sections of the tributaries in the watershed are private and have been heavily altered and roaded as well. Riparian vegetation in these areas is mostly gone.

On National Forest lands, the lower sections of the major tributaries mostly have parallel roads that permanently removed riparian vegetation. Some previous harvest has removed large trees in Riparian Reserves and RRs. Riparian areas are fragmented and poorly connected in these areas. Outside of these areas, in roadless areas, the riparian areas are in good condition. Improved riparian management and a focus to reduce the road network should improve some riparian areas in the future. However, many riparian areas remain in various states risk, especially the ones associated with the larger tributary streams and listed fish habitat.

With the exception of several intermittent headwater channels, burn severities were low in riparian areas. Coupled with the limited scope of riparian suppression and BAER impacts in RRs, we do not expect any element of the fires to have changed the Riparian Reserve indicator from a FAR status. However, short-term (3-5 years) degradation is anticipated, specifically from the debris flows and flooding. Long-term, riparian reserve function will recover, and potentially improve, as banks stabilize, accelerated inputs of LWD occur and from reduced risk of future uncharacteristic wildfire.

Overall, the Lower Methow Watershed is **functioning at risk** due to localized effects associated with past timber practice, road densities, and cattle and dispersed recreation infiltration within riparian reserves.

Disturbance Regime

Scour events, debris torrents, and catastrophic fires localized in several minor parts of the watershed with moderately compromised capacity of the watershed to recover from environmental disturbance. Settlement and development has affected natural processes and structures along the Lower Methow and development of the lower river area has increased in the last ten years. Approximately 6% of the private bottomlands used for grazing have erosional problems (Mullan et al, 1992). Historic timber harvest and road construction in some key areas within the watershed have reduced the capacity of the stream network to absorb energy.

Fire return intervals were historically much shorter than now. In the early 1900's, the Forest Service began to suppress all fires, and accumulated fuels have increased vegetative cover and changed fire-tolerant open stands to fire-intolerant dense stands. These changes are resulting in more large catastrophic wildfires, which burn soils' organic components, destroy ground-stabilizing vegetation, and result in effects to aquatic habitat (most likely sedimentation, soil erosion, and changes in stream temperatures).

The fires burned about 92,500 acres (47 %) of the Lower Methow River Watershed, which is a natural disturbance event. However, climate change coupled with over a hundred years of fire suppression has altered the size and intensity of wildfires to uncharacteristically more intense levels. Most of the fires burned at low burn severity, which will likely result in some potentially beneficial effects as described above. Fire suppression and post-fire flooding caused disturbance to riparian and aquatic habitat, with a mix of negative and positive outcomes. Fire suppression efforts had a relatively minor impact on aquatic ecosystems and nearly 100% of those impacts were rehabilitated or mitigated post fire. Still, the BAER report notes that there is increased risk via disturbance events potentially affecting at-risk fish species and their habitat. The Black Canyon debris torrent and documented high water events in Gold and Squaw Creeks are evidence of that risk. It is noted that increased risk and potential decreased resiliency have occurred. As such, the baseline for this indicator may have shifted from **Not Properly Functioning** short term (<or= 5 years) as a result of the fires. Long-term, resiliency will be returned to baseline and maintained from vegetation recovery and reductions in natural fuel loading.

Summary/Integration of all Species and Habitat Indicators – Lower Methow

Bull trout

The extent of impacts of the fire to bull trout are unknown. Prior to the fires, Foggy Dew and Crater Creek were used by bull trout for spawning and rearing. The fire and post-fire flooding and debris flows degraded habitat in these streams at least short-term (temperature, sediment, chemical contaminants/nutrients), there may also be some short and long-term benefits via deposition of spawning gravels and LWD, etc. Habitat conditions will likely be more at risk for a few years and the debris flow likely killed or harmed some bull trout present in the streams. Additionally, the retardant misapplication likely killed or harmed individuals as well. Post fire flooding and debris flows in those streams and Black Canyon Creek likely degraded habitat in the Methow River short-

term (3-5 years) until the river flushes out the fine sediment. Similar beneficial effects are likely to occur in the Methow too.

Steelhead and Spring Chinook salmon

The extent of impacts of the fire on steelhead and spring Chinook salmon are unknown. Habitat conditions in Gold Creek and Libby Creek are not properly functioning for a number of indicators but are improving based on comparison of 1996/1999 and 2009 data. The fires now exacerbates this; Gold Creek, SF Gold Creek, Black Canyon and the Methow River will have high fine sediment levels for a few years until high flows flush the system out. The debris flow and retardant drop may have killed or injured some fish but it is anticipated that fish would generally re-establish displaced habitat relatively quickly. Some benefits via deposition of spawning gravels and LWD may have occurred from the fires.

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POTENTIAL EFFECTS ON LISTED FISH AND CRITICAL HABITAT

The format from the Analytical Process for Developing Biological Assessments for Federal Actions Affecting Fish Within the Northwest Forest Plan Area (USDA et al. 2004) was used in preparing the project effects section. The analysis procedure involves looking at the following eight factors when considering effects: proximity, probability, magnitude, distribution, frequency, duration, timing, and nature. These were derived from the ESA consultation handbook (USDI and USDC 1998).

Summary statements for each indicator use the terms positive; negative; or neutral to describe the effect of the project elements on the direction of the baseline indicator over time. A positive effect would improve the direction of the baseline indicator. Conversely, a negative effect would cause a decline in the direction of the baseline indicator. A neutral effect would not change the baseline indicator nor affect the direction of the baseline indicator, either positively or negatively. For the purposes of this specific assessment, a discountable effect (either positive or negative) is a qualitative statement indicating that there is an extremely unlikely probability of something occurring. An immeasurable effect (either positive or negative) is a qualitative statement indicating a potential effect, but lacks sufficient magnitude to be meaningfully measured or affect resources.

The first three factors allow for a quick evaluation of project effects with insignificant, discountable, or no effects without further factor analysis. When assessing the Probability factor for an element, if the outcome is entirely discountable (extremely unlikely to occur), no further factor analysis is required for that element. If the outcome of the Probability analysis is not discountable, assess for Magnitude. Should the outcome for Magnitude result in insignificant effects, no further factor analysis is required for that project element. When the outcome to magnitude is significant or results in take, we analyzed the remaining five factors. Where some of the indicators needed little discussion to discount effects, we did not follow the above method.

Some project activities will have mechanisms for effects to indicators, but they would not reasonably be affected due to proximity or to a lack of probability or would require effects to other indicators that are insignificant. For example, effects to pool habitat would occur from changes in wood levels, sediment loads, and alterations of streambanks. If each of the effects to each of these individual indicators would be insignificant, it's logical their additive effects to pool habitat would be insignificant as well. In these cases, indicator effects were analyzed but in a condensed manner.

Note on Formatting - In this draft the effects determination overall is NLAA, so in the interest of reducing the document size, we lumped the direct effects for both HUC10 watersheds in one section. The following habitat indicator effects discussion was broke out by the Twisp and Lower Methow Watersheds.

DIRECTE EFFECTS

No direct effects to listed fish would occur from the non-ARBO II treatments proposed because none of the commercial harvest, prescribed fire, NCT, and associated road work would occur in critical habitat streams or occupied bull trout or steelhead stream segments. Some non-ARBO II treatments are proposed within the outer edges of RRs associated with CH, but they are at distances that would prevent any direct effects to instream habitat indicators. No effects to individual fish or

designated critical habitat are expected. From this point forward, the analysis will only discuss potential effects that are indirect effects to CH.

INDIRECTE EFFECTS

Project Elements

To be consistent with the 2004 Analytical Process for Developing Biological Assessments for Federal Actions Affecting Fish With-in the Northwest Forest Plan Area (USDA et al. 2004), the non-ARBO II Mission Project activities were divided into the following Project Elements:

- Commercial Harvest, yarding, landings
- Non-commercial Vegetation Treatments
- Prescribed Fire (pile burning, machine piling, post-harvest slash pile burning)
    - Note – Controlled burning in RRs (aka - Underburning and associated fireline construction - only handline) is covered under ARBO II. Controlled burning in the uplands, outside of RRs, was determined to be a no effect to instream habitat indicators. According to the Analytical Procedures guidelines, when an activity does not change or impact the instream Habitat Indicators the effects can be zero or none. See discussion below on this.
- Transportation System Management (TSM)/Log Hauling/Temp Roads

Indicators not affected by the Proposed Action
The following Indicators have no causal mechanisms linking project elements to the respective indicator:

Chemical contaminants/nutrients: Harvest activities, harvest-related road actions, prescribed fire, and transportation system PEs do not propose to apply chemicals to streams or other water features. Standard mitigating measures include hazardous materials storage in durable containers, use of spill kits, equipment inspection and maintenance, as well as spatial separation of equipment and activities from waterbodies. The project does not propose to use any chemicals for dust abatement. Clayton and Kennedy (1985) investigated changes in nutrient budgeting and runoff in Idaho streams following timber harvest (primarily clearcuts) and describe significant losses in dissolved nitrogen from disturbed soils. They suggest that use of logging systems that minimize erosion and use adequate buffer strips should not cause unacceptable nutrient loss. Jurgensen et al. (1997) found similar results in investigating Inland Northwest timber harvest operations and noted the importance of carefully planned use of prescribed fire and mechanical site preparation when accomplishing forest management objectives. All re-fueling and fuel storage must occur outside of RRs. We do not expect any chemicals to enter streams and therefore, the effect would be zero.

Physical Barriers: Harvest activities, prescribed fire, and related transportation system changes would not create or remove any migration barriers to fish. No harvest or other treatment proposes felling trees in proximity to streams or creating any physical disturbance within the fish-bearing stream network. The restorative road treatments include aquatic organism passage projects (8 number of culvert upgrades), road decommissioning and hydrologic closure (number of culverts

removed) which will open six miles of potential habitat and improve the physical barrier indicator. Direct effects of AOP and culvert removal will be covered under ARBO II.

Off-channel Habitat: This habitat type is rare in these drainages due to steep channels. The few areas with off-channel habitat, it is created by backwaters and side-channels. While some work is proposed within the RRs, none of the activities analyzed in this BA would change habitat indicators to affect off channel habitat.

Refugia: For those reasons cited above for barriers and off-channel habitat, activities would not interrupt or disconnect existing refugia habitat. No effects to temperature are expected. ARBO II consistent projects would improve this by increasing habitat complexity and restoring fish passage.

Floodplain Connectivity: No activities are proposed in riparian corridors that would sever the floodplain from the stream channel, particularly in areas adjacent to fish-bearing waters and areas near CH. There may be instances in decommissioned road segments where road-fill removal increases floodplain connectivity at a small scale; however most of these upland streams are Rosgen A- and B-channels with minimal floodplain development.

Upland underburning/Fire Line Construction

Upland underburning treatments are located outside of Riparian Reserves and will have **No Effect** on TES fish species due to the following;

- Upland units and fire lines are located outside Riparian Reserves
- Fire-lines will consist of the existing road network and/or hand fireline (~2 ft. wide) with 2.6 miles of small dozer line (3-5' wide path) located outside of Riparian Reserves.
- A maximum of ~750 acres of underburning would be done in any one year, which is approximately 3% of the watershed annually.
- The Mission Aquatics Report states:

> *"Prescribed fire is used as a management tool by itself or in conjunction with thinning to reduce fuel loading and the risk of uncharacteristically large fires. The most effective way to reduce fire severity is forest thinning in conjunction with prescribed burning. Most prescribed fires are ignited under conditions that limit the potential for high severity fires, they have less of an effect on vegetative litter and soil organic structure, and result in a lower risk of erosion and changes in water yield and peak flows."*
>
> *"Potential direct and indirect effects to hydrologic processes and water quality from non-commercial fuels treatments and prescribed fire are mitigated through BMPs and standards and guidelines. These limit fire intensity and severity, ground-disturbing activities (including firelines), and retain adequate groundcover."*

- Delivery of runoff and sediment input to streams generally increases the closer an activity is to a stream. The distance runoff and sediment travels, depends on several factors, including dispersion and hillslope vegetation. If down slope hills are well vegetated, runoff and sediment rarely travel more than 100 feet (MacDonald and Coe 2007; Ketcheson and Megahan 1996).
- Therefore, based on the location (outside Riparian Reserves) of upland under burning units, the design criteria and BMP's, the intensity and duration of the treatments and the distance from streams, the upland underburning treatments would have No Effect to ESA listed fish species or their critical habitat.

Indicators remaining for analysis

The remaining habitat indicators for analysis are shown below. Indicators will be lumped for analysis since similar causal mechanisms link them as listed in the table below. For example: streambank erosion/failures contribute fine sediment to the stream network. Fine sediment that in-fills substrate interstices is a primary mechanism in which substrates become embedded.

Indicator analysis lumping strategy.

Habitat Indicators	Lumped group name	Rationale for lumping
• Temperature • Large Woody Debris	Temperature & Wood	Indicators linked with vegetation/tree cover in relation to stream
• Sediment • Substrate Embeddedness • Pool Freq. / Quality • Large Pool Quantity	Sediment & Pools	Indicators linked with fine sediment delivery to streams and pools
• Avg. Width/Depth Ratio • Streambank Condition	Streambanks & Channel Geometry	Indicators linked to streambank stability/erosion
• Change in peak/base flow • Drainage Network • Road Density/Location	Roads & Drainage Network	Indicators linked to road network
• Disturbance History • RRs • Disturbance Regime	Disturbance & RRs	Indicators linked with clearing and disturbance in RRs

<u>Prescribed Fire Adaptive Management Treatments</u>

The proposed adaptive management treatments allow the FS to achieve fuel objectives in the event smoke clearances are not given. Smoke clearance is becoming more challenging to get, making some prescribed fire objectives hard to achieve. Each of these treatments were assessed for their change (increase) in impacts over the primary proposed treatments. Adaptive treatments that would result in less impact (lower ground disturbance) than the primary treatment would not be analyzed through the indicators. Treatments that would cause greater impact would be analyzed. Table 44 lists the activities and proposed alternative treatments in RRs and whether they would be analyzed in detail or not.

Alt Treatment (Total Acres)	Primary Prescription (Acres RR)	Primary Acres RR	Change in Effects (Increased/Reduced)	Effects Analyzed?
Chipping (397)	HP - 122	Chip – 122	**REDUCED EFFECTS -** Chipping would be less effects with no ground disturbance. Equipment would remain on open roads and work off roads done by hand	No, the effects are less, the effects discussion will address HP burning
Machine Piling/Burning (1,028)	UB - 9	MP – 9	**INCREASED EFFECTS -** Machine piling would cause more soil disturbance and some compaction.	Yes, this will be vetted through the effects discussion.
Hand Piling/Burning (6,199)	UB - 263	HP - 263	**REDUCED EFFECTS -** Handpile burning would result in less risk to surface erosion to adjacent stream..	Yes, this will be vetted through the effects discussion.

Note - The below effects section is split out by sub-watershed.

Effects to Habitat Indicators – Twisp River Watershed

The Buttermilk Creek drainage is within the Twisp Watershed and analyzed in this section.

Twisp Annex Treatments

The proposed treatment would entirely be done by hand to remove understory ladder fuel vegetation. A no-treatment buffer of 50 feet and limiting trees cut to under 50-foot would preclude any shade trees being removed or wood recruitment loss. There would be no avenues for sediment delivery to the small streams. Therefore, this treatment would have no effects to the adjacent stream nor the Twisp River. This treatment will not be discussed further.

Water Quality

Temperature and LWD

Analysis of potential effects to temperature and wood are lumped because the primary mechanisms affecting them are similar – shade loss (temperature) and physical material loss (reducing wood recruitment) via removal of streamside vegetation and trees either by harvesting, thinning, mortality through fire, or other physical means of removal.

Effects to Temperature

Removal of shade producing trees and vegetation is the primary mechanism that affects stream temperature. PEs that could reduce shade along streams include commercial harvest, non-commercial thinning, prescribed fire, and the TSM such as removal of vegetation while opening closed roads, closing roads, and decommissioning roads.

Effects to Instream Large Wood and Future Recruitment Potential

The primary mechanisms by which instream large wood and future wood recruitment are affected is via removal of trees from the core inner zone of streams where they would otherwise senesce and fall into the channel. No proposed vegetation treatment PEs would remove instream wood, limiting potential wood impacts to just altering future wood recruitment and increases in wood loading.

PEs – Commercial Harvest (felling, landing, & yarding) and Non-Commercial Thinning Actions (ladder fuel and pre-commercial thinning) combined

Proximity: Of the 1,897 acres of commercial harvest proposed, 52 total acres are proposed within the outer portions of designated RRs. In the Buttermilk drainage, 8 acres are proposed across seven units (001, 008, 009, 013, 019, 022, 024). Units 22 and 24 are aspen release units located above an existing beaver pond and above the headwaters of Black Pine Creek. All other units are either adjacent to Black Pine Creek, EF Buttermilk Creek, or Buttermilk Creek. Each of these units are at least 150 feet away from the creek and use an existing road for the unit boundary. Part of the rationale for treating in the RR was to take the unit to a road and avoid building temporary roads. Site potential trees in the Mission Project area average 100 feet tall.

The project Forester estimates that very few new landings would be constructed. Approximately 1 existing landings within the RRs in the Buttermilk Creek drainage would be re-used, based on a historic average of about 1 landing per every 10 acres (8 acres of harvest). These would be located according to the guidelines in Appendix G. No new or existing landings would occur within any no-cut buffers established for timber harvest. Consequently, landings would only be located farther than 150-feet from streams, i.e. outside of the zone where nearly all temperature moderation and LWD recruitment comes from. Similarly, all yarding would occur at least 150 feet from any stream.

There are 668 total acres of non-commercial thinning within the outer portion of RRs and 255 acres are within the Buttermilk Creek drainage. NCT stream buffers are listed in Table 8 for adjacent streams, which include down to 25 feet on intermittent streams and 50 feet on perennial streams. For proximity to critical habitat, some units are within the RRs Buttermilk and EF Buttermilk Creeks associated with critical habitat.

There is no commercial harvest proposed within RRs associated with intermittent streams in the Buttermilk Creek drainage. All non-commercial thinning in RRs associated with intermittent streams, which would not affect stream temperatures due to the lack of water during the summer and fall months.

Probability: The probability of commercial, non-commercial thinning, yarding, or landings affecting stream temperature or wood recruitment in adjacent streams and critical habitat below ranges from zero to discountable.

Using the prescribed no-treatment buffers would either prevent or minimize impacts to the adjacent channel sufficient to result an extremely low probability of impacts to critical habitat. Studies reported in FEMAT (p. V-28, 29; USDA et al., 1993) as well as more recent work (Moore et al., 2005; Sridhar et al., 2004) indicate that shade mostly approached 100% effectiveness when harvest buffer widths were between 0.5 and 1 SPT (Mission Project area SPT is generally about 100ft). Another study cited by FEMAT reported buffer widths of at least 100 feet in western Cascade Mountains provide as much shade as similar undisturbed sites. Johnston and others (2011) report that over 90% of wood in similar streams in interior British Columbia was sourced within about 60 feet of stream channels. We expect the proposed buffer widths along perennial streams would maintain existing shade sufficient to not measurably affect water temperatures or wood recruitment levels along perennial streams. Additionally, managing the outer RRs (beyond 100 feet in perennial streams) for larger, more resilient species, is expected to result in slightly larger trees capable of

being delivered to the stream from greater distances, in time. Neither commercial nor non-commercial thinning along intermittent streams would affect temperature because they would be dry during the summer/fall periods.

The 7.9 acres of commercial thinning in RRs are along perennial streams with at least 150-foot no cut buffers. Buffers this wide would protect existing shade levels and wood recruitment and result in a zero effect to stream temperature and LWD. Similarly, the buffers would prevent any effects from yarding or a landing from affect these stream indicators.

Removing trees small diameter trees up to within 25 feet of intermittent streams during the NCT treatments would, temporarily, reduce wood recruitment to the adjacent channel. Non-commercial thinning would remove trees up to 8" dbh and this size's average height is 50 feet, but most trees cut would be less than 20 feet tall. It is important to note too that not all of the trees in this outer zone would be removed. Only the trees that lay within 15-30 feet of large trees would be removed while all the small trees outside of this range would remain. Subsequently, some trees removed from within 40-25 feet proximity of intermittent streams could otherwise potentially fall into the stream. The current instream wood loading of intermittent and minor tributaries within the Buttermilk sub-watershed is not known, due to few of the streams having been surveyed. However, personal observations of a few streams suggest that many streams have abundant wood loadings. The last riparian logging operations were in the late 80s and 90s, when there was little protection for riparian areas. Stream size would limit wood movement downstream. The small intermittent streams are first and second order channels with widths generally between 2-4 feet wide. Streams of this small size do not have the capacity to move medium or larger sized wood except during infrequent debris flow events. These events are rare and are extremely unlikely to occur in the project area. Furthermore, the wood would have to travel anywhere from several hundred feet to over a mile to critical habitat down streams with road crossings. Therefore, the chance of thinning small diameter trees along intermittent streams affecting wood levels in critical habitat would be extremely unlikely.

Element Summary: Removing commercial sized trees at least 150ft from and non-commercial trees to within 50 feet of perennial streams would not affect stream shade or wood recruitment. Small diameter thinning along intermittent channels to within 25 feet has potential to affect localized wood recruitment, but the potential for impacts downstream in critical habitat are discountable. Factors like an intermittent channel's low transport capacity and the presence of road crossings downstream substantially reduce the potential for wood movement. Therefore, the proposed commercial harvest would result in a **neutral (0) effect** to temperature **discountable negative (-) effect** to LWD indicators in critical habitat.

PEs – Prescribed Fire (hand, machine, Firewood Collection, and landing pile burning)

Proximity: The project proposes a total of 10,220 acres of prescribed fire, which includes 2,848 acres of hand pile, 736.2 acres of machine pile, and 187 landing pile burning. A total of 668 acres is proposed within RRs across the entire project area. Within the Buttermilk Creek drainage, there would be 137.4 acres hand piles (1.3 total acres burned) and 7.9 acres of landing piling (~0.1 acre total burning).

Table 8 and 12 define the pile burning buffers to adjacent streams. Hand pile burning would occur along critical habitat in Buttermilk and EF Buttermilk as well as Black Pine Creek and other fishless tributaries. No machine piling in RRs is proposed in the Buttermilk Creek drainage as a primary treatment. With 7.9 acres of commercial harvest, there would potentially be one landing pile total in RRs. Based on the numbers of landing piles of 1 per 10 acres, there would be ~1 landing pile with all the 8 acres. Landings would follow the criteria listed in Appendix G and would be on flat ground and would be at least 150 feet from any stream based on the unit locations.

Hand pile burning along intermittent channels does not have a mechanism to affect summer stream temperature because they are dry during the summer. Piles would be located at least 25 feet from adjacent intermittent streams and 50 feet from perennial streams.

Machine piling, as an adaptive management (AM) treatment, is proposed for unit 019 near Black Pine Creek and involves 1.3 acres in the outer edge of the RR. This unit is located 250 feet from Black Pine Creek at its closest point.

As an adaptive management strategy if smoke clearance were not achieved, the 110 acres of LFR/NCT would not underburned. Alternatively, these acres would be hand piled and pile burned using the same stream buffers described for LFR/NCT in Table 8.

All firewood collection would occur on ML2 or higher roads. Only downed, recently thinned wood or wood from landing piles would be available. This would follow the same guidelines and restrictions with normal firewood permits. No collection would occur in RRs.

Probability/Element Summary: Pile burning would not influence shade along perennial streams because all piles would be located at least 50 feet from perennial steams and fires rarely and only minimally spread outside of the pile boundary because they are burned with vegetation is moist and air temperatures are cool. Additionally, pile burning would not affect wood recruitment, because piles are built and burned away from trees. There would be zero probability of pile burning affecting stream shade or wood recruitment. We expect shade levels to be fully or near fully maintained on the two perennial streams treated next to. Wood recruitment into critical habitat would remain unchanged from pile burning including the adaptive management hand pile burning on the 110 RR acres. If machine piling is done in unit 019, we expect no affects to stream shade or LWD recruitment. The unit is well over the distance of 1-SPT from the creek. Therefore, proposed prescribed fire treatments would result in a **neutral (0) effect** to temperature and LWD.

PE – Transportation System Management and Log Hauling

The TSM PE includes road treatments and log hauling in association with the commercial harvest. Aspects of the TSM PE that could influence shade or LWD are removal of vegetation while opening closed roads (negative), closing roads long-term (positive), and decommissioning roads (positive). The little bit of temporary road construction occurs outside of RRs.

Proximity: Opening Closed Roads - A total of 0.8 miles of closed roads in RRs are proposed for log hauling within the Buttermilk Creek drainage. Of these roads, the 4300525 road is not drivable and has small diameter trees growing on the road prism. The last 40 feet of the road overlaps the outer edge of an intermittent stream RR. All other road segments (10 total) are currently drivable with

nothing more than ground cover. Road Decommissioning - A total of ~470 feet of riparian roads would be decommissioned. The other roads are on the outer edge of RRs, outside of the shade zone and wood recruitment. Road Closure – a total of 5.3 miles of roads would be put in long-term storage in Buttermilk Creek with timber harvest dollars. Of these, 0.5 miles occur in RRs with two stream crossings where vegetation would grow. These crossings are above a sub-surface reach so they lack the proximity for downstream impacts to temperature or LWD; however, from a watershed scale, this hydrologic closure leads to overall improvements.

Probability: The proposed closed roads only have two crossings on one tributary to EF Buttermilk Creek where they would allow vegetation to grow for at least 20-50 years. The stream goes sub-surface below the cross, having no ability to transport wood and would negate any increase in stream temperature. All other RR roads are on the outer edge would not affect shade or wood recruitment. Therefore, there is zero probability of any effect to temperature or wood loading in critical habitat. Riparian road decommissioning would put ~470 feet of road back into functional riparian over time. This would result in a slight increase in riparian function, but a measurable benefit to stream temperature and wood recruitment would be extremely unlikely.

Element Summary: Opening and closing roads would have no mechanism to affect shade or wood recruitment in critical habitat. Riparian road decommissioning would result in a small, inconsequential improvements to watershed processes. Therefore, the roads PE would result in a **neutral (0) effect** for opening closed roads and closing roads and a **discountable positive (+) effect** for RR road decommissioning to the temperature and LWD indicators.

Indicator Summary: The proposed treatments within RRs are not expected to measurably affect stream shade or wood recruitment to adjacent streams. Setbacks for harvest or other thinning activities, low severity burning, and the few road activities may result in small, localized reductions in shade, but it is not expected to rise to a measurable impact. Likewise, the benefits of riparian road decommissioning, under harvest funded work, is not expected to have measurable benefits in the long-term. We expect a **neutral (0) effect** to stream temperature and a **discountable negative (-) short-term** and **positive (+) long-term effects** to LWD indicator.

Habitat Elements

Suspended Sediment/Turbidity and Substrate Embeddedness and Pool Frequency & Quality and Large Pools

Analysis of potential effects to sediment and pools are lumped because the primary mechanism affecting pool quality and quantity is sediment (in terms of filling in pools or degrading their quality). LWD also plays a role, but the effects to LWD were assessed above with temperature and determined to be insignificant in the analysis such that risk of wood reduction/pool formation is not a concern.

Data available in this sub-watershed consist of Wolman Pebble Counts to get percentages of fine sediment on channel surfaces. NTU or IGDO measurements have not been collected in these watersheds. Both the proportion of fine sediment ($\leq$ 6mm) to larger class substrates will be used as a surrogate for overall sediment, gravel interstitial space, and embeddedness conditions. Each of the

PEs would disturb ground within RRs and are assessed for potential sediment impacts to critical habitat.

All commercial harvest and prescribed fire outside of RRs have no causal mechanism to deliver sediment to streams. Any soil disturbance would stay on or near the sites and would not reach any streams because soils are stable, overland flows are extremely rare, and remaining ground vegetation would trap any mobilized sediment. Non-commercial harvest would be done by hand and would not cause any ground disturbance. Additionally, the ~0.8 miles of new temporary road construction in the Buttermilk Creek drainage would occur outside of RRs and have no mechanism to deliver sediment. These activities would have no effect to the sediment habitat indicators. The following PEs occur in RRs and have potential to deliver sediment to streams and subsequently to critical habitat: commercial thinning, prescribed fire, and TSM activities.

PE – Commercial Harvest (felling & yarding) and Non-Commercial Thinning Actions (ladder fuel and pre-commercial thinning) combined

Proximity: About 9 acres of commercial harvest is proposed in the outer edge of RRs and would lie at least 150 feet from an adjacent stream. See description under effects to temperature and LWD for more details on locations. Disturbed soils associated with timber harvest would be a minimum of 150-feet from perennial streams. Landings within RRs, particularly new ones, would be avoided unless no other practical location exists. Some existing landings within RRs would be used, with the same no-treatment buffers. All skid trails would occur in the outer edges and involves no stream crossings.

There are 668 total acres of non-commercial thinning within the outer portion of RRs and 255 acres are within the Buttermilk Creek drainage. See Temperature and LWD for more proximity details.

Probability: All harvest in RRs would be have no-cut buffers of at least 150 feet. There are no draws between the riparian units and the associated streams. Therefore, the only mechanism for sediment to reach streams is from surface runoff via overland flow. Surface runoff over undisturbed ground generally permeates the soil and moves to stream channels via subsurface flow (Chamberlain et al. 1991). Additionally, Sweeney et al. (2014), who looked at buffer widths to prevent the delivery of suspended sediment to streams suggests 30-meter (98ft) buffers are necessary to prevent ultra-fine sediment from reaching streams. Based on this study, the lack of steep riparian gradients, the design criteria of equipment walking on slash on multiple pass skid trails, and the prescribed 150-foot buffers, the project fish biologist expects no fine sediment to reach adjacent streams. None of the proposed yarding would cross any streams. Therefore, the project fish biologist expects zero probability of any sediment delivery to adjacent streams or affecting the sediment or pool indicators.

NCT treatments would be done by hand and have no ground disturbance. Therefore, this treatment would have zero probability of affecting stream sediment levels.

Element Summary: With the prescribed150-foot buffers of undisturbed vegetation, slopes of 0 to 20%, high infiltration rates, using slash on multiple pass skid trails, and no stream crossing, there is no mechanism to deliver sediment to streams or affect pool habitat. Therefore, riparian thinning,

riparian yarding, and landings would result in a **neutral (0) effect** on the sediment and pool indicators in the Buttermilk Creek drainage.

PE – Prescribed Burning and Firewood Collection

Proximity: Prescribed burning activities would occur across broad areas of the Buttermilk Creek drainage, including within RRs. There would be 141 acres of hand piles (1.3 total acres burned) and 7.9 acres of landing piling (~0.1 acre total burning). See the proximity description under temperature and LWD on page 161 for more details on proximity of prescribed burning to streams and critical habitat. Machine piling is proposed as an adaptive management strategy if too much slash is left on the ground following harvest in unit 19, it would add an additional 1.1 acre of machine piling on ground less than 10% slope and over 250 feet from Black Pine Creek.

To re-iterate the reason for the prescribed fire treatments in RRS, the purpose of the hand pile and landing pile burning is to reduce unnaturally high fuel loading and to dispose of slash that would otherwise pose a fire risk. We expect ~1 landing in the Buttermilk Creek drainage.

All firewood collection would occur on ML2 or higher roads. Only downed, recently thinned wood or wood from landing piles would be available. This would follow the same guidelines and restrictions with normal firewood permits. No collection would occur in RRs.

As an adaptive management strategy if smoke clearance were not achieved, the 110 acres of LFR/NCT would not underburned. Alternatively, these acres would be hand piled and pile burned using the same stream buffers described for LFR/NCT in Table 8.

Probability: The project proposes to hand pile burn and landing pile burn within Riparian Reserves. Some of these activities have potential to deliver sediment to the stream network. Hand pile burning within Riparian Reserves associated with perennial streams would be at least 50 feet from streams. Additionally, the adaptive management hand pile burning would be at least 50 feet from perennial streams. Landing piles would be at least 100 feet from any stream. These pile-burning activities would have a zero probability of delivering sediment across 50 and 100 feet of undisturbed ground. There is more than a discountable probability of hand pile burning up to 25 feet from intermittent channels.

Firewood collection would have a zero probability of causing stream sediment delivery. All would occur outside of RRs and from open roads.

Magnitude: Handpile burning would occur along intermittent channels with pile burning up to 25 feet of the channel, both as proposed and as an adaptive management strategy. Hand piles are constructed at a density of 25 piles per acre with an area of 16 square feet. At this density (burned area per acre), less than 1% of an acre would be burned in the hand pile units. Pile burning rarely leaves the footprint of the pile because they are burned under moist and often damp conditions. Up to 25 feet of undisturbed ground cover would sit between the piles and adjacent streams. If fire stays at the pile in most cases, only a few would creep closer to the stream. Some bare soil closer than 25 feet could occur in a few occasions, but it would still be minor. A small potential for sediment to enter an intermittent stream on a few occasions is not likely to be measurable in fish

bearing streams down stream. When these streams are flowing, background sediment levels are higher and a slight increase would be immeasurable.

Element Summary: The project fish biologist expects some sediment induced from the proposed pile burning along intermittent streams would enter the stream network. The estimated magnitude would be immeasurable where occupied fish habitat exists and critical habitat, therefore insignificant. Design details and mitigation measures are expected to be successful in maintaining water quality standards. Therefore, proposed prescribed fire would result in an **insignificant negative (-) effect** to the sediment and pool indicators in Critical Habitat.

PE – Transportation System Management and Log Hauling

Roads within the project area represent the largest erosion source (bare soil) contributing sediment to streams. Sediment deposition into streams impairs aquatic habitat by filling in pools and affecting spawning habitat for salmonids. The most significant sources of road-derived fine sediment are stream crossings and along native surface roads and segments within 300 feet of stream (Ketcheson and Meghan, 1996).

The Buttermilk Creek drainage is steep and considered primarily a transport drainage for fine sediment. Stream surveys assessed project area fine sediment levels in 1992 (USDA 1992) and most recently in 2011 (USDA 2011c). In 1992, sediment levels in Buttermilk Creek and its major tributaries were assessed using an outdated method, but were found to be low. In 2011, the percent surface fines <6 mm were less than 12% and most at 10% or less. The limited data available suggest fine sediment levels in the major fish streams in Buttermilk are low and have been for quite some time. Low fine sediment levels are attributed to a few factors: high gradient and transport capacity, low road density (1.3 mi/mi^2), lower number of stream crossings (23), and the sub-watershed is generally in stable condition.

This PE consists of all proposed road activities associated with timber harvest, which includes pre-project road maintenance, log hauling, opening closed roads, temporary road construction, closing and decommissioning roads, road conversion to ML2 administratively closed, adding roads to the system, and changing ML. The range of actions would have positive and negative effects to the overall sediment budget within the project area. Table 45 summarizes the type of actions proposed, incorporated design criteria by reference, and expected effects to the sediment indicator.

Table 45. Summary of harvest related transportation action effects to sediment indicator.

Action	Design Criteria[1]	General effects to sediment
Pre-/post-haul maintenance	Nat. BMPs	Short-term, small ↑, long-term net↓
Temporary road construction	62	Short-term net 0, long-term net 0
Opening closed roads	Nat. BMPs	Short-term, small ↑, long-term net 0
Log Hauling	Nat. BMPs	Short-term, small ↑, long-term net 0
Hydrologic road closure (timber sale)	Oka-Wen F Rd Plcy, Nat. BMPs	Short-term, small ↑, long-term net↓
Road Decommissioning (timber sale)	63, 66, Nat. BMPs	Short-term, small ↑, long-term net↓
Stream crossing removal (timber sale)	WDFW MOU, ARBO II Nat. BMPs	Short-term, small ↑, long-term net↓
Adding Non-system Roads	64	Neutral 0 effect

Action	Design Criteria[1]	General effects to sediment
Changing ML	64	Neutral 0, long-term net↓
Summary effect		**Short-term, small ↑, long-term net↓**

[1]Presented in Appendix A.

The project fish biologist conducted analysis based on relative changes in metrics that would drive sediment production. For example, total roads within RRs or 300-feet of streams, or total stream crossings, by project stage would provide suitable indicators of relative changes that would be expected to affect sediment delivery. Design criteria, provisions from the WDFW-Forest Service MOU for hydraulic projects (USDA and WDFW 2011), and the USFS National BMPs for water quality (USDA 2012) are incorporated to mitigate the short-term effects of these actions. In a realistic implementation schedule, the project fish biologist expects several of these actions to occur simultaneously.

Proximity: Buttermilk Creek is designated critical habitat for steelhead, bull trout, and chinook at the mouth. EF Buttermilk Creek is critical habitat for bull trout only, though rainbow/steelehad are documented there and in lower Black Pine Creek. WF Buttermilk Creek contains bull trout critical habitat, but the harvest related work would occur outside of the RRs.

Table 46 displays the proximity of the proposed haul route/road maintenance associated with harvest to critical habitat. Log hauling would occur on about 19 miles across the Buttermilk Creek drainage, which includes 3.3 miles on a paved ML4 road and 4.6 total miles within RRs. The 4.6 riparian road miles includes 2.2 miles on a ML4 paved road, 1.6 miles on gravel, and 0.8 miles on closed roads opened for hauling. Proximity to critical habitat includes a stream crossing right over EF Buttermilk Creek (BT), (0 feet), one over Black Pine Creek (~400 feet), and one on a tributary to EF Buttermilk Creek (0.3 mi). The 4300610 road would have one small, perennial stream culvert removed after log hauling for conversion to a ML2 administratively closed. This road is located about 0.3 miles upstream from EF Buttermilk Creek. All others are over 1/2 mile upstream from critical habitat. Twelve stream crossings are on the proposed haul routes, but two of them are on a stream that goes sub-surface below (year around) and is not a concern for ESA impacts. Four crossings are on the paved road, which leaves 6 stream crossings on gravel or natural surfaced roads on non-critical habitat streams with surface connection to critical habitat. Pre-haul road maintenance would occur on ~15.5 miles and the project team estimates heavy maintenance/reconstruction could occur on 3.5 miles of closed roads. Heavy maintenance involves one stream crossing that flows subsurface downstream. All other heavy maintenance would occur on the outer edges of RRs or fully outside RRs.

As part of the timber harvest portion of the project, 0.9 miles of road will be decommissioned. This includes a few hundred feet on the outer edge of a RR along Buttermilk Creek with no stream crossings. All other decom is outside of RRs. No causal mechanisms exist for the harvest related decom to deliver sediment exist. About 5.2 miles of roads would be hydrologically closed post-harvest including two stream crossings. Both of these crossings are on a single stream that goes subsurface before it reaches critical habitat, so no mechanism to affect sediment levels.

Table 46. Proximity of road activities to critical habitat.

Log Haul/Road Maintenance Routes				**Timber Sale Funded Decommission/Closure**				**Unauthorized Roads Added**		**Road to ML2 Admin**	
Existing Access	Mi.	Stream Xings	Prox to CH*(BT & ST)	Dec. (mi)	Dec. in RR (mi) [# Xings]	Close (mi)	Closed in RRs (mi) [# Xings]	Prop ML	UA (mi)	Exist ML	ML2A Mi
closed	7	0	BT - 0.3mi/ST - >0.6 mi	1.3	320ft [0]	5.2	0.5 [2]	ML1	0	ML1	0.8
open/gravel	7.9	6	BT - 0.0/ST - >0.6 mi					ML2	0.1	ML2	1.2
open/paved	3.3	4	BT - <300ft/ST - <300 ft					ML3+	0	ML3+	0
temp	0.8	0	outside of RRs					NA	0	NA	0
Grand Total	19	10***		1.3	320ft [0]	5.2	0.5 [2]		0.1		2

* Stream miles.
** Two more exist, but on a single stream that goes sub-surface downstream with no avenue for effects to critical habitat downstream.

Probability: Road maintenance and log hauling is proposed on gravel and natural surfaced roads that cross over critical habitat and on tributary streams with surface connection. Additionally, the proposal is to convert the 4300610 road to ML2 Admin that has one perennial stream crossing. The removal of this culvert would temporarily add sediment to the stream system. These activities are likely to add some sediment to the stream network and that could reach critical habitat and affect fine sediment levels and pool habitat conditions.

Magnitude: The potential for road related sediment delivery to streams was not analyzed using any modeling. Alternatively, changes in road density, riparian road density, road drainage network, road-stream crossing density, and percent ground cover were used to analyze impacts to stream sediment levels for the nepa process. This method followed the Draft Okanogan-Wenatchee's Whole Watershed Restoration Procedures (USDA 2015) method for assessing changes in road metrics and their potential to alter sediment delivery. Through these analyses and proposed design criteria, the project hydrologist estimates the short-term sediment delivery potential as insignificant. The project fish biologist does not expect measurable increases in fine sediment in occupied and critical habitat Buttermilk Creek drainage from the proposed roadwork. Road generated sediment to streams is assumed to occur almost completely from stream crossings. This is consistent with Coe (2006) and (Wemple et al. 1996) who both found stream crossings to account for about 60% of all connected road segments and thus provide the dominant causal mechanism for sediment delivery to the stream network. Therefore, to reduce the magnitude of sediment effects to streams, the project addresses sediment delivery at six key road-stream crossings.

Pre- and Post-Haul Maintenance/Heavy Road Maintenance – The locations where initial maintenance could generate sediment delivery to streams are the 4300000, 4300500, and to a lesser degree the 4300610 roads. Each of these roads cross streams with surface connection to EF Buttermilk Creek and the 500 road crosses directly over EF Buttermilk Creek and near the bottom of Black Pine Creek. It is possible some sediment would enter the stream, but the project fish biologist expects it would be minimal and immeasurable. All maintenance work would follow National BMPs (USDA 2012) and use the following practices:

- Do not permit side casting of maintenance-generated debris within the RR to avoid or minimize excavated materials entering waterbodies or riparian areas.
- Avoid overwidening of roads due to repeated grading over time, especially where sidecast material would encroach on waterbodies.
- Use potential sidecast or other waste materials on the road surface where practicable.
- Dispose of unusable waste materials in designated disposal sites.
- Remove vegetation from swales, ditches, and shoulders, and cut and fill slopes **only when** it impedes adequate drainage, vehicle passage, or obstructs necessary sight distance to avoid or minimize unnecessary or excessive vegetation disturbance.

All road maintenance would occur during dry weather conditions. It would cease when road conditions are wet or during heavy rain events when water would run on the surface. During the contractor's pre-haul maintenance meeting, the Forest Service will emphasize the importance of not adding sediment to streams in general and, especially, at these stream crossings.

Heavy maintenance would occur on about 0.8 miles of RR roads including three stream crossings, but two of them have a long sub-surface reach downstream. The other one is located 0.3 miles upstream from critical habitat on a perennial stream. This creek flows through a wetland that is likely to trap most, if not all sediment coming down stream. Nevertheless, there is potential for sediment to reach WF Buttermilk Creek. Few studies have quantified the volume or duration of sediment delivery to streams from constructing or removing stream crossings. Foltz et al. (2008) monitored concentrations of sediment and turbidity, duration, and impact distance downstream during culvert removals on 11 stream crossings between two locations in Idaho and one in eastern Washington. They looked at stream crossing removals on perennial streams with drainage areas ranging in size from 8.4 acres up to 1,720 acres. Sediment measurements were taken at various distances up to 1/2 mile downstream of the culvert removal site. The 610-road crossing is 0.3 miles upstream from EF Buttermilk Creek, which is less than the 1/2 mile study distance. In the Foltz et al. (2008) study, sediment concentrations measured 1/2 mile downstream of the work site were similar to upstream conditions. Construction on the 610 road would follow normal BMPs like dewatering the work site, setting straw bales in the creek below, and working during the approved instream work window. The creek draining the culvert site has an estimated low flow of about 1.2 cfs and where it reaches EF Buttermilk, the flow is ~15 cfs or higher. The contribution of this small stream is a fraction of the flows in critical habitat. Based on these factors, the volume of sediment expected to reach EF Buttermilk Creek is likely to be immeasurable. None of the rest of the heavy maintenance roads has stream crossings.

Normal road maintenance needs on the 4300000 and 4300500 would be minor. These roads are ML3 roads with more frequent road maintenance. Forest Service road crew graded the 43 road this fall and it now has a good running surface. The project team anticipates minimal road maintenance

required on this road. The 4300500 road is in good condition as well and will only need minor surface maintenance. The 4300610 road will require more blading before log hauling. All other stream crossings are at least 1/2 mile from critical habitat. Following these design criteria like no side casting, working in dry conditions, the project fish biologist anticipates the road maintenance would result in insignificant short-term delivery of sediment the stream network and critical habitat.

Log Hauling - Log hauling can generate sediment delivery to streams. Log hauling outside of winter conditions would occur during the dry season, under dry conditions. Hauling would not occur when road conditions are wet or during heavy rain events when water is running on the surface. If roads become too dusty, water may be applied to keep the dust down and limit sediment from reaching streams. These measures are expected to reduce sediment generation from log hauling to insignificant levels. Proposed log hauling is unlikely to cause measurable increases of suspended sediment and turbidity in occupied or critical habitat. This is due to a combination of the proposed BMPs/Design Criteria, and the spatial separation of most other haul route crossings. Implementation of the log hauling would result in insignificant negative (-) effect to the sediment and pool indicators.

Conversion to ML2 Administratively Closed – Converting the 610 road to a ML2 Admin road involves installing drivable dips. This work would be done using normal design criteria of working in the instream work windows, de-watering the road crossing, and normal Road BMPs such as working in dry conditions. Sediment would enter the stream at a location about 0.3 miles upstream from EF Buttermilk Creek. The channel is small at this location and working in the fall, it is expected to be less than ½ cfs. In addition, the crossing has a shallow fill (<2ft). Therefore, the amount of sediment generated and delivered downstream would be minimal. This creek flows into a low gradient wetland that would trap some of the sediment, if not all of it. The project fish biologist expects the amount of sediment to reach EF Buttermilk Creek would be immeasurable.

Element Summary: Road maintenance, log hauling, and culvert work on the 4300610 road would cause some increases in sediment delivery. Project design and BMPs will be implemented to minimize sediment effects to occupied and critical habitat conditions. Short-term sediment impacts to streams and critical habitat is expected to be minor and inconsequential. In the long-term, the sediment reduction from hydrologically closing 1.3 miles of moderate risk roads would result in a net reduction in road-related sediment input overall, though minimally. The reduction in anthropogenic sediment delivered to the stream network would be a net beneficial effect to the sediment regime and pool habitat. The Buttermilk Creek sub-watershed will have reduced fine sediment delivery to critical habitat, but the reductions are likely to be immeasurable. During the project implementation, the short-term impacts from road maintenance, log hauling, and culvert work would have an **insignificant negative (-) effect** to the sediment and pool indicators in critical habitat. Following the project, the reductions would have an **insignificant positive (+) effect** to the sediment and pool indicators.

Indicator Summary: The project fish biologist expects the harvest/yarding PE to not result in any sediment delivery to streams based on the no-harvest buffer widths to adjacent streams. The fuels treatment and harvest related roadwork are likely to deliver some sediment to the stream system and collectively are expected to slightly increase fine sediment in EF Buttermilk and Buttermilk Creek. The restorative roadwork, as part of the timber sale, would result in little benefit to streams.

Overall, the collective short-term increase in sediment would remain immeasurable and inconsequential in critical habitat. Using the above described design criteria's and BMPs, sediment delivery would be kept to a minimum and insignificant. Therefore, these PEs combine to create an **insignificant negative (-) effect** to the fine sediment and pool indicators and similarly, an **insignificant positive (+) effect**.

Channel Condition and Dynamics

Streambanks and Channel Geometry (3)

PE – Felling, Yarding, Landings, and Thinning Actions (LFR and NCT)
Timber felling, yarding, and thinning actions occur spatially distant (from 150 feet or more during commercial treatments) and have no causal mechanism to affect the habitat indicators. There may be potential for upland-sourced fine sedimentation to change channel geometry via sedimentation; however, the analysis of the sediment indicators found that that magnitude of short-term increases would be much less than those sufficient to measurably aggrade the channel miles downstream. This PE would have a **neutral (0) effect** to streambanks and channel geometry.

PE –Prescribed burning
Prescribed fire treatments generally occur spatially distant from streambanks. All pile burning would occur away from stream channels and little risk of fire creep. Analysis of the sediment delivery from project activities found that sediment would have a slight increase in sediment – but of small magnitude not likely sufficient to measurably aggrade a channel or change its width:depth ratio. This PE would have a **neutral (0) effect** to streambanks and channel geometry.

PE – Transportation System Management
Streambanks are generally only affected where changes to road-stream crossings occur. No other project action would directly affect streambanks, particularly at the sub-watershed scale.

Proximity: The 4300610 road-stream crossing is 0.3 miles upstream from EF Buttermilk Creek. Two other road crossings would be removed on the 4300615 road after harvest as it is hydrologically stored. These crossings have an 800 feet subsurface section downstream. The following points summarize road/stream crossing management:

- Temporary stream crossings installed during temporary road construction – zero, all temp roads outside of RRs.
- Temporary stream crossings installed during log yarding – zero
- Temporary stream crossings installed/used on currently closed ML-1 and unauthorized roads used for project - 1. The crossing on the 4300610 road already has a culvert and the 615 road has one crossing with culvert and one without. The subsurface section below would disconnect any impacts to critical habitat downstream.
- Crossings removed under the timber sale – 3, with two disconnected hydrologically.

There is no spatial or temporal overlap between PEs affecting streambanks and actual streambanks associated with critical habitat. There may be potential for upland-sourced fine sedimentation to change channel geometry via sedimentation; however, the analysis of the sediment indicators found that the magnitude would be insufficient to measurably change channel process/geometry. In the

long-term, the proposed road treatments would result in a reduction in fine sediment delivery, though its expected to be immeasurable as well. Due to the lack of impacts downstream and proximity, this PE would have a **neutral (0) effect** to streambanks and channel geometry.

Element Summary: Streambanks would be disturbed at three sites across the Buttermilk Creek drainage when the harvest road crossings are installed or removed. All of these sites are outside of critical habitat where some localized bank disturbance would occur. However, impacts at those sites would not affect bank stability in critical habitat. Local effects would be small, short-lived, and include positive and negative effects. Streambank stability is very high and W:D ratios are within expected ranges, suggesting they are not easily degraded. In all cases, the PEs are above listed fish habitat and two above a long subsurface reach. Incorporation of standard BMPs and WDFW-Forest Service MOU design criteria will mitigate local effects of sedimentation to small magnitudes at the site scale, such that downstream changes in the sediment yield would be insignificant and not capable of measurably aggrading or degrading the channel. Based on these findings, we expect that there would be **neutral (0) effect** to the streambank stability and width:depth ratio indicators.

Flow/Hydrology

Roads and Drainage Network, Road density and Changes in Peak/Base Flows

The Increased Drainage Network, Road Density/Location, and Change in Peak/Base Flows were lumped together because forest roads are believed the primary anthropogenic agent influencing stream flow relating to water quantity. Forest roads artificially increase the drainage network in a watershed. As an example, Wemple (1996) documented a substantial increase in drainage network from the road network in a forested watershed in western Oregon, which has shown to increase peak flows (Jones et al. 2000). In the Buttermilk Creek drainage, there is an estimated 10.4 miles of artificial drainage network from the road network, which amounts to ~15% increase in the drainage network. Road density in Buttermilk is relatively low at 1.4 mi/mi2, which is the primary factor in lower drainage network. Because of the increased drainage network, the project fish biologist assumes the road drainage network has altered peak and base flows to some degree. Commercial harvest can effect runoff and is discussed below, but the assessment concludes it would have an insignificant effect to peak and base flows.

PE – Commercial Felling, Yarding, Landings, and Thinning Actions (LFR and NCT)
This would not affect water yield in any measurable way from vegetation cover removal. There are no clear-cut or regeneration harvest acres proposed in this sub-watershed. A few different commercial thinning prescriptions are proposed across 575 acres in Buttermilk, which represents less than 3% of the drainage. When less than 25% of a watershed is harvested, no detectible change in peak flows have been observed (Stednick 1996, NOAA Fisheries Memorandum 2005). The commercial harvest would only result in a negligible impact to peak flows and baseflows. Felling and thinning actions lack causal mechanism to affect road or drainage network indicators. All skid trails are located outside of all RRs. Landings are the only activity that could alter the drainage network.

<u>Landings</u>
Proximity: Based on commercial unit layout, all harvest would be at least 150 feet or further from any stream and would use existing roads as lower boundaries.

Probability: It is certain that landings would be used within RRs potentially affecting the drainage network.

Magnitude: Potential impacts to aquatic habitat associated with the drainage network are most pertinent within 300-feet of streams (Ketcheson and Meghan 1996), thus actions in these areas are the focus for analysis of magnitude. It is estimated that a landing is needed for about every 10 acres of harvest units, with some deviation due to local conditions, volume available, etc. Across the project area there are about 9 acres of harvest unit within 300-feet of streams (including perennial and intermittent channels). Using the ratio of one landing per every 10 acres of harvest, we estimate there may be about one landing used within 300 feet of streams. The project forester has identified existing landings during partial layout thus far and expects there to be very few new landings created, less than 10% of landings are likely to be newly-constructed landings, all of which would be within harvest setbacks of at least 150 feet from streams. Landing use and creation would be subject to design criteria in Table **Error! Reference source not found.**8, BMPs in the National Core BMPs, RR Standard and Guidelines, and additional project-specific guidelines shown in Appendix G, and intended to control erosion and potential for storm runoff and require post-used restoration. We expect the actual new ground disturbance (compaction) to be very small, resulting in slight temporary increases in drainage efficiency, comprising an **insignificant negative (-) effect** to the drainage network indicator. Similarly, the vegetation treatments would have **insignificant negative (-) effect** to the Changes in Peak/Base flows, respectively.

Element summary: Overall, we expect that the magnitude of this PE's effects to the road/drainage network indicator to be insignificant and temporary as measured at the sub-watershed scale. Nearly all landings used in the project already exist. Where these existing landings do not meet design criteria intended to protect erosion and water quality, they would be brought into acceptable specifications or not be used. We expect the drainage network would be increased negligibly from the few landings in RRs. These effects would be short-lived (1-2 years) and would be well-mitigated via use of design criteria and current BMPs for the protection of water quality. We expect that there would be non-measurable, **short-term negative (-) effects** (insignificant overall magnitude) to road and drainage network indicators that would return to pre-project conditions after 2-3 years based on projected vegetation recovery expectations.

PE –Prescribed burning

Pile burning in forested watershed not demonstrated any impact on water yield on-site or downstream. Proposed fuels treatments do not propose any opening or closing of roads or trails. As a result, the Fuels Treatment PE would have a **neutral (0) effect** to the roads and drainage network indicators and to peak or base flows.

PE – Transportation System Management

Proximity/Probability: The project does not propose any new permanent roads. All of the 0.8 miles of new temporary road, within the Buttermilk Creek drainage, would be located outside of RRs. The project would open up 8.3 miles of closed roads for log hauling that includes 0.8 miles within RRs. About 1 mile of these roads would be decommissioned and 5.3 miles hydrologically closed via commercial harvest. Additionally, the project would bring closed and open unauthorized roads onto the NF System, close currently open system and unauthorized roads, and decommission roads. Each of these has different combinations of negative/positive effects to the drainage network. See

proximity discussion under Temperature/LWD and Sediment for more details on locations. These activities would change the road drainage network and road densities and could affect peak flows.

Roads within proximity to streams are the most concern in affecting aquatic habitat and water quality and therefore, the BA provides an analysis of closed and open RR road mileage, including NFS and unauthorized roads, by project stage (Table 47). Additionally, this analysis includes Buttermilk drainage road density (Table 48) across project phases and a comparison of the number of road-stream crossings by project phases (Table 49).

Magnitude: Overall, road density and drainage network would have a trivial increase during the timber harvest phase of the project, thereby having an insignificant effect to changes in peak and base flows. The project would construct 0.8 miles of new temporary roads, but they would be located outside of any RRs. Opening 8.3 miles of closed roads for log hauling would improve their drainage efficiency, but many of these roads are already drivable so the change would be negligible. Within RRs, 0.77 miles would be opened for log hauling but most of these are already drivable (~0.7 miles). The amount of roads within RRs would not change during harvest road use, just the amount of open roads. Increase in drainage network is estimated to be negligible. Construction of 0.8 miles of temporary in the uplands, outside of any RRs, would increase road density by 0.02 miles per square miles or by 1% (Table 48). Combined, these changes would amount to small localized increases in drainage area where ML1 or closed unauthorized roads are re-opened for short periods (<1y) and then a negligible net-negative road drainage network with the harvest road roadwork. Following the harvest related roadwork portions of the project, the net road network is reduced by about 0.9 miles with decommissioning and 5.2 miles of hydrologic storage. This includes a reduction of about 0.1 mile of RR road as shown in Table 47 under Post Harvest. Additionally, the restorative roadwork with the harvest would remove two crossings, making direct improvements reducing the drainage network (Table 49).

Streams within the Buttermilk Creek drainage are generally in stable conditions, with adequate vegetation to protect banks and dissipate stream energy. Streambank stability in mainstem Buttermilk, WF Buttermilk, and EF Buttermilk Creeks were greater than 90% in 2011 (USDI 2011). Anticipated changes in stream flow due to changes in road density (+1%) and drainage network (negligible) would not measurably affect peak or base flows during harvest or from the harvest related restoration roadwork.

Table 47. Mission RR roads – Riparian Road Mileage by Project Phase. Green shows roads only used and treatments done associated with harvest funded work.

Road Status	Exist. Cond. (All Roads)	Exist. Cond. (Haul Routes Only)	Harvest Phase (Haul Routes Only)	Post-harvest (Haul Routes Only)	Post-Harvest (All Roads)
ML4 – Comfort	2.19	2.19	2.19	2.19	2.19
ML3 – Pass. Car	1.99	1.59	1.59	1.59	1.99
ML2 – High-clearance	0.67	0	0.77 (ML1>ML2)	0	0.99
ML1 – Closed	1.94	0.68		0.51	0.72
Unauthorized	0.62	0.09			
ML2 - Admin				0.17	0.47
Decommissioned				-0.09	-1.05
All Roads	7.41	4.55	4.55	4.46 (-2%)	6.36 (-14%)

Table 48. Mission Road Densities by Project Phase. Green shows road changes from just harvest funded road work. ML1 roads are counted a roads present during the density calculations.

Sub-watershed	Current road mileage and sub-watershed square miles		Road Densities (mi/mi²)			
			Prior to Implementation	During Implementation	Post-Harvest Implementation	Post All Treatments Implementation
Buttermilk	54.4	37.1	1.47	1.49 (+1%)	1.42 (-3%)	1.19 (-19%)

Table 49. Mission Road-Stream Crossings by Project Phase. Green shows road changes from just harvest funded road work.

Sub-watershed	# of Stream Xings	During Implementation	Post-Harvest Implementation	Post-Harvest Treatments	Post All Treatments Implementation	Post All Treatments
Buttermilk	20*	20	18 (-10%)	2 > ML1 crossings removed	14 (-30%)	4>Decom, 2>ML1

*This value conservatively assumes all closed roads have culverts in place.

Element summary: Based on the slight increases to road density and riparian road drainage, the project would have a short-term minor negative impact to these metrics (1-3 years) and to peak and base flows. Following the post-harvest road decommissioning and road closure, two crossings (~10%) would be removed. The restorative roadwork, albeit minor, would result in a long-term positive (+) effect via reductions in the overall road network. The post-project road decommissioning and closures would all provide further movement towards restoration for the project area drainages. Incorporation of current unauthorized roads would provide the opportunity for road maintenance and associated improvements to road-related hydrological conditions that exist with currently no maintenance. Overall, the reduction of the road network across the Buttermilk Creek drainage would be 0.9 miles from the harvest related work and a total of 9.3 miles once the project is completed. Note - the net in change in RR road mileage is minor at 0.09 miles. The 0.9 miles, though not reflected in the above tables, is the overall net change in road mileage associated with timber harvest. These reductions will also allow the roads program to better focus shrinking maintenance budgets on roads that needed, thus reducing their effects. The proposed harvest-related road activities would result in a **short-term insignificant negative (-)** and **long-term insignificant positive (+) effect** on the Drainage Network, Road Density, and Changes to Peak/Base Flows.

Indicator summary: The harvest, prescribed fire, and road management PEs would change the drainage network slightly. There will some minor short-term negative for the drainage network, as skid trails will compact some soils and while firelines exist, but mitigation measures will effectively decouple this disturbance and potential for rill development from the stream network. Temporary road construction, management, and hauling will have an inconsequential negative short-term on the drainage network. Long term, road management activities associated with this project will minimally reduce the total size of the drainage network associated with roads by slightly reducing road density from 1.47 to 1.42 mi/mi^2. Included in this would be the removal of two stream crossings (10% of total) and likely multiple ephemeral draw culverts, resulting in a decrease of the dominant link between roads and streams. The magnitude of change resulting from these improvements would be a **short-term insignificant negative (-) effect** and a **long-term insignificant positive (+) effect** in the long-term for these indicators.

Watershed Indicators

Disturbance History

The project proposes to harvest timber on 1,897 acres total with 575 acres within Buttermilk Creek sub-watershed. Harvest related roadwork would have a slight net decrease in road density (0.05 miles/square mile). About 413 acres of treatments would occur in RRs ranging from commercial harvest, non-commercial thinning, and prescribed fire and restorative road treatments all with the objective of improving conditions in presently overstocked stands with high densities, reducing wildfire risks, and reducing sediment sources. Vegetation and prescribed fire related activities would have insignificant negative and positive effects. The analysis of effects to the peak flow indicator determined the proposed timber harvest would not result in measurable changes in peak and base flow volumes. Consequently, there would be an **insignificant negative (-) effect** and a **long-term insignificant positive (+) effect** in the long-term to the disturbance history.

Riparian Reserves

The proposed vegetation treatments in RRs include 9.3 acres of commercial harvest and 668 acres of non-commercial thinning. Prescribed fire includes 137.4 acres of pile burning in RRs. As an adaptive management proposal, 1.3 acres of machine piling would occur over flat ground and up to 110 acres of hand piling and pile burning on the proposed underburning RR acres. Harvest and other actions would occur within outer bands of RRs, in areas not described as riparian or wetland, either in soil- or vegetation-type. Setbacks would be sufficient to protect key habitat elements including provision of shade/ maintenance of temperature, recruitment of large woody debris, wildlife connectivity, and buffering capacity for overland transport of fine sediment or other contaminants. Overall, we expect the Commercial Harvest and Prescribe Fire PEs to result in a temporary **insignificant negative (-) effect** to the Riparian Area indicator and have **no effect** to RRs or off-forest riparian areas associated with ESA-listed salmonids. In the long-term, the project would have a **long-term insignificant positive (+) effect** in the long-term to RRs.

Disturbance Regime

The proposed timber harvest, prescribed fire, and road construction activities would result in insignificant effects the disturbance regime. The proposed 255 acres of vegetation and prescribed fire treatments occur on less than 1/10 of the total RR acres. Half of these acres are light treatments (non-commercial thinning and handpile burning). The prescribed no treatment buffers would protect stream conditions and fish habitat. Temporary road construction, management, and hauling will have an inconsequential negative short-term on the drainage network. Long term, road management activities associated with this project will move the project area towards a more stable condition, albeit the improvements would be negligible. The magnitude of change resulting from these improvements would be a **short-term insignificant negative (-) effect** and a **long-term insignificant positive (+) effect** in the long-term for the disturbance regime indicator.

<u>Effects to Habitat Indicators – Lower Methow River Watershed</u>

The Libby Creek drainage is within the Lower Methow River Watershed and analyzed in this section.

Water Quality

Temperature and LWD

Analysis of potential effects to temperature and wood are lumped because the primary mechanisms affecting them are similar – shade loss (temperature) and physical material loss (reducing wood recruitment) via removal of streamside vegetation and trees either by harvesting, thinning, mortality through fire, or other physical means of removal.

Effects to Temperature
The primary mechanism by which stream temperature is affected is the removal of shade producing trees and vegetation. PEs that could reduce shade along streams include commercial harvest, non-commercial thinning, prescribed fire, and the TSM such as removal of vegetation while opening closed roads, closing roads, and decommissioning roads.

Effects to Instream Large Wood and Future Recruitment Potential
The primary mechanisms by which instream large wood and future wood recruitment are affected is via removal of trees from the core inner zone of streams where they would otherwise senesce and fall into the channel. No proposed vegetation treatment PEs would remove instream wood, limiting potential wood impacts to just altering future wood recruitment and increases in wood loading.

PEs – Commercial Harvest (felling & yarding) and Non-Commercial Thinning Actions (ladder fuel and pre-commercial thinning) combined

Proximity: Of the 1,897 acres of commercial harvest proposed, 1,322 acres are proposed in the Libby Creek drainage. Within RRs in the Libby Creek drainage, 44.1 acres are proposed across 12 units (047, 048, 050, 053, 054, 055, 056, 057, 064, 065, 066, 078, and 079). Units are located along upper Smith, Hornet Draw, Chicamun, Ben Canyon, and SF Libby Creeks. Units 047, 048, 050, 057, and 064 are along perennial streams or stream reaches and have at least 100 feet no-treatment buffers. The other units are along intermittent streams or reaches and follow the no-treatment buffers listed on page 27. Units 053, 054, 055, 056, 057, 064, 065, 066 are units with the objective to increase hardwood production for beaver release. The other units have the objective to improve forest health along streams. Part of the rationale for treating in these RRs for some units was to take the unit to a road and avoid building temporary roads. Heavy equipment use would not occur in perennially wet areas or in mesic vegetation areas. Most machinery use in RRs would be during winter (73%) over frozen ground or an equally low impact method. Overall, about 2% of RRAs would be managed for commercial thinning across the Libby Creek drainage area, with nearly all conducted during winter (89%).

No commercial harvest would occur in RRs associated with steelhead critical habitat and the closest bull trout and spring chinook critical habitat is ~5 miles downstream in the Methow River. The closest riparian unit to critical habitat is in Hornet Draw at ~0.3 miles upstream with a road crossing between. Unit 050 is on the outer 50 feet of the SF Libby Creek RR, which is assumed to have steelhead rearing.

There are 668 total acres of non-commercial thinning within the outer portion of RRs and 413 acres are within the Libby Creek drainage. Table 8 lists the prescribed stream buffers for adjacent streams, which include down to 25 feet on intermittent streams and 50 feet on perennial streams.

Libby Creek contains both critical habitat and ESA listed fish species. Steelhead critical habitat extends up to 3.4 miles to the confluence with Smith Canyon Creek. Steelhead and an occasional bull trout are assumed to extend up to natural barriers in NF and SF Libby Creek. Juvenile chinook have been documented up to RM 2.5. Steelhead spawning habitat, based on past redd surveys and stream gradient, is believed to primarily occur up to RM 6.4. Bull trout and chinook are assumed to not spawn in Libby Creek.

Units 078 and 079 occur on upper Smith Canyon Creek with an approximate 2.5-mile sub-surface reach below these units before picking up again. There would be no potential for any impacts to stream temperature, LWD, or any other downstream impact from treatments in these RRs and they will not discussed further.

The hand piling/pile burning adaptive management strategy for the underburning would have the same vegetation treatment, just the slash disposal would be hand piled and burned. The stream buffers prescribed in Table 8 for LFR/NCT would apply to the adaptive hand piling/pile burning acres in RRs.

Probability: The probability of commercial or non-commercial thinning affecting stream temperature or wood recruitment in adjacent streams and critical habitat below ranges from zero to discountable.

Using the prescribed no-treatment buffers would either prevent or minimize impacts to the adjacent channel sufficient to result an extremely low probability of impacts to critical habitat. Studies reported in FEMAT (p. V-28, 29; USDA et al., 1993) as well as more recent work (Moore et al., 2005; Sridhar et al., 2004) indicate that shade generally approached 100% effectiveness when harvest buffer widths were between 0.5 and 1 SPT (Mission Project area SPT is generally about 100ft). Another study cited by FEMAT reported buffer widths of at least 100 feet in western Cascade Mountains provide as much shade as similar undisturbed sites. Johnston and others (2011) report that over 90% of wood in similar streams in interior British Columbia was sourced within about 60 feet of stream channels. We expect the proposed buffer widths along perennial streams would maintain existing shade sufficient to not measurably affect water temperatures or wood recruitment levels along perennial streams. Additionally, managing the outer RRs (beyond 100 feet in perennial streams) for larger, more resilient species, and increased hardwood component, may result in slightly larger trees capable of being delivered to the stream from greater distances, in time. Neither commercial nor non-commercial thinning along intermittent streams would affect temperature because they would be dry during the summer/fall periods.

The proposed commercial harvest acres in RRs would fully protect stream shade and mostly protect wood recruitment to adjacent streams. Of the 44.1 acres of harvest in the Libby Creek drainage, 19 acres occur along perennial streams with at least 100-foot or 1–SPT no-cut buffers. Buffers of this width would protect existing shade levels and would protect all onside wood recruitment. Thinning along intermittent streams would not affect temperature because they would be dry during the summer/fall periods. The other 25.1 acres of harvest in RRs occurs along intermittent streams. An

internal no-treatment buffer would be used based on slope gradient described in the project description. Most of these 25.1 acres (22.3) do not have a road as the lower boundary and is where the effect to recruitment would take place. Unit 66 along Hornet Draw boarders a road and if a tree were to fall towards the stream it would be cut out because it would block the road. The remaining 22.3 acres have no road bordering the unit and were further analyzed to identify approximate buffer widths. Most of these acres (20.7), occur along Chicamun Creek where the goal is to increase hardwood and shrub species for future beaver release. Here the proposal is for normal equipment buffers listed on page 27, but additional trees would be removed that can be reached from the 50 and 75-foot buffers. The intent here is for greater openings and increase growth of hardwoods and shrubs. In-stream wood levels were assessed in this creek in 2016 and over 100 pieces per mile were counted. Additionally, some wood in this zone will be felled towards the creek and left on site.

To assess wood recruitment changes, the RR side slope percentages were assessed to define impacts to on-site wood recruitment. Of the 22.3 RR harvest acres, 17.3 acres would have 50-foot no-cut buffers and 5 acres with 75-foot buffers based on RR slope percentages. Considering some wood would be removed up to within 25 and 50 feet from these equipment buffers along Chicamun Creek, some wood would be removed that is within ¼ of a site potential tree. According to the literature (FEMAT 1993 and Liquori et al. 2008) on buffer widths for wood recruitment, harvesting trees within the outer half to 3/4 of 1-SPT (50-100 feet) RR width would result in maintaining around 40-70% of the potential wood recruitment and within would remove some trees within the zone that generally supplies 25-60% of on-site recruitment. To off-set this loss, some trees would be felled towards and into Chicamun Creek or girdled and left on site to fall down naturally. Additionally, current wood loading in Chicamun Creek is considered properly functioning. Nonetheless, there would be some recruitment loss from the riparian thinning along intermittent streams. Effects to wood levels in fish bearing streams and down on critical habitat is extremely unlikely. Chicamun Creek has a bank full width of about 10 feet and it would be incapable of transporting medium to large sized wood except for extreme floods. Two permanent road-stream crossings exist downstream that further reduce the potential for wood transport. These factors coupled with the abundant wood in the channel now with more being added, there would be no loss in wood loading or reduction below properly functioning condition on site. Therefore, the impact to downstream wood loading would be discountable. The few other intermittent harvest units occur in upper Smith Canyon Creek with no stream connection to Libby Creek and along Hornet Draw Creek. that creek has a bank full width of 6 feet, is low gradient (~4%) and has a level 3 road crossing downstream. Removal of wood from this are will not influence wood loading Libby Creek either.

Removing trees small diameter trees up to within 25 feet of intermittent streams would, temporarily, reduce wood recruitment to the adjacent channel. Non-commercial thinning would remove trees generally up to 9” dbh and this size’s average height is 50 feet, but most trees cut would be less than 20 feet tall. It is important to note that not all of the trees in this outer zone would be removed. Only the trees that lay within 15-30 feet of large trees would be removed while all the small trees outside of this range would remain. Subsequently, some trees removed from within 40-25 feet proximity of intermittent streams could otherwise potentially fall into the stream. Current instream wood loading is incompletely known, but the few streams inventoried or observed appeared to have abundant wood. The last riparian logging operations were in the late 80s and 90s, when there was little protection for riparian areas. Stream size would limit wood movement downstream. The small intermittent streams adjacent to the non-commercial units are first and

second order channels that lack the energy to transport 20 to 50-foot long wood pieces. Furthermore, the wood would have to travel anywhere from 1.5 stream miles to over six miles to critical habitat down streams with road crossings. Therefore, the chance of thinning small diameter trees along intermittent streams affecting wood level sin critical habitat would be extremely unlikely.

The probability of shade loss and associated stream temperature increases or reduced large woody debris recruitment (especially in terms of instream wood volumes) from the proposed tree harvest and non-commercial thinning actions is discountable. Proportionately, about 2% of RRs would be managed for commercial thinning and 18% managed for non-commercial thinning across the Libby Creek drainage area.

Element Summary: Removing commercial sized trees ≥100ft and non-commercial trees ≥50 feet of perennial streams would not affect stream shade or wood recruitment. Small diameter thinning along intermittent channels ≥25 feet has potential to affect localized wood recruitment, but the potential for impacts downstream in critical habitat are discountable. Factors like an intermittent channel's low transport capacity and the presence of road crossings downstream substantially reduce the potential for wood movement. Current instream wood volume in these channels adequate. Therefore, the proposed commercial harvest would result in a **neutral (0) effect** to temperature and **discountable negative (-) effect** to LWD indicators in critical habitat.

PEs – Prescribed Fire (hand, machine, and landing pile burning)

Proximity: The project proposes a total of 10,220 acres of prescribed fire, which includes 2,442 acres of hand and machine piling within the Libby Creek drainage. Based on the number of acres of harvest, there would be ~132 landing piles equaling about 13.2 total acres of landing pile burning. A total of 252.7 acres of prescribed fire is proposed within RRs with the following treatment breakdown: 250.7 acres of hand piles (~2 total acres burned) and 1.8 acres of machine piling, and 44.1 acres of landing piling (~0.4 acre total burning).

Table 8 and 12 define the pile burning buffers to adjacent streams. Hand pile burning would occur along critical habitat in Libby Creek as well as upstream in occupied steelhead habitat. An estimated 13.6 acres of handpile burning would occur in RRs along critical habitat and about 110 acres would occur along NF Libby, SF Libby, and mainstem Libby Creek where rainbow/steelhead are present. All others occur in along tributaries to these larger fish streams. Machine pile burning would occur in one unit, in the outer 50 feet of a 300-foot wide RR along NF Libby Creek. This section of Libby Creek averages 10% gradient, which is close to or above suitable gradient for steelhead (Sheer et al. 2009 & Burnett et al. 2007). As an adaptive strategy, unit 064 along Hornet Draw Creek would include machine piling on flat ground with a road as the unit boundary. This unit would occur at least 100 feet from Hornet Draw. The proposed ~44 acres of timber harvest in RRs would have ~four landings total, which would occur mostly along Chicamun Creek. Landings would follow the criteria listed in Appendix G and would be on flat ground and would be at least 100 feet from any stream based on the unit locations and existing roads.

All prescribed fire treatments along intermittent channels do not have a mechanism to affect stream temperature because they are dry during the summer.

Machine piling, as an AM treatment, is proposed for unit 64 near Hornet Draw Creek and involves 7.6 acres in the outer edge of the RR. This unit, where machine piling would occur, is located 150 feet from the creek at its closest point. Slopes in this unit are nearly flat. The hand piling/pile burning adaptive management strategy for the underburning of ~153 acres in RRs be hand piled and pile burned using the same stream buffers described for LFR/NCT in Table 8.

Probability/Element Summary: Pile burning would not influence shade along perennial streams because all piles would be located at least 50 feet from steams and fires do not spread outside of the pile boundary. Additionally, pile burning would not affect wood recruitment, because piles are built and burned away from trees. There would be zero probability of pile burning affecting stream shade or wood recruitment. We expect shade levels to be fully or near fully maintained on the two perennial streams treated next to. Wood recruitment into critical habitat would remain unchanged from pile burning including the adaptive management hand pile burning on the 153 RR acres. If machine piling is done in unit 64, we expect no affects to stream shade or LWD recruitment. The unit is well over the distance of 1-SPT from the creek. Therefore, proposed prescribed fire treatments would result in a **neutral (0) effect** to temperature and LWD.

PE – Transportation System Management and Log Hauling

The TSM PE includes road treatments and log hauling in association with the commercial harvest. Aspects of the TSM PE that could influence shade or LWD are removal of vegetation while opening closed roads (negative), closing roads long-term (positive), and decommissioning roads (positive). The little bit of temporary road construction occurs outside of RRs.

Proximity: Opening Closed Roads - A total of 2.1 miles of closed riparian roads are proposed for opening up for log hauling within the Libby Creek drainage. These roads include seven stream crossings with three perennial and four intermittent streams. Two crossings are confirmed to have culverts in place (RS 4340775) while the other four crossings are confirmed or assumed without a culvert. These stream crossings, which would be constructed temporarily, are on Elderberry Canyon, Chicamun Canyon, and Mission Creek. Elderberry Canyon is the closest crossing to critical habitat at ~2 miles upstream. The closest crossing to occupied rainbow/steelhead is a tributary to Mission Creek, which is at 0.4 miles upstream. NF Libby Creek is steeper here and a 2011 snorkel survey observed rainbow/steelhead to account for about 16% of the total fish observed, with cutthroat the dominant species. All other closed roads range from 50 to 260 feet from adjacent streams. Streams with roads less than 100 feet from the stream include Hornet Draw and Mission Creek, along intermittent reaches and valley slopes less than 10%. Road Decommissioning - A total of 2.1 miles of riparian roads (6 crossings) would be decommissioned. These road segments and crossings are the same ones described above for opening closed roads. Road Closure – a total of 635 feet of riparian roads would be closed under the commercial harvest work. Therese two road segments are along upper Mission Creek and Hornet Draw and ~50 and 200 feet away from adjacent streams. There are no stream crossings associated with these roads. All other road use would occur outside of RRs or on existing open roads with no changes to shade or wood recruitment.

Probability: The only TSM activities that could affect stream shade and wood recruitment are those that open up stream crossings, remove them, or change road conditions within 1-SPT of streams. All other TSM activities are too far away to affect these indicators.

Magnitude: Temperature Seven stream crossings would be used for log hauling and only three of them cross perennial streams. The other four are on intermittent streams. The perennial stream crossings have grass on the road surface and opening them up would not alter shade. The amount of shade loss would be minor and immeasurable. These crossings are proposed for decommissioning and would, eventually, return to forested ground with natural stream shading levels. Both changes would be inconsequential and immeasurable. Opening up roads within 100 feet of streams may remove some shade producing vegetation, but these roads have already been compacted and only small trees grow on them at most. LWD None of the seven stream crossings have even medium sized trees growing on them and most lack trees all together. Opening these crossings up would not measurably affect wood recruitment nor the parallel roads. Field review indicates they have small diameter trees growing that would not reach adjacent streams. Decommissioning these roads would allow them develop mature trees over time and recruit instream wood at natural rates. The short segments would not measurably increase wood recruitment. In addition, the streams these roads are on are too small to transport medium or large sized trees down to critical habitat. Based on this assessment, the impacts to stream temperature and wood levels in critical habitat and in occupied steelhead habitat would be an inconsequential negative impact for the short-term and long-term beneficial effect.

Element Summary: Opening and closing roads would have such a small affect to shade or wood recruitment that it would be immeasurable in critical habitat. Riparian road decommissioning would result in a small, inconsequential improvement. Therefore, the roads PE would result in an **insignificant negative (-) effect** for opening closed roads and closing roads and an **insignificant positive (+)** for riparian road decommissioning to the temperature and LWD indicators.

Indicator Summary: The proposed treatments within RRs are not expected to measurably affect stream shade or wood recruitment to adjacent streams. Setbacks for harvest or other thinning activities, pile burning, and the few road activities may result in small, localized reductions in shade, but it is not expected to rise above an immeasurable impact. Likewise, the benefits of riparian road decommissioning, under harvest-funded work, are not expected to have measurable benefits in the long-term. We expect **insignificant negative (-) short-term** and **positive (+) long-term effects** to the temperature and LWD indicators.

Habitat Elements

Suspended Sediment/Turbidity and Substrate Embeddedness

These indicators are lumped together because they have the same mechanisms that influence their condition. Data available in this watershed consist of Wolman Pebble Counts to get percentages of fine sediment on channel surfaces and inferences based on streambank stability data collected during the 1999 stream survey of Libby Creek as well as during 2010 field data collection. We have not collected NTU or IGDO measurements in the Lower Methow River watershed. Both the proportion of surface fine sediments ($\leq$ 6mm) and percent fines <0.85mm in Libby Creek will be used as a surrogate for overall sediment, gravel interstitial space, and embeddedness conditions.

Soil erosion potential for the Libby Creek is mostly moderate (39%) to high (45%) suggesting natural erosion would be high. However, the most evident soil erosion in the drainage is the existing

road network. Most notably, inadequately vegetated road cut slopes, road surfaces, and fill slopes present the highest surface erosion in the drainage (USDA 1995b). The available data suggests the sediment levels are in Libby Creek and its two forks ranges from moderate to high.

Effects to Sediment

The primary mechanism by which fine sediment increases in aquatic habitat is by ground disturbing activities within proximity to streams. In the project area, the road network is likely the chief factor contributing fines to streams. Potential ground disturbance from ground-based logging systems exists has potential to mobilize fine sediment that can be transported to streams when sufficient roughness is lacking in the riparian buffer.

All commercial harvest and prescribed fire outside of RRs have no causal mechanism to deliver sediment to streams. Any soil disturbance would stay on or near the sites and would not reach any streams because soils are stable, overland flows are extremely rare, and remaining ground vegetation near streams would trap any mobilized sediment. Non-commercial harvest would be done by hand and would not cause any soil disturbance. Additionally, the ~0.4 miles of new temporary road construction would occur outside of RRs and have no mechanism to deliver sediment. These activities would have no effect to the sediment habitat indicators. The following PEs occur in RRs and have potential to deliver sediment to streams and subsequently to critical habitat: commercial thinning and prescribed fire within RRs and TSM activities.

PE – Commercial Harvest (felling & yarding) and Non-Commercial Thinning Actions (ladder fuel and pre-commercial thinning) combined

Proximity: About 43 acres of commercial harvest are proposed in the outer edge of RRs in the Libby Creek drainage. No harvest would occur in RRs associated with steelhead critical habitat and the closest bull trout and spring chinook habitat is ~5 miles downstream in the Methow River. The closest riparian unit to critical habitat is in Hornet Draw at ~1.5 miles upstream. One unit is within the RR of South Fork Libby Creek with a distance of 280 feet from the streams edge and on a flat terrace. Snorkel surveys confirmed rainbow/steelhead is present in the channel at this location. Of the 43 acres of RR harvest, 38.3 acres are either during winter conditions or an equivalent low impact harvest method and 4.7 acres of either winter or summer harvest season. Proximity of the optional summer harvest units range from 130 feet (over flat ground) to ~280 feet along SF Libby Creek. The remaining harvest acres would follow the Table 5 buffer widths on page 25 gives. Landings within RRs, particularly new ones, would be avoided unless no other practical location exists. Some existing landings within RRs would be used, with the same no-treatment buffers. There would be one skid trail over Elderberry Creek at 1.5 miles upstream from Libby Creek where critical habitat is designated and about 1 mile above Smith Canyon Creek with assumed steelhead presence. The unit is a winter or equivalent harvest unit; therefore, the impacts would be minor. A suitable location was identified with gentle approaches and no channel incision.

There are 668 total acres of non-commercial thinning within the outer portion of RRs and 413 acres are within the Libby Creek drainage. See Temperature and LWD for more proximity details.

Probability: About 45 percent of the total commercial harvest in the Libby Creek drainage would be during winter or other low impact method where the impacts would be mitigated and not occur. However, there will be some limited amount ground disturbance relating to the small amount use of

equipment in RRs and one skid trail over an intermittent channel. The probability of ground disturbance resulting from felling and yarding actions is greater than discountable.

NCT treatments would be done by hand and have no ground disturbance. Therefore, this treatment would have zero probability of affecting stream sediment levels.

Magnitude – Percent changes in ground cover and proximity of units to adjacent streams were used to analyze impacts of the proposed felling, yarding, and landings in RRs to stream sediment levels. The combination of no-cut buffers and most harvest acres occurring during winter (89%) is expected to diminish potential sediment impacts to inconsequential levels.

All optional summer harvest units in RRs would be have no-cut buffers of at least 130 feet and the winter harvest units would range from 50 feet on flat ground up to 90 feet on moderate slopes. There are no draws between the riparian units and the associated streams. Therefore, the only mechanism for sediment to reach streams is from surface runoff via overland flow. Surface runoff over undisturbed ground generally permeates the soil and moves to stream channels via subsurface flow (Chamberlain et al. 1991).

The combination of no-cut buffers and undisturbed forest floors can be an effective tool to prevent sediment delivery to streams. Rashin et al. (2006) studied the effectiveness of forested buffer strips at preventing erosional features associated with harvest operations from delivering depositional sediment to adjacent stream channels. In their study, they reviewed 26 forested logging operations across WA State that included some sites on the eastern slopes of the Cascade Mountains. They observed the primary operational factors that influenced sediment delivery (coarse fines) to streams were the proximity of timber falling and yarding activities to streams, valley side-slope gradient, and the presence or absence of designated stream buffers. Rashin found that erosion from harvest activities closer than 30 feet of streams would generally produce and deliver sediment to streams. Outside of 30 feet, sediment delivery rates drop rapidly with increasing distance to the channel. Rashin concluded that harvest and yarding setbacks of 10m (30ft) could be expected to prevent 95% of depositional sediment delivery to streams from harvest-related erosion features, supporting the value of the prescribed buffers. Factors that aid in the buffer effectiveness are the amount of forest ground cover and soil infiltration, which can limit sediment transport distances. Excess water is needed to mobilize sediment and soils in the project area are considered well-drained (Annie Greene, personal communication), thus overland sheetflow would not be expected for great distances. Rashin's study did not look at suspended sediment and he said their prescribed buffer width may not trap suspended sediment (Rashin personal communication 2014). Sweeney et al. (2014), who did consider suspended sediment, suggests 30 meter (98ft) buffers are necessary to trap ultra-fine sediment from reaching streams. Based on these protection measures and the available literature, some suspended sediment may reach an adjacent stream if surface erosion occurs from harvest activities closer than 1 SPT, but its likely to be small and immeasurable. Harvesting in this zone over frozen ground is expected to minimize the potential for compacting soils or creating surface erosion features. Where harvest would occur up to 50 feet of streams, slope gradients would be $\leq$10%, which would reduce the potential for overland flow. As terrain gets steeper, the buffer width gets wider, allowing for more undisturbed forest floor to trap suspended sediment. For the potential summer units, there would be 130-280 foot no-treatment buffers. With these measures in place, we expect no depositional sediment to reach adjacent streams and the potential for suspended sediment to reach would be unlikely. If any sediment were delivered to an intermittent stream, it

would inconsequential and indiscernible from background levels downstream where fish habitat exists.

One skid trail is proposed over Elderberry Creek to bring logs from unit 058 across the creek. This unit is proposed as a winter harvest or other similarly low impact method. The crossing was pre-identified in the field with the project fish biologist at a location with gentle approaches. Some sediment would likely be generated during log skidding. The creek is intermittent at this location and when it mobilizes sediment in the spring, natural background sediment levels would be higher. Following the proposed design criteria described here along with the detailed specs in Appendix D, the amount of sediment expected would be minor at the site. The amount reaching critical habitat 1.5 miles downstream or occupied habitat 1.0 mile downstream would be immeasurable in the spring runoff period.

The estimated number of landings in RRs (one landing per ten acres) amounts to ~4 landings total. Following no treatment buffers and restricting landing use to the winter or in optional summer harvest units of at least 130 feet (39 meters) from streams, there would be a discountable probability of sediment delivery from this action. It is unlikely any sediment would mobilize to adjacent streams, but if it occurred, the magnitude would be inconsequential and immeasurable.

Working over frozen ground is effective at minimizing erosion and would limit the potential for sediment entering streams to zero or very unlikely potential. Winter logging on frozen soils has shown to reduce the amount of soil compaction and surface rutting (Page-Dumroese et al. 2006). We expect little to no sediment delivery to adjacent streams from winter logging or other equally low impact methods. If any sediment did reach adjacent streams, it would be minor, inconsequential amounts. The one skid trail over a creek would be under similar low impact conditions and over 1.5 miles upstream from critical habitat.

Element Summary: The felling and yarding, i.e. "harvest" PE would have inconsequential effects to sediment delivery to salmonid habitat and pools. Due to the factors described above, this sediment delivery increase would not be measurable in downstream for steelhead, spring Chinook, or bull trout. This PE would result in an **insignificant negative (-) effects** to the sediment and pool indicators.

PE – Prescribed Burning and Firewood Collection

Proximity: Prescribed burning activities would occur across broad areas of the Libby Creek drainage, including within RRs. There would be 252.7 acres of prescribed pile burning in RRs with the following treatments: 250.7 acres hand piles (2.0 total acres burned), 1.8 acres of machine piling (0.05 acres total burning), and 44 acres of landing piling (~0.4 acre total burning). The landing piles will occur in either underburn or pile burning units and they are not counted as additive. See the proximity description under temperature and LWD on page 177 for more details on proximity of prescribed burning to streams and critical habitat.

Four streams would have active ignition within the RR and fire allowed to back-in towards streams. The first is Mission Creek that drains into NF Libby Creek at RM 0.7, which has intermittent flow. A second stream flows into Mission Creek at RM 0.2 that is perennial, making the mouth of Mission Creek perennial. Where Mission Creek connects with NF Libby Creek, snorkel surveys

observed six juvenile rainbow/steelhead in NF Libby Creek over three snorkel reaches and they represented 4% of the total fish observed. Compared to snorkel surveys down in the mainstem of Libby Creek (96-100%), rainbow steelhead use in NF Libby Creek substantially less. The third one is a perennial stream draining into mainstem Libby Creek, just below the confluence of NF and SF Libby Creek. The fourth one is Elderberry creek, which drains into Smith Canyon Creek and then into the mainstem Libby Creek at the upper end of steelhead critical habitat.

A total of 22.8 miles of fire line construction is proposed in the Libby Creek drainage that includes 2.6 miles of dozer line and 20.2 miles of hand line. Of these miles, 1.5 miles of handline are proposed within RRs. The closest handline to steelhead critical habitat is 1.6 miles upstream in Elderberry Creek. A few handlines are in the NF and SF Libby Creeks. Each section of handline would occur at least one mile up stream from steelhead critical habitat.

Machine piling, as an AM treatment, is proposed for unit 64 near Hornet Draw Creek and involves 7.6 acres in the outer edge of the RR. This unit, where machine piling would occur, is located 150 feet from the creek at its closest point. Slopes in this unit are nearly flat.

All firewood collection would occur on ML2 or higher roads. Only downed, recently thinned wood or wood from landing piles would be available. This would follow the same guidelines and restrictions with normal firewood permits. No collection would occur in RRs.

As an adaptive management strategy if smoke clearance were not achieved, the 153 acres of LFR/NCT would not underburned. Alternatively, these acres would be hand piled and pile burned using the same stream buffers described for LFR/NCT in Table 8.

Probability: The project proposes to hand pile burn, machine pile burn and landing pile burn within Riparian Reserves. Some of these activities have potential to deliver sediment to the stream network. Burning outside of RRs would have no probability of delivering sediment to streams because there would be unburned vegetation between the areas and channels. Within the RRs, hand pile burning along perennial streams, machine pile burning, and landing pile burning would be 50 (hand pile) to 100 feet or more from adjacent streams. These distances would be sufficient to prevent them from causing sediment delivery to streams and so have zero probability. Hand pile burning within 25 feet of intermittent channels could potentially add sediment to the stream network. If machine piling is done in unit 64, we expect no probability to change sediment levels in Hornet Draw Creek due to the flat ground being treated. There is no avenue for sediment delivery. Additionally, the unit is well over the distance of 1-SPT from the creek. The adaptive management hand pile burning would be at least 50 feet from perennial streams.

Magnitude: Handpile burning would occur along ~36 acres of intermittent channels with pile burning up to 25 feet of the channel. Additionally, another 153 acres would be piled and pile burned by hand as an AM. Hand piles are constructed at a density of 25 piles per acre with an area of 16 square feet. At this density, less than 1% of an acre would be burned. Pile burning rarely leaves the footprint of the pile because they are burned under moist and often damp conditions. Up to 25 feet of undisturbed ground cover would sit between the piles and adjacent streams. If fire stays at the pile in most cases, only a few would creep closer to the stream. Some bare soil closer than 25 feet could occur in a few occasions, but it would still be minor. A small potential for sediment to enter an intermittent stream on a few occasions is not likely to be measurable in fish bearing streams

downstream. When these streams are flowing, background sediment levels are higher and a slight increase would be immeasurable.

Element Summary: The project fish biologist expects some sediment induced from the proposed pile burning along intermittent streams would enter the stream network. The estimated magnitude would be immeasurable where occupied fish habitat exists and critical habitat, therefore insignificant. Design details and mitigation measures are expected to be successful in maintaining water quality standards. Therefore, proposed prescribed fire and AM treatments would result in an **insignificant negative (-) effect** to the sediment and pool indicators in Critical Habitat.

PE – Transportation System Management and Log Hauling

This PE consists of all proposed road activities associated with timber harvest, which includes pre-project road maintenance, log hauling, opening closed roads, temporary road construction, closing and decommissioning roads, road conversion to ML2 administratively closed, adding roads to the system, and changing ML. The range of actions would have positive and negative effects to the overall sediment budget within the project area. Table 50 summarizes the type of actions proposed, incorporated design criteria by reference, and expected effects to the sediment indicator.

Table 50. Summary of harvest related transportation action effects to sediment indicator.

Action	Design Criteria[1]	General effects to sediment
Pre-haul Rock Armoring	85	Short-term net 0, long-term net↓
Pre-/post-haul maintenance	Nat. BMPs	Short-term, small ↑, long-term net↓
Temporary road construction	62	Short-term net 0, long-term net 0
Opening closed roads	Nat. BMPs	Short-term, small ↑, long-term net 0
Log Hauling	Nat. BMPs	Short-term, small ↑, long-term net 0
Hydrologic road closure (timber sale)	Oka-Wen F Rd Plcy, Nat. BMPs	Short-term, small ↑, long-term net↓
Road Decommissioning (timber sale)	63, 66, Nat. BMPs	Short-term, small ↑, long-term net↓
Stream crossing removal (timber sale)	WDFW MOU, ARBO II Nat. BMPs	Short-term, small ↑, long-term net↓
Adding Non-system Roads	64	Neutral 0 effect
Changing ML	64	Neutral 0, long-term net↓
Summary effect		**Short-term, small ↑, long-term net↓**

[1]Presented in Appendix D.

See discussion under the Buttermilk Creek drainage section for additional TSM analyses details.

Proximity: Libby Creek is designated critical habitat for steelhead up to RM 3.4. The Methow River is the closest spring Chinook and bull trout critical habitat. Table 51 displays the proximity of the proposed haul route/road maintenance to critical habitat.

Rock armoring would occur on six locations to reduce sediment impacts to listed fish and their habitat. Four of the six rock crossings are on the 43 road and will be rocked because some harvest will occur outside of winter. The other two are on the 4300100 and will be done if summer log hauling occurs, otherwise they will be done under external funding sources. The Log hauling would

occur on about 36.7 miles of gravel and natural surfaced roads across the Libby Creek drainage, which includes 7.0 total miles within RRs. The 7.0 miles of riparian road miles includes 2.9 miles on a ML3 gravel road, 2.2 miles on ML2 gravel, and 2.0 miles on closed roads opened for hauling. Proximity to critical habitat includes a stream crossing right over Libby Creek, at the top of steelhead critical habitat at RM 3.4. Log hauling crossings occur over Libby Creek at the upper end on the 4300100 road, and crossings over NF Libby and SF Libby Creeks. All constructed temporary roads are outside of RRs.

Road maintenance would occur on all the 36.7 miles to bring them up to hauling standards, which includes 12 miles of closed roads. Conservatively, all the 12 miles of closed roads are estimated to need some level of reconstruction or heavy maintenance. The closest stream crossing to occupied steelhead habitat is on the 4340790 road over the tributary to Mission Creek. This site is 0.44 miles upstream from NF Libby Creek. All other sites are 1-stream mile from Libby Creek. See closed road descriptions under temperature and LWD for other crossings and proximity to critical habitat. Routine maintenance would occur all of the 24.3 open roads, which includes 19 stream crossings. The haul route includes crossings over NF Libby, SF Libby, and mainstem Libby Creek at the top of steelhead critical habitat.

Road decommissioning would occur on 6.8 miles of roads with 2 miles of riparian roads and six stream crossings. About 6.7 miles of roads would be hydrologically closed that includes 630 feet in the outer edges of RRs, with no stream crossings.

Table 51. Proximity of road activities to critical habitat and road changes.

Log Haul/Road Maintenance Routes				**Timber Sale Funded Decommission/Closure**					**Unauthorized Roads Added**		**Road to ML2 Admin**	
Existing Access	Mi.	Stream Xings	Prox to STHD CH*	Dec. (mi)	Dec. in RR (mi) [# Xings]	Prox to STHD CH	Close (mi)	Closed in RRs (mi) [# Xings]	Prop ML	UA (mi)	Prop ML	ML2A Mi
closed	12.1	7**	>2.0 mi	6.2	2.0 [6]	0.4 mi	6.7	630 ft [0]	ML1	2.2	ML1	0.6
open/gravel	24.2	19	Crossing over CH						ML2	0.1	ML2	2.4
temp	0.4	0	Zero, outside of RRs	Not counted					NA	0	NA	0
Grand Total	36.7	26		6.2	2.0 [6]		6.7	0.5 [0]		2.3		3.0

* Stream miles.
** Three culverts are currently in place on one road.

Probability: Road maintenance, log hauling, opening closed roads, and road decommissioning have potential to add sediment to the stream network. Rock armoring six crossings prior to summer log hauling would result in immediate reduction in sediment delivery to the stream network.

Magnitude: The potential for road related sediment delivery to streams was not analyzed using any modeling. Alternatively, changes in road density, riparian road density, road drainage network, road-stream crossing density, and percent ground cover were used to analyze impacts to stream sediment levels for the nepa process. This method followed the Draft Okanogan-Wenatchee's Whole Watershed Restoration Procedures (USDA 2015) method for assessing changes in road metrics and their potential to alter sediment delivery. Through these analyses and proposed design criteria, the project hydrologist estimates the short-term sediment delivery potential as insignificant. The project fish biologist does not expect measurable increases in fine sediment in critical habitat or NF Libby, SF Libby, and mainstem Libby Creek from the proposed roadwork. Road generated sediment to streams is assumed to come almost completely from stream crossings. This is consistent with Coe (2006) and (Wemple et al. 1996) who both found stream crossings to account for about 60% of all connected road segments and thus provide the dominant causal mechanism for sediment delivery to the stream network. Therefore, to reduce the magnitude of sediment effects to streams, the project addresses sediment delivery at six key road-stream crossings.

Pre-haul Rock Armoring - This work would immediately reduce sediment delivery to the important fish bearing streams. We expect net fine sediment reduction per crossing by about 80% where implemented, based on Ward and Seiger's work (1983), who observed an 80% reduction in sediment from rocking road-stream crossings.

Results from Coe's (2006) study of sediment production and delivery from unpaved forest roads suggest rocking the approaches to stream crossings and reducing the number of stream crossings are effective means for reducing road related erosion. As an example, Ward and Seiger (1983) found when adding crushed rock, an 80% reduction of road surface erosion could be expected. The Buck Forest and Fuels project modeled changes in surface erosion rates following rock armoring using the Hillslope Erosion Model (HEM) and the Watershed Erosion Prediction Model (WEPP). Outputs from those models estimated a reduction of 1.7 tons per year of sediment delivery to streams from rocking 23 stream crossings. Up to six crossings would be rocked for Mission log hauling and it is estimated, assuming all things equal, these crossing would reduce sediment delivery to streams by 0.4 tons per year. Therefore, to reduce the magnitude of sediment delivery effects to streams, the project proposes armoring stream crossings and reducing the number of road-stream crossings. Implementation of the pre-rock armoring would result in insignificant positive (+) effects to the sediment and pool indicators.

Pre- and Post-Haul Maintenance/Heavy Rd Maintenance – Road maintenance would occur on 36.75 miles of roads in the action area and heavy road maintenance or reconstruction would occur on 12 of these miles. Most maintenance would occur on gravel and natural surfaced road segments located well away from critical habitat and closer, not directly over occupied steelhead habitat. A few sections of the 43 and 4300100 roads cross directly over occupied or critical habitat, but these are ML 2 and 3 roads with good running surfaces. Surface grading, ditch relief culvert clearing, and ditch cleaning may allow delivery of some sediment into NF Libby, SF Libby, and mainstem Libby Creek. Following the following BMPs and project design criteria would minimize sediment delivery to streams:

- Do not permit side-casting of maintenance-generated debris within the RR to avoid or minimize excavated materials entering waterbodies or riparian areas.
- Avoid overwidening of roads due to repeated grading over time, especially where sidecast material would encroach on waterbodies.
- Use potential sidecast or other waste materials on the road surface where practicable.
- Dispose of unusable waste materials in designated disposal sites.
- Remove vegetation from swales, ditches, and shoulders, and cut and fill slopes only when it impedes adequate drainage, vehicle passage, or obstructs necessary sight distance to avoid or minimize unnecessary or excessive vegetation disturbance.
- All road maintenance would occur during dry weather conditions.

Heavy maintenance would occur on about 2 miles of RR roads including seven stream crossings. The closest crossing to occupied habitat is 0.44 miles upstream on the 4340790 road. The creek is perennial and flows into Mission Creek. When this site work is done, Mission Creek would be dry and the only flow is from this creek. During the low flow period, this creek is estimated at 1 cfs and about 10% of NF Libby Creek's flow. Some sediment would be transported downstream when flow is reintroduced into the work site. This crossing is not expected to have a culvert in place and therefore, no depositional area above the crossing and channel adjustment is expected to be minor. The volume of sediment transported downstream to NF Libby Creek is difficult to quantify, but is not likely to be measurable.

Few studies have quantified the volume or duration of sediment delivery to streams from constructing or removing stream crossings. Foltz et al. (2008) monitored concentrations of

sediment and turbidity, duration, and impact distance downstream during culvert removals on 11 stream crossings between two locations in Idaho and one in eastern Washington. They looked at stream crossing removals on perennial streams with drainage areas ranging in size from 8.4 acres up to 1,720 acres. Sediment measurements were taken at various distances up to 1/2 mile downstream of the culvert removal site. The 790-road crossing is 0.44 miles upstream from NF Libby Creek, just under the 1/2 mile study distance. In the Foltz et al. (2008) study, sediment concentrations measured 1/2 mile downstream of the work site were similar to upstream conditions. The construction would follow normal BMPs like dewatering the work site, setting straw bales in the creek below, and working during the approved instream work window. Based on these factors, the volume of sediment expected to reach NF Libby Creek is not likely to be measurable. All other heavy maintenance culvert sites are farther away than 1/2 mile and expected to have similar insignificant magnitude of sediment effects.

During the normal road maintenance, most stream crossings are intermittent. Therefore, most sediment transport sites would occur during rain events or spring peak flows. When intermittent streams are activated, sediment is likely to become mobilized. This would likely be in small amounts at a time, as the roadwork will occur in stages rather than a large pulse of sediment moving at once. This would occur mostly when background levels of sediment are naturally high. While some sediment delivery is expected and transported downstream, the volume is likely to be small and undetectable downstream in occupied habitat and critical habitat.

In summary, the volume of sediment generated from general road maintenance is difficult to quantify, but is not likely to be measurable in occupied and critical habitat streams. Sources are likely isolated and well separated. Road maintenance would also allow for existing chronic sediment sources to be eliminated or reduced, resulting in a positive effect. Implementation of the road maintenance project element would result in insignificant negative (-) and positive (+) effects to the sediment and pool indicators.

Log Hauling - The greatest risk for log hauling to deliver sediment to streams exists where haul routes cross over streams. At these locations, log hauling can generate sediment delivery to streams. All crossings over occupied or critical habitat would be rocked or used during winter, when sediment delivery would be near zero. Hauling would not occur when road conditions are wet or during heavy rain events when water is running on the surface. If roads become too dusty, water may be applied to keep the dust down and limit sediment from reaching streams. These measures are expected to reduce sediment generation from log hauling to insignificant levels. Proposed log hauling is unlikely to cause measurable increases of suspended sediment and turbidity in occupied or critical habitat. This is due to a combination of rocking crossings on occupied and critical habitat, the proposed BMPs/Design Criteria, and the spatial separation of most other haul route crossings. Implementation of the log hauling would result in insignificant negative (-) effect to the sediment and pool indicators.

Closing and Decommissioning Roads – The same roads opened up for log hauling would be decommissioned following harvest and one closed that is over 2 miles from Libby Creek. The culvert distances are the same and the anticipated sediment effects would be not likely be measurable.

Conversion to ML2A – Converting the three roads to ML2 Administratively Closed would include installing drivable dips, improving their storm capabilities. Additionally, this would substantially reduce vehicle traffic. This would result in a small improvement to the sediment indicator by reducing road surface erosion, though it would not likely be measurable.

Element Summary: The roadwork is expected to cause some increases in sediment delivery, particularly the work occurring at stream crossings. Design details and BMPs would minimize sediment effects to occupied and critical habitat conditions. Where road-stream treatments occur, most are over ½ mile upstream and the sediment effects are not expected to be measurable where occupied and critical habitat occurs. In the long-term, the sediment reduction from removing 6.2 miles of moderate and high aquatic risk roads, hydrologically closing 6.7 miles of moderate risk roads, and armoring stream crossings would result in a net reduction in road-related sediment input overall. The reduction in anthropogenic sediment delivered to the stream network would be a net beneficial effect to the sediment regime and pool habitat. The Libby Creek sub-watershed will have reduced fine sediment delivery to critical habitat, but the reductions are likely to be immeasurable. During the project implementation, the short-term impacts from road maintenance, log hauling, and culvert work would have an **insignificant negative (-) effect** to the sediment and pool indicators in critical habitat. Following the project, the reductions would have an **insignificant positive (+) effect** to the sediment and pool indicators.

Indicator Summary: The project fish biologist expects the harvest/yarding, prescribed fire, and harvest related road work likely to deliver some sediment to the stream system and collectively are expected to slightly increase fine sediment in NF Libby, SF Libby, and mainstem Libby Creek. The little restorative roadwork would result in a benefit to streams, but likely not be measurable.

The overall, the collective short-term increase in sediment would remain immeasurable and inconsequential in critical habitat. Using the above described design criteria's and BMPs, sediment delivery would be kept to a minimum and insignificant. Therefore, these PEs combine to create an **insignificant negative (+) effect** and **insignificant positive (+) effect** to the fine sediment and pool indicators.

Channel Condition and Dynamics

Streambanks and Channel Geometry (3)

PE – Felling, Yarding, Landings, and Thinning Actions (LFR and NCT)

Timber felling and yarding occur spatially distant (equipment buffers 50-270 feet or more) and have no causal mechanism to affect the habitat indicators, except for one location. There may be potential for upland-sourced fine sedimentation to change channel geometry via sedimentation; however, the analysis of the sediment indicators found that that magnitude of short-term increases would be much less than those sufficient to measurably aggrade the channel miles downstream. One skid trail is proposed across Elderberry Creek about two miles upstream from Libby Creek. Yarding conditions would be either over frozen ground or with some other equally light impact equipment method. Minor localized impacts to streambanks would not affect

channel dimensions or bank stability two miles downstream. This PE would have a **neutral (0) effect** to streambanks and channel geometry in critical habitat.

PE – Prescribed burning
Prescribed fire treatments generally occur spatially distant from streambanks. All pile burning would occur away from stream channels and little risk of fire creep. We don't expect effects on the ground to reach levels capable of removing vegetation or breaking down streambanks. As such, the only mechanism whereby channel geometry could be affected is via large increases in the sediment yield sufficient to aggrade the channel. Analysis of the sediment delivery from project activities found that sediment would have a slight increase in sediment – but of small magnitude not likely sufficient to measurably aggrade a channel or change its width:depth ratio. This PE would have a **neutral (0) effect** to streambanks and channel geometry.

PE – Transportation System Management
Streambanks are generally only affected where changes to road-stream crossings occur. No other project action would directly affect streambanks, particularly at the sub-watershed scale.

Proximity: There are seven stream crossings on the 12 miles of closed roads opened up for log hauling. The closest crossing to critical habitat is over 2 miles upstream. One crossing is 0.44 miles upstream from lower NF Libby Creek. Two of these crossings already have culverts in place, limiting the pre-haul culvert installation to just five crossings. One of these is perennial and the rest are intermittent and would be dry during installation. Each of these same crossings is proposed for permanent road decommissioning. The following points summarize road/stream crossing management:

- Closed roads opened for log hauling – 12.0 miles and 7 stream crossings
- # of crossings needing installed – 5 total, with one being perennial
- Proximity of closest crossing to critical habitat +2 miles, proximity of closest crossing to occupied rainbow/steelhead habitat 0.43 miles
- # of crossings removed with harvest related decommissioning – 7 (Same ones as above)

There is no spatial or temporal overlap between PEs affecting streambanks and actual streambanks associated with critical habitat. There may be potential for upland-sourced fine sedimentation to change channel geometry via sedimentation; however, the analysis of the sediment indicators found that the magnitude would be insufficient to measurably change channel process/geometry. This PE would have a **neutral (0) eff**ect to streambanks and channel geometry.

Element Summary: Streambanks would be disturbed at seven sites in the Libby Creek drainage when the harvest road crossings are installed or removed. Local effects would be small, short-lived, and include positive and negative effects. Streambank stability is very high and W:D ratios are within expected ranges, suggesting they are not easily degraded. In all cases, the PEs are above listed fish habitat and two above a long subsurface reach. Incorporation of standard BMPs and WDFW-Forest Service MOU design criteria will mitigate local effects of sedimentation to small magnitudes at the site scale, such that downstream changes in the sediment yield would be insignificant and not capable of measurably aggrading or degrading the channel. Based on these

findings, we expect that there would be **neutral (0) effect** to the streambank stability and width:depth ratio indicators.

Flow/Hydrology

Roads and Drainage Network, Road density and Changes in Peak/Base Flows

The Increased Drainage Network, Road Density/Location, and Change in Peak/Base Flows were lumped together because forest roads are believed the primary anthropogenic agent influencing stream flow relating to water quantity. Forest roads artificially increase the drainage network in a watershed. In the Libby Creek drainage, there is an estimated 25.5 miles of artificial drainage features from the road network, which amounts to ~44% increase in the drainage network. Road density in the Libby Creek drainage is relatively low at 1.9 mi/mi^2; however, there are several parallel roads to streams in close proximity across the project area. The parallel roads are the primary factor in the higher drainage network estimate. Because of the increased drainage network, the project fish biologist assumes the road drainage network alters peak and base flows. Commercial harvest can effect runoff and is discussed below, but the assessment concludes it would have an insignificant effect to peak and base flows.

PE – Commercial Felling, Yarding, Landings, and Thinning Actions (LFR and NCT)
Commercial harvest and associated activities would not affect water yield in any measurable way from vegetation cover removal. There are no clear-cut acres proposed in this sub-watershed. About 59 acres of regeneration harvest and a few different commercial thinning prescriptions are proposed across 1,322 acres in Libby, which represents less than 6% of the drainage. When less than 25% of a watershed is harvested, studies indicate no detectible change in peak flows occurs (Stednick 1996, NOAA Fisheries Memorandum 2005). The commercial harvest would result in a negligible impact to peak flows and base flows. Felling and thinning actions lack causal mechanism to affect road or drainage network indicators. One skid trail is proposed over Elderberry Creek, while all others are located outside of all RRs. Therefore, the one skid trail and proposed landings are the only activities that could alter the drainage network.

<u>Landings and Skid Trails</u>
Proximity: Based on commercial unit layout, all harvest would be at least 150 feet or further from any stream and would use existing roads as lower boundaries.

Probability: It is certain that landings would be used within RRs potentially affecting the drainage network.

Magnitude: Potential impacts to aquatic habitat associated with the drainage network are most pertinent within 300-feet of streams (Ketcheson and Meghan 1996), thus actions in these areas are the focus for analysis of magnitude. It is estimated that a landing is needed for about every 10 acres of harvest units, with some deviation due to local conditions, volume available, etc. Across the project area there are about 49 acres of harvest unit within 300-feet of streams (including perennial and intermittent channels). Using the ratio of one landing per every 10 acres of harvest, we estimate there may be about 5 landings used within 300 feet of streams. The project forester has identified existing landings during partial layout thus far and expects there to

be very few new landings created, less than 10% of landings are likely to be newly-constructed landings, all of which would be within harvest setbacks of at least 150 feet from streams. Landing use and creation would be subject to design criteria in Table 8, BMPs in the National Core BMPs, and additional project-specific guidelines shown in Appendix B, and intended to control erosion and potential for storm runoff and require post-used restoration. We expect the actual new ground disturbance (compaction) to be very small, resulting in slight temporary increases in drainage efficiency, comprising **an insignificant negative (-) effect** to the drainage network indicator. Similarly, the vegetation treatments would have **insignificant negative (-) effect** to the Changes in Peak/Base flows, respectively.

Element summary: Overall, we expect that the magnitude of this PE's effects to the road/drainage network indicator to be insignificant and temporary as measured at the sub-watershed scale. Nearly all landings used in the project already exist. Where these existing landings do not meet design criteria intended to protect erosion and water quality, they would be brought into acceptable specifications or not be used. We expect the drainage network would be increased negligibly from landings and the one skid trail stream crossing. These effects would be short-lived (1-2 years) and would be well-mitigated via use of design criteria and current BMPs for the protection of water quality. We expect that there would be a short-term, **insignificant negative (-) effects** (insignificant overall magnitude) to road and drainage network indicators that would return to pre-project conditions after 2-3 years based on projected vegetation recovery expectations.

PE –Prescribed burning

Pile burning in forested watershed not demonstrated any impact on water yield on-site or downstream. Proposed fuels treatments do not propose any opening or closing of roads or trails. As a result, the Fuels Treatment PE would have a **neutral (0) effect** to the roads and drainage network indicators and to peak or base flows.

PE – Transportation System Management

Proximity/Probability: The project does not propose any new permanent roads. All of the 0.4 miles of new temporary road would be located outside of RRs. The project would open up 12 miles of closed roads for log hauling that includes 1.2 miles within RRs. Timber receipts would fund the decommissioning of about 7 miles and hydrologic close ~7 miles of road. Post-harvest road treatments include 2 miles of riparian road decommissioning and ~600 feet of riparian road closure. Additionally, the project would bring closed and open unauthorized roads onto the NF System, close currently open system and unauthorized roads, and decommission roads. Each of these has different combinations of negative/positive effects to the drainage network. See proximity discussion under Temperature/LWD and Sediment for more details on locations. These activities would change the road drainage network and road densities and could affect peak flows.

Roads within proximity to streams are the most concern in affecting aquatic habitat and water quality and therefore, the BA provides an analysis of closed and open RR road mileage, including NFS and unauthorized roads, by project stage (Table 52). Additionally, this analysis includes Libby drainage road density (Table 53) across project phases and a comparison of the number of road-stream crossings by project phases (Table 54).

Magnitude: Overall, road density and drainage network would have a trivial increase during the timber harvest phase of the project, thereby having an insignificant effect to changes in peak and base flows. The project would construct 0.4 miles of new temporary roads, but they would be located outside of any RRs. Opening 12 miles of closed roads for log hauling would improve their drainage efficiency, but many of these roads are already drivable so the change would be negligible. Within RRs, ~2.1 miles would be opened for log hauling and some of these are already drivable. The amount of roads within RRs would not change during harvest road use, just the amount of open roads. Increase in drainage network is estimated to be negligible. Construction of 0.4 miles of temporary in the uplands, outside of any RRs, would increase road density by 0.01 miles per square miles or by <1% (Table 53). Combined, these changes would amount to small localized increases in drainage area where ML1 or closed unauthorized roads are re-opened for short periods (<1yr) and then a negligible net-negative road drainage network with the harvest road roadwork. Following the harvest related roadwork portions of the project, the net road network is reduced by about 6.2 miles with decommissioning and 6.7 miles of hydrologic storage. This includes a reduction of about 2.0 mile of RR road as shown in Table 52 under Post Harvest. Additionally, the restorative roadwork with the harvest would remove a six crossings, making direct improvements reducing the drainage network (Table 54). This would reduce the artificial drainage network by an estimated 1.5 miles or ~3%. The post-harvest phase of the project would further reduce the road network by up to almost 18 miles and closure of 16.5 miles.

Streams draining Libby are generally in stable conditions, with adequate vegetation to protect banks and dissipate stream energy. Streambank stability in NF Libby, SF Libby, and mainstem Libby Creeks were greater than 90% in 2010 (USDI 2010). Anticipated changes in stream flow due to changes in road density (<1%) and drainage network (negligible) would not measurably affect peak or base flows during harvest or from the harvest related restoration roadwork.

Table 52. Mission RR roads – Riparian Road Mileage by Project Phase. Green shows roads only used and treatments done associated with harvest-funded work.

Road Status	Exist. Cond. (All Roads)	Exist. Cond. (Haul Routes Only)	Harvest Phase (Haul Routes Only)	Post-harvest (Haul Routes Only)	Post-Harvest (All Roads)
ML3 – Pass. Car	3.13	2.89	2.89	2.89	3.13
ML2 – High-clearance	3.34	1.95	4.06	1.41 (-28%)	1.88 (-56%)
ML1 – Closed	6.18	1.73		0.13	0.63
Unauth. (Closed)	1.71	0.38			
Unauth. (Open)	0.13				
ML2 - Admin				0.51	0.92
Decommissioned				-2.01	-7.93
All Roads	14.49	6.95	6.95	4.94 (-29%)	6.56 (-55%)

Table 53. Mission Road Densities by Project Phase. Green shows road changes from just harvest funded road work.

Sub-watershed	Current road mileage and sub-watershed square miles		Road Densities (mi/mi²)			
			Prior to Implementation	During Implementation	Post-Harvest Implementation	Post All Treatments Implementation
Libby	76.5	40.4	1.89	1.9 (+0.005%)	1.71 (-10%)	1.27 (-32%)

Table 54. Mission Road-Stream Crossings by Project Phase. Green shows road changes from just harvest funded road work.

Sub-watershed	# of Stream Xings	During Implementation	Post-Harvest Implementation	Post-Harvest Treatments	Post All Treatments Implementation	Post All Treatments
Libby	52*	52	46 (-11%)	6 Decom	27 (-48%)	17>Decom, 8.ML1

*This value conservatively assumes all closed roads have culverts in place, which has been the is from opening closed roads for log hauling.

Element summary: Based on the slight increases to road density and riparian road drainage, the project would have a short-term minor negative impact to these metrics (1-3 years) and to peak and base flows. Following the post-harvest road decommissioning and road closure, six crossings (~12%) of the crossings would be removed. The restorative roadwork, albeit minor, would result in a long-term positive (+) effect via reductions in the overall road network. The post-project road decommissioning and closures would all provide further movement towards restoration for the project area drainages. Incorporation of current unauthorized roads would provide the opportunity for road maintenance and associated improvements to road-related hydrological conditions that exist with currently no maintenance. Overall, the reduction of the road network across the Libby Creek drainage area would be 6.2 miles from the harvest related work and a total of 9.3 miles once the project is completed. Note - the net in change in RR road mileage is 2.0 miles. The 6.2 miles, though not reflected in the first table, is the overall net change in road mileage associated with timber harvest. These reductions will also allow the roads program to better focus shrinking maintenance budgets on roads that needed, thus reducing their effects. The proposed harvest-related road activities would result in a **short-term insignificant negative (-)** and **long-term insignificant positive (+) effect** on the Drainage Network, Road Density, and Changes to Peak/Base Flows.

Indicator summary: The harvest and road management PEs would change the drainage network slightly. There will some minor short-term negative for the drainage network, as skid trails will compact some soils and closed roads opened, but mitigation measures will effectively decouple this disturbance and potential for rill development from the stream network. Temporary road construction, management, and hauling will have an inconsequential negative short-term on the drainage network. Long term, road management activities associated with the harvest will minimally reduce the total size of the drainage network associated with roads by reducing road density from 1.89 to 1.71 mi/mi^2. Included in this would be the removal of six stream crossings (11% of total) and likely multiple ephemeral draw culverts, resulting in a decrease of the dominant link between roads and streams. The magnitude of change resulting from these improvements would be a **short-term insignificant negative (-) effect** and a **long-term insignificant positive (+) effect** in the long-term for this indicator.

Watershed Indicators

Disturbance History

The project proposes to harvest timber on 1,897 acres total with 1,322 acres within Libby Creek sub-watershed. Harvest related roadwork would have a slight net decrease in road density (0.18 miles/square mile). About 255 acres of treatments would occur in RRs ranging from commercial harvest, non-commercial thinning, and prescribed fire and restorative road treatments all with the objective of improving conditions in presently overstocked stands with high densities, reducing wildfire risks, and reducing sediment sources. Vegetation and prescribed fire related activities would have insignificant negative and positive effects. The analysis of effects to the peak flow indicator determined the proposed timber harvest would not result in measurable changes in peak and base flow volumes. Consequently, there would be an **insignificant negative (-) effect** to the disturbance history.

Riparian Reserves

The proposed vegetation treatments in RRs include 44.1 acres of commercial harvest and 413 acres of non-commercial thinning. Prescribed fire includes 252.7 acres of pile burning and 1.8 acres of machine pile burning. As an adaptive management proposal, 7.6 acres of machine piling would occur over flat ground and up to 153 acres of hand piling and pile burning on the proposed underburning RR acres. Harvest and other actions would occur within outer bands of RRs, in areas not described as riparian or wetland, either in soil- or vegetation-type. Setbacks would be sufficient to protect key habitat elements including provision of shade/ maintenance of temperature, recruitment of large woody debris, wildlife connectivity, and buffering capacity for overland transport of fine sediment or other contaminants. Overall, we expect the Commercial Harvest and Prescribe Fire PEs to result in a **temporary insignificant negative (-) effect** to the Riparian Area indicator and have **no effect** to RRs or off-forest riparian areas associated with ESA-listed salmonids.

Disturbance Regime

The proposed timber harvest, prescribed fire, and road construction activities would result in insignificant effects the disturbance regime. The proposed 413 acres of vegetation and prescribed fire treatments occur on less than 1/5 of the total RR acres. Over half of these acres are light treatments (non-commercial thinning and handpile burning). The prescribed no treatment buffers would protect stream conditions and fish habitat. Temporary road construction, management, and hauling will have an inconsequential negative short-term on the drainage network. Long term, road management activities associated with this project will move the project area towards a more stable condition, albeit the improvements would be negligible. The magnitude of change resulting from these improvements would be a **short-term insignificant negative (-) effect** and a **long-term insignificant positive (+) effect** in the long-term for the disturbance regime indicator.

ESA Effects Determination

Project Effects Determination Key – Mission Restoration Project

Effects determinations for all indicators were similar across the two major sub-watersheds. The project effects determination key will make a single determination for the two watersheds.

Project effects determination key for Columbia River Bull Trout, Upper Columbia Spring Chinook Salmon, and Upper Columbia Steelhead, and their Designated Critical Habitat

1) Do any of the indicator summaries have a positive (+) or negative (-) conclusion?

   Yes – Go to 2
   No – No Effect

2) Are the indicator summary results only positive?

   Yes – NLAA
   No – Go to 3

3) If any of the indicator summary results are negative, are the effects insignificant or discountable?

   Yes – NLAA - Bull Trout, Steelhead, Spring Chinook
   No - LAA

<u>Summary of Effects to Listed Fish and Critical Habitat</u>

The Mission Restoration Project, as a whole, would make substantial improvements to restoring watershed processes related to road-stream interactions that include reducing chronic sediment sources, reducing artificial drainage networks, reducing road density, storm-proofing the road network, improving fish passage, increasing habitat in important fish habitat reaches, increasing natural water storage, and increasing resiliency in RRs. The non-ARBO II bin activities analyzed in this BA would range from neutral to insignificant impacts to steelhead, bull trout, and spring chinook habitat.

Bull Trout
Designated bull trout critical habitat extends into the headwaters of WF Buttermilk Creek and to RM 3.0 in EF Buttermilk. Documented spawning and rearing habitat exists in both of these streams, above where any project effects would occur. Little use is believed to occur in Libby Creek based on past pit-tag data and snorkel survey. Foraging bull trout may use, on occasion, Libby Creek and they are confirmed to use the mainstem of Buttermilk Creek. Some non-ARBO II road treatments would occur on roads crossing over occupied bull trout habitat, but no activity is proposed within occupied stream channels and therefore would not result in any direct effects to fish or critical habitat.

Bull Trout PCE

The 2010 CH designation for CR bull trout provided a list of nine PCEs to evaluate in addition to the Matrix of Pathways and Indicators (MPI) subsequently discussed in this assessment (75 FR 63897). The nine PCEs elate to: (1) Water quality; (2) migration habitat; (3) food availability; (4) instream habitat; (5) water temperature; (6) substrate characteristics; (7) stream flow; (8) water quantity; and (9) nonnative species. All of these PCEs are present within Methow River Sub-basin except for the marine shoreline component of the 'instream habitat' PCE. No Forest actions or action areas occur within marine shoreline habitats.

The following crosswalk tables show how PCEs 1 through 9 correspond to the MPI habitat indicators that are considered in this assessment.

PCE 1. Springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) to contribute to water quality and quantity and provide thermal refugia.

PCE 1 Criterion	MPI Habitat Indicator(s)
Water quantity	Change in peak/base flows
Water quality	Water temperature Sediment/turbidity Chemical contamination/nutrients
Thermal Refugia	Water temperature

Effect Determination to bull trout Designated Critical Habitat (DCH) PCE 1

Effect to this PCE would not be adversely affected because no changes to water quantity or stream temperature are expected. Short-term, insignificant increases in stream sediment levels would occur followed by long-term reductions in road related sediment delivery. Bull trout spawning life stages occur above the ESA Action Area. Sub-adult and juvenile bull trout are likely to occupy the ESA Action Area.

PCE 2. Migration habitats with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and freshwater and marine foraging habitats, including but not limited to permanent, partial, intermittent, or seasonal barriers.

PCE 2 Criterion	MPI Habitat Indicator(s)
Permanent, partial, intermittent, or seasonal barriers	Physical barriers Water temperature

Effect Determination to bull trout DCH PCE 2

Effect to this PCE would be neutral because migratory conditions within DCH or potential bull habitat would not be measurably changed or have no change.

PCE 3. An abundant food base, including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.

PCE 3 Criterion	MPI Habitat Indicator(s)

Food base*	All MPI habitat indicators

*There is no directly corresponding MPI habitat indicator for food base. Bull trout are opportunistic feeders that prey upon other organisms such as terrestrial and aquatic insects, macrozooplankton, and small fish and adult migratory bull trout feed almost exclusively on other fish. Habitat must provide the necessary aquatic and adjacent terrestrial conditions to harbor and maintain prey species in sufficient quantity and diversity to meet the physiological requirements necessary to maintain bull trout populations. We do not typically collect biological data to assess aquatic food webs. All the MPI habitat indicators influence the production of aquatic and terrestrial invertebrates and small native fish; therefore, "Food Base" will be indirectly assessed by all of the MPI habitat indicators.

Effect Determination to bull trout DCH PCE 3

Effect to this PCE would not be adversely affected because no changes to water quantity or stream temperature are expected. Short-term, insignificant increases in stream sediment levels would occur followed by long-term reductions in road related sediment delivery. It is unlikely any measurable change would occur to bull trout's prey base or prey habitat.

PCE 4. Complex river, stream, lake, reservoir, and marine shoreline aquatic environments, and processes that establish and maintain these aquatic environments, with features such as large wood, side channels, pools, undercut banks and unembedded substrates, to provide a variety of depths, gradients, velocities, and structure.

PCE 4 Criterion	MPI Habitat Indicator(s)
Complex Aquatic Environment*	Water temperature Substrates Large wood Off-channel habitat Pool frequency and quality Large pools Refugia Width/Depth ratio Streambank condition Floodplain connectivity

*There is no marine shoreline habitat in the Action Area therefore it would not apply.

Effect Determination to bull trout DCH PCE 4

Effect to this PCE would not be adversely affected because no changes to water quantity or stream temperature are expected. Short-term, insignificant increases in stream sediment levels would occur followed by long-term reductions in road related sediment delivery. In the long-term, less sediment delivery would improve existing rearing and foraging habitat.

PCE 5. Water temperatures ranging from 2 to 15 [deg]C (36 to 59 [deg]F), with adequate thermal refugia available for temperatures that exceed the upper end of this range. Specific temperatures

within this range will depend on bull trout life-history stage and form; geography; elevation; diurnal and seasonal variation; shading, such as that provided by riparian habitat; streamflow; and local groundwater influence.

PCE 5 Criterion	MPI Habitat Indicator(s)
Thermal Refugia	Water temperature

Effect Determination to bull trout DCH PCE 5

This PCE would not be adversely affected because stream shading will not be measurably changed by the project.

PCE 6. In spawning and rearing areas, substrate of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. A minimal amount of fine sediment, generally ranging in size from silt to coarse sand, embedded in larger substrates, is characteristic of these conditions. The size and amounts of fine sediment suitable to bull trout will likely vary from system to system.

PCE 6 Criterion	MPI Habitat Indicator(s)
Substrate amount, size, and composition	Substrate

Effect Determination to bull trout DCH PCE 6

Effect to this PCE would not be adversely affected because the project design criteria and mitigation would limit changes to sediment to be short-term, iimmeasurable levels. The long-term change would be reductions in road related sediment delivery, which would improve rearing and foraging habitat.

PCE 7. A natural hydrograph, including peak, high, low, and base flows within historic and seasonal ranges or, if flows are controlled, minimal flow departure from a natural hydrograph.

PCE 7 Criterion	MPI Habitat Indicator(s)
Flow/Hydrology	Change in peak/base flows Increase in drainage network

Effect Determination to bull trout DCH PCE 7

This PCE would not be adversely affected at the sub-watershed scale because no part of the proposed project would alter hydrology such that measureable changes to summer base flows or peak flows would occur.

PCE 8. Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited.

PCE 8 Criterion	MPI Habitat Indicator(s)
Water Quality	Water temperature Sediment/turbidity Chemical contamination/nutrients

Water Quantity	Change in peak/base flows Increase in drainage network

Effect Determination to bull trout Designated Critical Habitat (DCH) PCE 8
Effect to this PCE would not be adversely affected because no changes to water quantity or stream temperature are expected. Additionally, no part of the project would put chemicals or other like materials into streams. Short-term, insignificant increases in stream sediment levels would occur followed by long-term reductions in road related sediment delivery. The artificial road drainage would have an inconsequential increase during the project and a larger decrease in the long-term. Bull trout spawning life stages occur above the ESA Action Area. Sub-adult and juvenile bull trout are likely to occupy the ESA Action Area.

PCE 9. Sufficiently low levels of occurrence of non-native predatory (e.g., lake trout, walleye, northern pike, smallmouth bass); interbreeding (e.g., brook trout); or competing (e.g., brown trout) species that, if present, are adequately temporally and spatially isolated from bull trout.

PCE 9 Criterion	MPI Habitat Indicator(s)
Non-native Fish Species*	Summary/Integration of all Species and Habitat Indicators

*There is no directly corresponding MPI habitat indicator for non-native fish species that present risks to bull trout. Eastern brook trout is a non-native trout species stocked within the Upper Columbia Basin that poses the greatest risk to bull trout relating to predation, displacement, and interbreeding. Brook trout competes with bull trout for food and space, they can hybridize with bull trout and adult brook trout are known to feed on juvenile bull trout. Brook trout can also displace bull trout from rearing areas. In some streams, brook trout are so well established that they may have greatly reduced the number of bull trout in them (USFWS 2002). We do not collect data on brook trout population size but do have data on their distribution. Non-native fish species will be indirectly assessed by the Summary/Integration of all Species and Habitat Indicator.

Effect Determination to bull trout DCH PCE 9
This PCE would not be adversely affected.

In Summary, we expect some short, temporary increases in fine sediment delivery that would be immeasurable and insignificant. Road maintenance and log hauling would occur under dry conditions. Slight improvements would occur in Buttermilk Creek, but they would not result in measurable improvements.

Activities in The Libby Creek drainage are in closer proximity to fish habitat, but bull trout presence there is suspected to be very low. Although we expect slight more sediment impacts, they are still expected to be immeasurable. Thus, the proposed actions covered under this stand-alone BA would result in a ***may affect, not likely to affect*** bull trout habitat.

Steelhead and Chinook
Steelhead critical habitat is designated in the mainstem of Buttermilk Creek at RM 2.4 and up to 3.4 in Libby Creek. Occupied rainbow/steelhead habitat exists in WF Buttermilk, EF Buttermilk, and in the lower part of Black Pine Creek. In the Libby Creek drainage, they occur throughout mainstem Libby Creek and the lower parts of NF and SF Libby Creeks.

Chinook critical habitat is located in the lower part of Buttermilk Creek and in the Methow River, outside of Libby Creek. Juveniles and perhaps some adults use the lower parts of these streams as well.

Steelhead and Chinook PCEs
The 2005 CH designation for UCR spring-run Chinook and steelhead provided a list of six PCEs to evaluate in addition to the Matrix of Pathways and Indicators (MPI) subsequently discussed in this assessment (70 FR 52630). The PCEs consist of the physical and biological features (PBFs) identified as essential to the conservation of the listed species in the documents that designate critical habitat. A summary of the PBFs are freshwater spawning areas, freshwater rearing areas, freshwater migration corridors, estuarine areas, nearshore marine areas, and offshore marine areas. According to the NMFS designation of where the six PBFs would apply for these species, only the first three apply for the Methow River sub-basin. In addition, no Forest actions or action areas occur within estuarine habitats, nearshore marine habitats, or offshore marine habitats.

The following crosswalk tables show how PBFs within the range of habitat types within the scope of effects from the proposed project and how they correspond to the MPI habitat indicators that are considered in this assessment.

PBF 1. Freshwater spawning features include water flow, quality and temperature conditions and suitable substrate for spawning and incubation, as well as migratory access for adults and juveniles.

Site Attribute	MPI Habitat Indicator(s)	Species Life History Event
Substrate	substrate	Adult Spawning Embryo Incubation Alevin Growth and Development
Water quality	Water temperature Sediment/turbidity Chemical contamination/nutrients	
Water quantity	Change in peak/base flows	

Effect Determination to UCR steelhead and chinook DCH PBF 1
This PCE will not be adversely affected because project related fine sediment delivery would be immeasurable in DCH. Effects to water temperatures and flow regimes would be immeasurable and insignificant at the sub-watershed scale.

PBF 2. Freshwater rearing habitat features include sites with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as

shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.

Site Attribute	MPI Habitat Indicator(s)	Species Life History Event
Water quantity	Change in peak/base flows	Fry emergence from gravel Fry/parr/smolt growth and development
Floodplain connectivity	Floodplain connectivity	
Water quality	Water temperature Sediment/turbidity Chemical contamination/nutrients	
Forage*	Water quality indicators Riparian reserves Substrate Large woody debris	
Natural cover	Water temperature (shade) Riparian reserves Large woody debris Substrate Pool frequency Pool quality Width/depth ratio Floodplain connectivity Off-channel habitat Streambank condition	

*There is no directly corresponding MPI habitat indicator for forage. We do not typically collect biological data to assess aquatic food webs and nutrient cycles; therefore "Forage" will be indirectly assessed by the following relevant/related MPI habitat indicators in this assessment. The primary food items for juvenile anadromous salmonids are aquatic and terrestrial invertebrates. Production of aquatic invertebrates is influenced by water quality. Fine sediment and substrate embeddedness affect living space for aquatic invertebrates and sustained elevated turbidity may reduce aquatic invertebrate production and the ability of juvenile fish to find invertebrate food items. Chemical contamination may reduce or eliminate production of certain aquatic invertebrates and excess nutrient levels may lead to lethal or sublethal effects to aquatic invertebrates. "Forage" is also influenced by the extent and condition of riparian vegetation as evaluated by the MPI Riparian Reserve indicator. Shade provided by streamside vegetation influences water temperatures which, in turn, affects aquatic invertebrate production. Organic matter from riparian vegetation provides allocthonous inputs that sustain aquatic food webs. Woody debris provides substrate and a food source for aquatic invertebrates. Riparian vegetation provides food and substrate for terrestrial invertebrates which become a significant food source when they drop to the water below.

Effect Determination to UCR steelhead and chinook DCH PBF 2

This PCE will not be adversely affected because project related effects to water quantity, quality, and habitat conditions would be immeasurable in DCH.

PBF 3. <u>Freshwater migration</u> habitat features include water flow, quality and temperature conditions supporting larval and adult mobility, abundant prey items supporting larval feeding after yolk sac depletion, and free passage (no obstructions) for adults and juveniles.

Site Attribute	MPI Habitat Indicator(s)	Species Life History Event
Water quantity	Change in peak/base flows	Adult sexual maturation Adult upstream migration and holding Kelt (steelhead) seaward migration Fry/parr/smolt growth, development, and seaward migration
Water quality	Water temperature Sediment/turbidity Chemical contamination/nutrients	
Freshwater migration corridors free of obstruction	Physical barriers	
Natural cover	Water temperature (shade) Riparian reserves Large woody debris Substrate Pool frequency Pool quality Width/depth ratio Floodplain connectivity Off-channel habitat Streambank condition	

Effect Determination to MCR steelhead DCH PCE 3
Effect to this PCE would be neutral because migratory conditions within DCH or potential steelhead/bull habitat would not be changed.

As stated above under the bull trout section, we expect slight increase in sediment delivery the harvest related road work and potentially from the harvest work. The use of BMPs and design criteria such as low impact harvest methods would reduce potential sediment impacts so they are not likely measurable. Because the impacts would be immeasurable, the result would be insignificant. Thus, the proposed actions included in this BA would result in a ***may affect, not likely to adversely affect*** steelhead and chinook habitat.

<u>Essential Fish Habitat</u>

The Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act), as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267) requires federal agencies to consult with NOAA Fisheries on activities that may adversely affect essential fish habitat (EFH). In addition, the law requires fishery management councils to include descriptions of EFH and potential threats to EFH in all federal fishery management plans.

The objective of this EFH assessment is to determine whether or not the proposed action(s) "may adversely affect" designated EFH for relevant commercially, federally-managed fisheries species within the proposed action area. It also describes conservation measures proposed to avoid,

minimize, or otherwise offset potential adverse effects to designated EFH resulting from the proposed action.

Essential fish habitat is defined in the Magnuson-Stevens Act as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. The law provides the following additional definitions for clarification:

- "Waters" include aquatic areas and associated physical, chemical, and biological properties used by fish, and may include areas historically used by fish as appropriate.
- "Substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities.
- "Necessary" means the habitat required to support a sustainable fishery and the managed species contribution to a healthy ecosystem.
- "Spawning, breeding, feeding, or growth to maturity" covers the full species life cycle.

Essential Fish Habitat has been designated by the National Marine Fisheries Service (NMFS) within the Buttermilk sub-watersheds under the Magnuson-Stevens Fishery Conservation and Management Act. EFH includes all Chinook and coho salmon habitat, either currently occupied or historically accessible. In the Buttermilk Creek sub-watershed, approximately 1.4 RM of EFH for Chinook and coho have been designated and in Libby Creek, approximately 2.5 RM is accessible and designated. The Twisp and Methow River, from their mouths to well beyond the project area sub-watersheds are designated as EFH.

Potential Adverse Effects of Proposed Action on EFH for Salmonids

For the proposed non-ARBO II bin actions, effects analyses pertain to species protected under both EFH status and Endangered Species Act protection. Consequently, the effects analysis for EFH cross-references the effects analyses and findings provided within this BA for ESA salmonid critical habitat. The effects analysis pertains to critical habitat for UCR steelhead and spring Chinook, and mid-Columbia bull trout. Collectively, these species' life histories and habitat requirements represent the needs of coho salmon well and are appropriate for use as a surrogate for EFH habitat effects determinations. ESA effects determinations are limited to findings of either *no effect* or *may affect not likely to adversely affect* for all habitat indicators. As such, we conclude that there may be minor, temporary effects to some habitat indicators; however, any effects would be limited to short-term, temporary effects, or effects with insignificant magnitude. Therefore, this project as proposed with the implementation of conservation measures will **not result in an adverse effects to Essential Fish Habitat** in the either the Twisp or Lower Methow River watersheds.

Summary of Aquatic Conservation Strategy (ACS) Consistency

The Aquatic Conservation Strategy (ACS) is an integral part of the 1994 Northwest Forest Plan (USDA and USDI 2004) that was developed to restore and/or maintain the ecological health of watersheds and aquatic ecosystems within public lands. The ACS has nine objectives (USDA and USDI 2004: B-11) toward meeting the goal of healthy ecosystems and watersheds. Design criteria and mitigation measures for the proposed Mission Restoration project are designed so the project would be consistent with the ACS at sub-watershed and watershed scales.

The ACS most pertinent to the desired conditions and riparian management objectives within the project area, and that were tracked through the analysis are as follows:

- ACS objective #4 - Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems.
- ACS objective #5 - Maintain and restore the sediment regime under which aquatic ecosystems were formed.
- ACS objective #6 - Maintain and restore instream flows sufficient to create and sustain riparian, aquatic, and wetland habitats and to retain patterns of sediment, nutrient, and wood routing. The timing, magnitude, duration, and spatial distribution of peak, high, and low flows must be protected.
- ACS objective #8 - Maintain and restore the species composition and structural diversity of plant communities in riparian areas and wetlands to provide adequate summer and winter thermal regulation, nutrient filtering, appropriate rates of surface erosion, bank erosion, and channel migration and to supply amounts and distributions of coarse woody debris sufficient to sustain physical complexity and stability.

The preferred alternative for the Mission Restoration project would meet management objectives to: improve hardwood species in select areas to improve future beaver release sites, improve existing aspen stands, restore natural stand conditions in outer portions of riparian reserves by leaving the largest trees on site and removing overstocked shade tolerant competitors, maintain stream temperatures through the use of “no activity” buffers, maintain large wood within channels by falling trees towards and into the stream channel along Chicamun Creek and leaving a no treatment buffer next to streams to provide for long term woody debris input, and avoid adverse water yield by leaving adequate forest cover to prevent increased flows. Site-specific prescriptions for the project will maintain current conditions or move conditions towards the range of natural variability for the water quality and riparian vegetation ACS objective (#4 & 8). Restoration treatments would improve past altered riparian zones, fish habitat, and sediment regimes.

Due to the moderate volume of roads and their extensive hydrologic connectivity across the Mission project area, the proposed road treatments have the greatest potential to affect the sediment regime ASC objective #8. There would some minor short-term sediment produced during project activities. However, with the modified road treatment proposal of rock-armoring, road closure, and decommissioning, the project would result in a net reduction in sediment production during and after the project. In the long-term, the project would move sediment rates (ACS objective #5) toward naturally occurring conditions.

Buttermilk Creek is within the larger Twisp River Tier 1 Key Watershed, for which the NWFP provides direction for no net increase in road miles over the baseline conditions. The baseline road mileage against which new road construction is compared is the mileage that existed on May 13, 1994, the effective date of the NWFP ROD (REO 1999). Since the signing of the

NWFP, the Forest Service decommissioned an estimated 38.4 miles of road across the Twisp River Key Watershed, which includes about 14 miles in the buttermilk Creek sub-watershed. The 1996 Shady Timber Sale in the Buttermilk Creek drainage decommissioned 14 miles of roads. A few years later, the TPR Timber Sale in the Little Bridge Creek area decommissioned 24.2 miles with a decision date of 2000. According to our guidance on road density in Key Watersheds, there is no language suggesting unauthorized roads are not counted in the decommissioning. None the less, there has been substantially more decommissioning since the ROD was signed than the small temporary roads proposed in Mission.

Road Type	Miles Decommissioned
System	22.7
Unauthorized	15.7
Grand Total	38.4

This project proposes 0.8 miles of new temporary road that would be decommissioned the same year or right after haul use is done. The project proposes 0.9 miles of road decommissioning from the proposed timber sale funds. Buttermilk Creek, and the larger Twisp River, is already at a substantial net reduction on road miles and this project's short-term (1-2yrs) of temporary road construction would not result in a net increase in road mileage. Additionally, the proposed temporary roads are outside of any RRs with no mechanism to affect streams. Therefore, the roadwork proposed in the Buttermilk Creek drainage associated with timber harvest would be consistent with the Key Watershed Standard.

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Appendix A: Vegetation Prescriptions and Prescribed Fire Treatments

COMMERCIAL THINNING PRESCRIPTIONS

Aspen Release (Aspen) (8 units/ 160 acres total)

Conifers of merchantable diameter would be harvested to release existing aspen trees from conifer encroachment and promote the establishment of aspen and other hardwood regeneration. This treatment would be applied to reduce conifer competition for sunlight and soil moisture, improve the vigor of existing aspen trees, and stimulate sprouting of new aspen stems where conifers have invaded or are shading out aspen clones.

Conifer removal for aspen release treatment would be implemented within existing aspen clones (defined as five or more healthy aspen trees greater than or equal to five feet tall located within a 15 foot radius) and a 50 foot wide buffer located adjacent to aspen clone perimeters. Desired treatment objectives include 10 percent or less canopy closure contributed by conifers following treatment within aspen stands and the adjacent buffer (Shepherd, et al. 2006; Swanson, et al. 2010). Implementation of this objective would be achieved by retaining a maximum stocking level of approximately ten merchantable sized conifers per acre following treatment within aspen stands and the buffer. Ponderosa pine is the preferred conifer species to retain within aspen stands and the adjacent buffer. Douglas-fir and subalpine fir are the least preferred conifer species to retain within aspen stands and the adjacent buffer. The largest conifers of the most preferred species present would be favored for retention. Conifers would be retained in clumps when possible to attain conifer canopy closure objectives. Live defective conifers with favorable characteristics for wildlife habitat would be retained within and adjacent to aspen stands. Douglas-fir and subalpine fir 21 to 24 inches DBH with an estimated age of less than 150 years (based on criteria described in Van Pelt 2008) would be harvested where needed to achieve desired conifer stocking levels except in areas with field verified old forest multistory structure located in unit 21. All conifers larger than 24 inches DBH and 21 to 24 inches DBH with an estimated age of 150 or more years would be retained in aspen clones and the adjacent buffers even if conifer stocking exceeds the desired maximum retention level. No aspen or other deciduous broadleaf trees would be harvested.

Conifer stands within aspen release treatment unit boundaries which are located outside of aspen clones and more than 50 feet away from aspen clone perimeters would be treated with the Dry Forest Restoration Thin (DFR) or Dry Forest Thin with Dwarf Mistletoe Reduction (DFDMT) harvest treatments, which are described below, depending on existing stand conditions.

Non-merchantable conifers remaining following harvest would be felled in aspen clones and adjacent 50 foot wide buffers to reduce competition with existing aspen stems and promote expansion of aspen clones.

Dry Forest Restoration Thin (DFR) (49 units/ 1,288 acres total)

Conifers of merchantable diameter would be harvested to maintain and restore elements of historic forest stand structures including tree density, large and old trees, species composition, and spatial patterns (including tree clumps, individual trees, and canopy openings) to increase

stand and landscape resiliency to natural disturbances including forest insect attacks, tree diseases, and wildfires. Desired residual tree density, species composition, and spatial patterns within stands are derived from data collected in reference stands located in the eastern Washington Cascades (Nature Conservancy et al. 2016; Ohlson and Schellhaas. 2002; Ohlson 1996) and previously implemented projects on the Methow Valley Ranger District. This treatment would be applied primarily in densely stocked mixed conifer species or ponderosa pine stands with single or multiple canopy layers (stem exclusion closed canopy, young forest multistory, or understory re-initiation stand structures) and sufficient numbers of healthy trees in the upper canopy layer to achieve desired density, species composition, and spatial pattern of residual trees. The majority of trees in stands with this proposed treatment are less than 150 years old and large (> 25 inches DBH) and old trees (≥ 150 years) may be nonexistent to relatively abundant. Dwarf mistletoe and root disease may be present in individual trees or small pockets and are not widespread throughout treated stands.

The table below displays the desired range of post-harvest tree density levels of residual merchantable sized conifers and 5 inch DBH or larger aspen trees for proposed dry forest restoration thin harvest units. Anticipated tree mortality caused by post-harvest fuels treatments would be taken into consideration during development of timber marking guidelines to achieve desired live tree density levels. Plant association groups in the Mission analysis area are described in the *Field Guide for Forested Plant Associations of the Wenatchee National Forest* (Lillybridge, et al. 1995). Target numbers of trees to remain will vary within harvest units based on plant association group and would be reduced based on root disease and the presence of dwarf mistletoe.

Mission Desired Tree Stocking Levels in Dry Forest Restoration Thin Harvest Units

Plant Association Group(s)	Approximate average number of trees per acre retained
Hot-dry ponderosa pine and Douglas-fir	20 - 30
Warm-dry and warm-mesic Douglas-fir	30 - 50
Cool-dry Douglas-fir and subalpine fir	40 - 50

The desired spatial pattern or horizontal arrangement of residual trees within stands can best be described in terms of individual trees, tree clumps, and canopy openings (Churchill et al. 2014; Larson and Churchill 2012; Larson et al. 2012). A clump of trees is defined as two or more trees in close enough proximity that a portion of their crowns are interlocking. Approximately 65 percent of residual trees in dry forest restoration thin harvest units would be retained in clumps of various size with a spacing of 20 feet or less between leave tree boles. A leave tree is considered part of a clump if the bole of the tree is located 20 feet or less horizontal distance from at least one other leave tree bole. Approximately 35 percent of residual trees would be retained as individual trees located more than 20 feet away from all other leave trees. To promote an irregular distribution of residual trees, average tree stocking and clump target levels would be achieved over the entire area of a treatment unit rather than on every acre. Canopy openings would be comprised of those areas where the distance between residual tree boles is greater than

3 times the maximum "clumped" tree distance (60 feet). Canopy openings, generally expected to be one third acre in size or less, would occur on approximately 20 percent of treatment areas.

Generally, the largest and most vigorous conifers (with regard to height, bole diameter and live crown volume) of the most preferred species present in a given area would be retained to achieve the target or desired stocking levels and spatial pattern of residual trees. All trees greater than 24 inches DBH would be retained. All trees 21 inches DBH and larger with an estimated age of 150 years or greater (based on criteria described in Van Pelt 2008) would be retained and vigorous trees would be released from competition with adjacent younger and smaller trees. Live defective trees and dying trees would be retained as needed to provide cavity dependent habitat. Complex patches which include large snags, live defective trees, large and old trees, or large dwarf mistletoe infected trees would be retained. No aspen or other deciduous broadleaf trees would be harvested. Aspen clones one quarter acre and larger (includes adult trees and suckers) in size included within dry forest restoration thin harvest units would receive the previously described Aspen Release (Aspen) harvest treatment (see Aspen Release description below for specifications). Aspen trees of at least 5 inches DBH would count towards individual and clump targets.

Dry Forest Restoration Thin with Dwarf Mistletoe Reduction (DFDMT) (10 units/ 284 acres total)

This treatment is similar to the previously described dry forest restoration thin treatment with an emphasis on reducing Douglas-fir dwarf mistletoe infection levels in treated stands. This treatment would be applied in mixed conifer species stands comprised primarily of trees less than 150 years old with sufficient healthy ponderosa pines, Douglas-firs, and other conifer species to achieve desired density levels in the majority of the stand and moderate to high levels of Douglas-fir dwarf mistletoe infection in other portions of the stand. These stands typically have multiple canopy layers including areas with densely stocked trees, openings, and widely spaced trees. Large (> 25 inches DBH) and old (≥ 150 years) Douglas-fir and ponderosa pines may be present in some stands.

The Dry Forest Restoration Thin harvest treatment would be applied throughout areas that are adequately stocked with vigorous and disease-free trees to meet density, species composition, and spatial pattern treatment objectives. Young and mature trees (with an estimated age of less than 150 years) 20 inches DBH and smaller infected with dwarf mistletoe would be harvested throughout treatment units to achieve dry forest restoration thin tree retention objectives (including heterogeneous spatial patterning of residual trees) and reduce the proportion of infected trees in treated stands. Vigorous trees with low infection levels (dwarf mistletoe infection ratings generally of 2 or less; Hawksworth 1977) would be retained where needed to achieve tree retention objectives. Infected trees 21 to 24 inches DBH with an estimated age of less than 150 years would be harvested on a case by case basis consistent with stand treatment objectives. All trees 21 inches DBH and larger with an estimated age of 150 or more years (based on criteria described in Van Pelt 2008) would be retained and vigorous trees not infected with dwarf mistletoe would be released from competition with adjacent younger trees. Aspen clones one quarter acre and larger in size included within dry forest restoration thin harvest units would receive the previously described Aspen Release (Aspen) harvest treatment.

Treatment objectives include reducing future susceptibility to Douglas-fir dwarf mistletoe infection in treated stands. This includes shifting trees species composition towards ponderosa pine and other conifer species that are not susceptible to Douglas-fir dwarf mistletoe and confining infections in residual trees where possible. Infected trees 21 inches DBH and larger would be retained as isolated individuals or discrete clumps with the removal of smaller Douglas-firs located within 50 feet to reduce the spread of dwarf mistletoe (Schmitt 1997). Removal of suppressed, diseased or dwarf mistletoe susceptible trees may result in post-harvest conifer stocking levels up to approximately 25 percent less than the respective dry forest restoration thin (DFR) desired residual tree stocking numbers displayed above. Canopy openings larger than two acres created by harvest and post-harvest fuels treatments would be assessed to determine if reforestation with pines or other non-susceptible species is needed to meet treatment objectives.

Moist Forest Thin (MFT) (4 units/ 70 acres total)

Conifers of merchantable diameter would be harvested to maintain or promote the development of large trees and multistory stand structure in two stands totaling an estimated 38 acres (units 1 and 65) currently providing or with potential to provide northern spotted owl habitat. This treatment would be applied primarily in densely stocked mixed conifer stands with multiple canopy layers (young forest multistory stand structure) where the majority of trees are less than 150 years old and large and old trees are present in the overstory canopy layer. Treatment objectives include retaining multistory stand structure while reducing stand density to 60% or greater canopy closure with variable thinning from below to remove smaller subordinate trees which are competing with larger trees present in treated stands. All trees 18 inches DBH and larger would be retained. Areas comprised primarily of trees less than 18 inches DBH would be thinned to retain vigorous trees, reduce but not necessarily eliminate dwarf mistletoe infection, and provide growing space for residual trees to develop into larger trees. The preferred spatial pattern for tree retention would include approximately 70% or greater of trees retained in clumps of variable size comprised primarily of Douglas-firs and 30% or less individual trees. Vigorous old ponderosa pine trees 21 inches DBH and larger with an estimated age of 150 years or greater (based on criteria described in Van Pelt 2008) would be treated with release felling to remove trees less than 18 inches DBH with crowns located within the pine tree canopy dripline. Trees growing within the canopy dripline of declining pines (less than 30% live crown ratio) 21 inches DBH and larger would be retained to promote clump development around future snag recruits. Complex patches which include large snags, live defective trees, large and old trees, or large dwarf mistletoe infected trees would be retained. Canopy openings created by tree removal would be limited to one quarter acre and smaller in size.

Conifers of merchantable diameter would be harvested to reduce subalpine fir/Engelmann spruce forest cover and promote Douglas-fir and lodgepole pine forest cover in two stands totaling an estimated 37 acres (units 26 and 27). This treatment would be applied in mesic and dry mixed conifer stands stocked with subalpine fir, Engelmann spruce, Douglas-fir, and lodgepole pine trees in multiple canopy layers (young forest multistory stand structure). Portions of these stands have experienced lodgepole pine mortality caused by mountain pine beetle attacks. With the exception of subalpine fir, the largest and most vigorous conifers (with regard to height, bole diameter and live crown volume) of the most preferred species present would be retained in clumps of various sizes to achieve the target or desired residual stocking level of approximately 40 to 50 trees per acre. Tree species retention preference in descending order is Douglas-fir

followed by ponderosa pine, Engelmann spruce and lodgepole pine. Standing dead and down lodgepole pines in excess of snag and large woody debris retention objectives would be removed for firewood or other forest products. All trees greater than 24 inches DBH and all trees 21 inches DBH and larger with an estimated age of 150 years or greater (based on criteria described in Van Pelt 2008) would be retained. Live defective trees and dying trees would be retained as needed to provide cavity dependent habitat. Complex patches which include large snags, live defective trees, large and old trees, or large dwarf mistletoe infected trees would be retained. No aspen or other deciduous broadleaf trees would be harvested. Aspen clones one quarter acre and larger in size included within harvest units 26 and 27 would receive the Aspen Release (Aspen) harvest treatment previously described in this document.

Variable Retention Regeneration (VRR) (2 units/ 59 acres total)

Conifers of merchantable diameter would be harvested to simulate mixed to high severity fire, regenerate a new cohort of early seral tree species, and consolidate and increase the patch size of adjacent early seral forest vegetation while retaining forest patches, tree clumps, and individual trees for structural and biological diversity. All trees larger than 24 inches DBH and all trees 21 to 24 inches DBH with an estimated age of 150 years and older (based on criteria described in Van Pelt 2008) would be retained. This treatment would be applied primarily in stands with multiple canopy layers (young forest multistory stand structure), dwarf mistletoe in the overstory and understory canopy layers, and where a high proportion of trees have poor crowns, disease, or other conditions that would prevent the development of stand structures comprised of large ponderosa pines or Douglas-firs.

Variable retention regeneration (VRR) treatment objectives would include retention of at least 15 percent of the forested area associated with each treatment unit. Seventy percent of the area retained would be comprised of forest patches 0.5 to 2.5 acres in size and 30 percent of the area retained would be comprised of individual trees and tree clumps less than 0.5 acres in size. Retention patches, individual trees, and clumps would include the largest, oldest, decadent or leaning trees, and hard snags present in each treatment unit (USDA and USDI. 1994). Vigorous ponderosa pines and disease free Douglas-firs would be the preferred trees for retention as individual trees and tree clumps after the previously listed retention criteria are satisfied.

Following harvest, all remaining diseased, damaged, or suppressed conifers eight DBH and smaller would be felled to prepare the site for prescribed burning and reforestation. Reforestation would be accomplished by planting ponderosa pine seedlings grown from locally adapted seed to ensure prompt establishment of ponderosa pine regeneration, natural seeding of other conifer species, and suckering of aspen stems from clones within regeneration harvest units. Conifer seedlings would be planted in microsites associated with tree stumps, down logs, and other shade providing woody debris at an approximate rate of 150 seedlings per acre with an estimated survival rate of 70 percent. Regeneration establishment would be monitored following planting and certified within five years of harvest completion. The minimum acceptable stocking level for reforestation certification is 100 vigorous conifer seedlings per acre.

NON-COMMERCIAL THINNING PRESCRIPTIONS

Conifer Girdling for Aspen Restoration (CGAR) (9 units/ 71 acres total)

Non-commercial thinning and girdling treatment of conifers to release existing aspen trees from conifer encroachment and promote the establishment of aspen and other hardwood regeneration. This treatment would be applied to reduce conifer competition for sunlight and soil moisture, improve the vigor of existing aspen clones, and stimulate sprouting of new aspen stems where conifers have invaded or are shading out aspen stands.

Conifer thinning and girdling for aspen restoration would be implemented within existing aspen clones (defined as five or more healthy aspen trees greater than or equal to five feet tall located within a 15 foot radius) and in a 50 foot wide buffer located adjacent to aspen clone perimeters. Desired treatment objectives include 10 percent or less canopy closure contributed by conifers following treatment within aspen clones and the adjacent buffer (Shepherd, et al. 2006; Swanson, et al. 2010). Implementation of this objective would be achieved by retaining a maximum stocking level of approximately ten conifers per acre larger than 10 inches DBH following treatment within aspen clones and the buffer. Conifers 10 inches DBH and smaller would be felled with chainsaws (no ground disturbing mechanized equipment) to reduce conifer encroachment. Conifers larger than 10 inches DBH and less than 21 inches DBH would be girdled with chainsaws and left standing to attain desired conifer canopy closure treatment objectives. All conifers 21 inches DBH and larger would be retained in aspen clones and the adjacent buffers even if conifer stocking exceeds the desired maximum retention level. No aspen or other deciduous broadleaf trees would be harvested.

Ladder Fuel Reduction Thin (LFR) (39 units/ 6,492 acres total)

Non-commercial thinning treatment of young conifers to break up the vertical continuity of fuels from the forest floor (surface fuel) to the overstory canopy layer, reduce competition with larger conifers, and to reduce conifer competition with aspen trees. Conifers less than or equal to eight inches DBH and greater than two feet tall infected with dwarf mistletoe or located within 15 to 30 feet of conifers larger than 8 inches DBH or vigorous aspen trees greater than five feet tall would be felled with chainsaws (no ground disturbing mechanized equipment). Branches on live conifers remaining after thinning would be pruned to a height of six feet from ground level to further reduce fuel ladders from the ground to the tree canopy layer. No aspen or other broadleaf deciduous trees would be felled.

Post and Pole Thin (PP) (2 units/ 36 acres total)

Conifers less than 13 inches DBH located within 200 feet of roads open to the public would felled with chainsaws and removed without ground disturbing mechanized equipment to provide posts and poles for personal use. This treatment would be applied in densely stocked mixed conifer stands comprised of Douglas-fir, lodgepole pine, and ponderosa pine trees with multiple canopy layers (young forest multistory and understory re-initiation stand structures) where ladder fuel reduction thinning and post thinning prescribed fire treatments would also be applied (see Ladder Fuel Reduction thin description below for specifications). Lodgepole pine and Douglas-fir trees less than 13 inches DBH would be removed to reduce competition with larger trees and create small canopy openings (generally one acre and smaller in size).

Young Plantation Thin (TSI) (63 units/ 1,738 acres total)

Non-commercial thinning treatment of young conifer plantations established in previous regeneration harvest treatment areas to maintain existing overstory trees, accelerate the growth of residual trees, and reduce disease levels of residual trees. Conifers eight inches DBH and

smaller would be felled with chainsaws (no ground disturbing mechanized equipment) to achieve the following desired residual tree stocking levels:

1. 120-150 trees per acre in treatment units with existing road access and slopes generally less than 35%.
2. 80-110 trees per acre in treatment units without road access or slopes generally exceeding 35%.

Trees among the largest and most vigorous conifer species present would be retained. Early seral conifers would be preferred for retention; however retention of conifer species diversity is desired. Thinning treatment would promote variable residual tree spacing and understory vegetation diversity. Openings or areas with few residual conifers generally one third acre and smaller in size would be created on up to 30% of a treatment unit. Conifers (eight inches DBH and smaller) growing within 30 feet horizontal distance of vigorous overstory conifers (generally 16 inches DBH and larger) or dwarf mistletoe infected overstory trees would be felled to maintain overstory trees or to reduce the spread of dwarf mistletoe into susceptible understory trees. Conifers located within 20 feet of vigorous aspen trees greater than 5 feet tall would be felled. No aspen or other broadleaf deciduous trees would be felled.

Wetland Thin (WT) (2 units/ 22 acres total)

Non-commercial thinning treatment of young conifers growing in wetlands located in Blackpine Meadows and around the perimeter of Mission Pond. Conifers 10 inches DBH and smaller would be felled with chainsaws (no ground disturbing mechanized equipment) to reduce conifer encroachment on wetland vegetation. No aspen or other broadleaf deciduous trees would be felled.

SUMMARY OF PROPOSED THINNING AND PRESCRIBED FIRE TREATMENTS

Thinning Treatment Summary

- Non-commercial understory-only thinning treatments (TSI, LFR outside of commercial units and Wetland Thin) 8,260 acres.
- Non-commercial overstory thinning with non-commercial understory treatments (PP, CGAR): 107 acres.
- Commercial overstory thinning with non-commercial understory treatments (includes post-harvest ladder fuel reduction or whip fell thinning): 1853 acres.
    - **Total thinning treatments: 10,220 acres**.

Prescribed Fire Treatment Descriptions

- Hand piling and pile burning: 2875 acres. Hand piling and pile burning on 660 acres would be followed up by underburning.
- Machine piling and pile burning: 737 acres. All of these are in harvest units except for 85 acres in two Timber Stand Improvement (TSI) units. Machine piling and pile burning in these 85 acres would be followed by underburning.
- Underburning: 6598 acres. Of these, 822 acres would be treated first with hand piling and pile burning.
- Landings: 187 landings (about 0.1 acres (66’ X 66’) each.

- Prescribed fires would be ignited by hand using equipment such as drip torches, fusees, propane torches; or aerially using a helicopter with a sphere machine or helitorch.
- Machine piling (MP) would occur between spring and fall as needed by picking up materials off the ground with equipment such as an excavator with bucket/thumb. Piles would be between 4' X 4' up to 8' X 8' depending on distance from tree boles and drip lines. Slash mats would be required for machinery as described in the Appendix D. No machine piling would be allowed in Riparian Reserves except in two units as specified in Appendix D.
- Initial underburn treatments would occur within approximately 1 – 3 years after the initial thinning treatment (depending on weather, funding, and smoke approval). Units where underburning is proposed would be evaluated within 10-15 years of the initial prescribed fire treatment and considered for maintenance underburning at that time. Internal resource review of maintenance burning would occur before implementation to assure consideration of any subsequent changes in site conditions and compliance with law or policy.
- Fireline associated with underburning includes approximately 29.4 miles of hand fireline and 2.6 miles of machine fireline (created with an excavator or dozer with 3 – 5' blade/shovel).
- Adaptive Management strategies for prescribed burning include:
  - Firewood collection would be encouraged where landing piles and scattered thinning debris are accessible from open roads, and where consistent with current firewood regulations. This activity would reduce emissions from prescribed burning and applies to approximately 179 gross acres on landings and any thinning units adjacent to open roads. Firewood collection would not be allowed from machine piles or hand piles.
  - Chipping would be allowed when economically feasible where debris is collected at landings or accessible within approximately 50' from existing open roads. Chipped debris would be widely scattered on forest floor. This activity would reduce emissions from prescribed burning and applies to approximately 395 gross acres in 13 units. Biochar production from landing piles has been analyzed as an alternative to landing slash pile burning.
  - Debris from thinning would be hand-piled and piles burned in some units as a substitute for underburning if underburning is curtailed by smoke emission restrictions. Where machine piling is proposed, if debris is too light for machine piling but still in need of fuel reduction, then debris would be hand-piled and piles burned. This would allow treatment of debris by alternative means if underburning were curtailed or machine piling unnecessary. This applies to 6,192 gross acres in 55 units.
  - Debris from thinning would be machine-piled and piles burned in some units as a substitute for underburning in mechanical thinning units if underburning is curtailed by smoke emission restrictions. This would allow treatment of debris by alternative means if underburning were curtailed. Applicable to 1153 gross acres in 53 units.

Dominant Vegetation treatments by unit, as described above. Thinning treatment abbreviations are described in Appendix A.

Unit	Dominant Overstory Thinning Prescription	Understory Thinning Prescription	Primary Prescribed Fire Prescription*	Follow-up Prescribed Fire Prescription*	Adaptive Management Prescribed Fire Prescription*	Operating Season	Logging System	Sub-watershed	Acres**
001	MFT	LFR	MP	LP	UB	Any	Ground	Buttermilk	8
001	MFT	LFR	UB	LP	HP	Any	Ground	Buttermilk	3
002	DFR	LFR	UB	LP	MP	Any	Ground	Buttermilk	52
003	DFR	LFR	UB	LP	MP	Any	Ground	Buttermilk	17
004	DFDMT	LFR	UB	LP	MP	Any	Ground	Buttermilk	29
005	None	LFR	HP	None	CHIP	N/A	N/A	Buttermilk	11
006	DFR	LFR	UB	LP	MP	Any	Ground	Buttermilk	39
007	DFDMT	LFR	UB	LP	MP	Any	Ground	Buttermilk	24
008	DFR	LFR	UB	LP	MP	Any	Ground	Buttermilk	12
009	Aspen	LFR	UB	LP	MP	Any	Ground	Buttermilk	23
010	None	LFR	UB	LP	MP	N/A	N/A	Buttermilk	25
011	DFR	LFR	UB	LP	MP	Any	Combi	Buttermilk	44
012	DFDMT	LFR	UB	LP	MP	Any	Ground	Buttermilk	41
013	DFR	LFR	UB	LP	MP	Any	Ground	Buttermilk	28
014	DFR	LFR	UB	LP	HP	Any	Cable	Buttermilk	11
015	DFR	LFR	UB	LP	MP	Any	Ground	Buttermilk	12
015	DFR	LFR	MP	LP	HP	Any	Ground	Buttermilk	2
016	Aspen	LFR	UB	LP	MP	Any	Ground	Buttermilk	9
019	DFR	LFR	UB	LP	MP	Any	Ground	Buttermilk	20
019	DFR	LFR	MP	LP	HP	Any	Ground	Buttermilk	2
020	DFDMT	LFR	UB	LP	MP	Any	Ground	Buttermilk	11
020	DFDMT	LFR	MP	LP	HP	Any	Ground	Buttermilk	1

Unit	Dominant Overstory Thinning Prescription	Understory Thinning Prescription	Primary Prescribed Fire Prescription*	Follow-up Prescribed Fire Prescription*	Adaptive Management Prescribed Fire Prescription*	Operating Season	Logging System	Sub-watershed	Acres**
021	Aspen	LFR	UB	LP	MP	Any	Ground	Buttermilk	12
021	Aspen	LFR	MP	LP	HP	Any	Ground	Buttermilk	7
022	Aspen	LFR	MP	LP	UB	Any	Ground	Buttermilk	10
023	DFDMT	LFR	UB	LP	MP	Any	Ground	Buttermilk	26
024	Aspen	LFR	UB	LP	MP	Any	Ground	Buttermilk	22
024	Aspen	LFR	MP	LP	HP	Any	Ground	Buttermilk	18
025	None	LFR	HP	None	None	N/A	N/A	Buttermilk	10
026	MFT	LFR	MP	LP	HP	Any	Ground	Buttermilk	22
027	MFT	LFR	MP	LP	HP	Any	Ground	Buttermilk	14
028	DFR	LFR	UB	LP	MP	Any	Ground	Libby	8
029	DFDMT	LFR	UB	LP	MP	Any	Ground	Libby	12
030	DFR	LFR	UB	LP	MP	Any	Ground	Libby	21
031	DFDMT	LFR	UB	LP	MP	Any	Ground	Libby	19
032	DFR	LFR	MP	LP	HP	Any	Ground	Libby	13
033	DFR	LFR	MP	LP	HP	Any	Ground	Libby	4
034	DFR	LFR	MP	LP	HP	Any	Cable	Libby	12
035	DFR	LFR	MP	LP	HP	Any	Ground	Libby	8
035	None	LFR	HP	None	None	N/A	N/A	Libby	15
036	DFR	LFR	MP	LP	HP	Any	Ground	Libby	9
036	None	LFR	HP	None	None	Any	N/A	Libby	23
037	DFR	LFR	MP	LP	HP	Any	Ground	Libby	9
038	DFDMT	LFR	MP	LP	HP	Any	Ground	Libby	86
038	DFDMT	LFR	UB	LP	MP	Any	Ground	Libby	15

Unit	Dominant Overstory Thinning Prescription	Understory Thinning Prescription	Primary Prescribed Fire Prescription*	Follow-up Prescribed Fire Prescription*	Adaptive Management Prescribed Fire Prescription*	Operating Season	Logging System	Sub-watershed	Acres**
039	VRR	Whip	UB	None	None	Any	Ground	Libby	33
040	Aspen	LFR	UB	LP	MP	Any	Ground	Libby	49
041	DFR	LFR	UB	LP	MP	Any	Ground	Libby	72
042	DFR	LFR	UB	LP	MP	Any	Ground	Libby	17
043	DFR	LFR	UB	LP	MP	Any	Ground	Libby	4
044	DFR	LFR	UB	LP	MP	Any	Ground	Libby	22
045	DFR	LFR	UB	LP	MP	Any	Ground	Libby	28
046	DFR	LFR	UB	LP	MP	Any	Ground	Libby	12
047	DFR	LFR	MP	LP	HP	Winter	Ground	Libby	12
048	DFR	LFR	UB	LP	MP	Any	Ground	Libby	44
049	DFDMT	LFR	UB	LP	MP	Any	Ground	Libby	9
050	DFR	LFR	MP	LP	None	Any	Ground	Libby	21
050	DFR	LFR	UB	LP	MP	Any	Ground	Libby	14
051	VRR	Whip	UB	None	None	Any	Ground	Libby	26
053	DFR	LFR	MP	LP	HP	Winter	Ground	Libby	19
054	DFR	LFR	MP	LP	HP	Winter	Ground	Libby	82
055	DFR	LFR	MP	LP	HP	Winter	Ground	Libby	50
056	DFR	LFR	MP	LP	HP	Winter	Ground	Libby	56
057	DFR	LFR	MP	LP	HP	Winter	Ground	Libby	19
058	DFR	LFR	UB	LP	MP	Winter	Ground	Libby	77
058	DFR	LFR	MP	LP	HP	Winter	Ground	Libby	71
058	DFR	LFR	UB	LP	MP	Winter	Ground	Libby	17
059	DFR	LFR	UB	LP	MP	Winter	Ground	Libby	8

Unit	Dominant Overstory Thinning Prescription	Understory Thinning Prescription	Primary Prescribed Fire Prescription*	Follow-up Prescribed Fire Prescription*	Adaptive Management Prescribed Fire Prescription*	Operating Season	Logging System	Sub-watershed	Acres**
060	DFR	LFR	UB	LP	MP	Winter	Ground	Libby	9
061	DFR	LFR	UB	LP	MP	Any	Cable	Libby	39
061	None	LFR	UB			N/A	N/A	Libby	15
062	DFR	LFR	MP	LP	HP	Winter	Ground	Libby	16
063	DFR	LFR	UB	LP	MP	Winter	Ground	Libby	77
063	DFR	LFR	MP	LP	HP	Winter	Ground	Libby	34
064	DFR	LFR	UB	LP	MP	Winter	Ground	Libby	15
065	MFT	LFR	MP	LP	None	Winter	Ground	Libby	23
066	Aspen	LFR	UB	LP	MP	Any	Ground	Libby	5
067	DFR	LFR	UB	LP	MP	Any	Ground	Libby	21
068	DFR	LFR	UB	LP	MP	Any	Ground	Libby	7
069	DFR	LFR	MP	LP	HP	Any	Ground	Libby	16
071	Aspen	LFR	UB	LP	MP	Any	Ground	Libby	5
072	DFR	LFR	UB	LP	MP	Any	Ground	Libby	12
073	DFDMT	LFR	UB	LP	MP	Any	Ground	Libby	11
074	DFR	LFR	UB	LP	MP	Any	Ground	Buttermilk	10
075	DFR	LFR	UB	LP	MP	Any	Ground	Libby	11
075	DFR	LFR	MP	LP	None	Any	Ground	Libby	2
076	DFR	LFR	UB	LP	MP	Any	Ground	Libby	13
077	DFR	LFR	UB	LP	MP	Any	Ground	Libby	12
078	DFR	LFR	MP	LP	UB	Any	Ground	Libby	6
079	DFR	LFR	UB	LP	MP	Any	Ground	Libby	5
300	None	TSI	HP	None	None	N/A	N/A	Buttermilk	13

Unit	Dominant Overstory Thinning Prescription	Understory Thinning Prescription	Primary Prescribed Fire Prescription*	Follow-up Prescribed Fire Prescription*	Adaptive Management Prescribed Fire Prescription*	Operating Season	Logging System	Sub-watershed	Acres**
300	None	TSI	HP	UB	None	N/A	N/A	Buttermilk	4
301	None	TSI	HP	None	None	N/A	N/A	Buttermilk	32
302	None	TSI	HP	None	None	N/A	N/A	Buttermilk	8
303	None	TSI	HP	UB	None	N/A	N/A	Buttermilk	12
303	None	TSI	HP	None	None	N/A	N/A	Buttermilk	1
304	None	TSI	HP	UB	None	N/A	N/A	Buttermilk	5
305	None	TSI	HP	UB	None	N/A	N/A	Buttermilk	21
306	None	TSI	HP	None	None	N/A	N/A	Buttermilk	11
307	None	TSI	HP	UB	None	N/A	N/A	Buttermilk	15
308	None	TSI	HP	None	None	N/A	N/A	Buttermilk	14
309	None	TSI	HP	UB	None	N/A	N/A	Buttermilk	69
310	None	TSI	HP	UB	None	N/A	N/A	Buttermilk	21
311	None	TSI	HP	UB	None	N/A	N/A	Buttermilk	36
312	None	TSI	HP	UB	None	N/A	N/A	Buttermilk	30
313	None	TSI	HP	UB	None	N/A	N/A	Buttermilk	20
314	None	TSI	HP	UB	None	N/A	N/A	Buttermilk	30
315	None	TSI	HP	UB	None	N/A	N/A	Buttermilk	34
316	None	TSI	HP	None	UB	N/A	N/A	Buttermilk	15
317	None	TSI	HP	None	CHIP	N/A	N/A	Buttermilk	17
318	None	TSI	HP	None	None	N/A	N/A	Buttermilk	35
319	None	TSI	HP	None	None	N/A	N/A	Buttermilk	4
320	None	TSI	HP	None	None	N/A	N/A	Buttermilk	29
321	None	TSI	HP	None	None	N/A	N/A	Buttermilk	35

Unit	Dominant Overstory Thinning Prescription	Understory Thinning Prescription	Primary Prescribed Fire Prescription*	Follow-up Prescribed Fire Prescription*	Adaptive Management Prescribed Fire Prescription*	Operating Season	Logging System	Sub-watershed	Acres**
322	None	TSI	HP	None	None	N/A	N/A	Buttermilk	23
323	None	TSI	HP	None	None	N/A	N/A	Buttermilk	38
324	None	TSI	HP	UB	None	N/A	N/A	Buttermilk	11
325	None	TSI	HP	UB	None	N/A	N/A	Buttermilk	11
326	None	TSI	HP	UB	None	N/A	N/A	Libby	49
327	None	TSI	HP	UB	None	N/A	N/A	Libby	6
328	None	TSI	HP	None	None	N/A	N/A	Libby	27
329	None	TSI	HP	None	None	N/A	N/A	Libby	31
330	None	TSI	HP	None	None	N/A	N/A	Libby	35
331	None	TSI	HP	None	None	N/A	N/A	Libby	32
332	None	TSI	HP	None	None	N/A	N/A	Libby	14
333	None	TSI	HP	None	None	N/A	N/A	Libby	36
334	None	TSI	HP	UB	None	N/A	N/A	Libby	25
335	None	TSI	HP	None	CHIP	N/A	N/A	Libby	22
336	None	TSI	HP	None	CHIP	N/A	N/A	Libby	54
337	None	TSI	HP	None	None	N/A	N/A	Libby	27
338	None	TSI	HP	None	None	N/A	N/A	Libby	17
339	None	TSI	HP	None	None	N/A	N/A	Libby	11
340	None	TSI	HP	UB	None	N/A	N/A	Libby	18
341	None	TSI	HP	None	None	N/A	N/A	Libby	12
342	None	TSI	HP	UB	None	N/A	N/A	Libby	28
343	None	TSI	HP	None	None	N/A	N/A	Libby	17
344	None	TSI	HP	None	None	N/A	N/A	Libby	23

Unit	Dominant Overstory Thinning Prescription	Understory Thinning Prescription	Primary Prescribed Fire Prescription*	Follow-up Prescribed Fire Prescription*	Adaptive Management Prescribed Fire Prescription*	Operating Season	Logging System	Sub-watershed	Acres**
345	None	TSI	HP	None	None	N/A	N/A	Libby	28
346	None	TSI	MP	UB	HP	N/A	N/A	Libby	58
347	None	TSI	MP	UB	HP	N/A	N/A	Libby	27
347	None	TSI	HP	None	None	N/A	N/A	Libby	10
348	None	TSI	HP	None	None	N/A	N/A	Libby	42
349	None	TSI	HP	UB	HP	N/A	N/A	Libby	5
350	None	TSI	HP	None	None	N/A	N/A	Libby	36
351	None	TSI	HP	None	None	N/A	N/A	Libby	12
352	None	TSI	HP	None	None	N/A	N/A	Libby	15
353	None	TSI	HP	None	None	N/A	N/A	Libby	9
354	None	TSI	HP	None	None	N/A	N/A	Libby	18
355	None	TSI	HP	None	CHIP	N/A	N/A	Libby	43
356	None	TSI	HP	None	CHIP	N/A	N/A	Libby	43
357	None	TSI	HP	None	None	N/A	N/A	Libby	40
358	None	TSI	HP	None	None	N/A	N/A	Libby	31
359	None	TSI	HP	UB	None	N/A	N/A	Libby	136
359	None	TSI	HP	None	None	N/A	N/A	Libby	18
361	None	TSI	HP	UB	None	N/A	N/A	Buttermilk	22
362	None	TSI	HP	UB	None	N/A	N/A	Buttermilk	52
363	None	TSI	HP	None	None	N/A	N/A	Libby	15
400	None	LFR	HP	None	None	N/A	N/A	Twisp River	163
402A	None	LFR	HP	None	None	N/A	N/A	Buttermilk	3
402B	None	LFR	HP	None	CHIP	N/A	N/A	Buttermilk	9

Unit	Dominant Overstory Thinning Prescription	Understory Thinning Prescription	Primary Prescribed Fire Prescription*	Follow-up Prescribed Fire Prescription*	Adaptive Management Prescribed Fire Prescription*	Operating Season	Logging System	Sub-watershed	Acres**
403	None	LFR	HP	None	CHIP	N/A	N/A	Buttermilk	80
404	None	LFR	UB	None	HP	N/A	N/A	Buttermilk	605
405	None	LFR	UB	None	HP	N/A	N/A	Buttermilk	479
406	None	LFR	UB	None	HP	N/A	N/A	Buttermilk	1129
407	None	LFR	UB	None	HP	N/A	N/A	Buttermilk	88
408	None	LFR	HP	None	CHIP	N/A	N/A	Buttermilk	56
409	None	LFR	HP	None	CHIP	N/A	N/A	Buttermilk	29
410	None	LFR	UB	None	HP	N/A	N/A	Libby	822
411	None	LFR	HP	None	None	N/A	N/A	Libby	356
412	None	LFR	HP	None	CHIP	N/A	N/A	Libby	5
413	None	LFR	UB	None	HP	N/A	N/A	Libby	697
414	None	LFR	HP	None	None	N/A	N/A	Libby	6
415	None	LFR	HP	None	None	N/A	N/A	Libby	32
416	None	LFR	UB	None	HP	N/A	N/A	Libby	164
417	None	LFR	HP	None	None	N/A	N/A	Libby	27
418	None	LFR	UB	None	HP	N/A	N/A	Libby	512
419	None	LFR	HP	None	None	N/A	N/A	Libby	108
420	None	LFR	HP	None	None	N/A	N/A	Libby	19
421	None	LFR	UB	None	HP	N/A	N/A	Libby	120
422	None	LFR	UB	None	HP	N/A	N/A	Libby	331
423	None	LFR	HP	None	None	N/A	N/A	Libby	28
424	None	LFR	UB	None	HP	N/A	N/A	Libby	158
425	None	LFR	HP	None	None	N/A	N/A	Libby	21

Unit	Dominant Overstory Thinning Prescription	Understory Thinning Prescription	Primary Prescribed Fire Prescription*	Follow-up Prescribed Fire Prescription*	Adaptive Management Prescribed Fire Prescription*	Operating Season	Logging System	Sub-watershed	Acres**
426	None	LFR	UB	None	HP	N/A	N/A	Libby	133
427	None	LFR	HP	None	CHIP	N/A	N/A	Libby	22
429	None	WT	HP	None	None	N/A	N/A	Libby	7
430	None	WT	HP	None	None	N/A	N/A	Buttermilk	15
431	None	LFR	UB	None	HP	N/A	N/A	Libby	61
432	None	LFR	HP	None	CHIP	N/A	N/A	Libby	4
433	None	LFR	HP	None	None	N/A	N/A	Libby	80
434	None	LFR	HP	None	None	N/A	N/A	Libby	46
500	CGAR	Aspen_UST	HP	None	None	N/A	N/A	Libby	9
501A	CGAR	Aspen_UST	HP	None	HP	N/A	N/A	Buttermilk	1
501B	CGAR	Aspen_UST	HP	None	N/A	N/A	N/A	Buttermilk	6
501C	CGAR	Aspen_UST	HP	None	None	N/A	N/A	Buttermilk	5
502	CGAR	Aspen_UST	UB	None	HP	N/A	N/A	Libby	19
503	CGAR	Aspen_UST	HP	None	None	N/A	N/A	Buttermilk	12
504A	CGAR	Aspen_UST	UB	None	HP	N/A	N/A	Libby	3
504B	CGAR	Aspen_UST	UB	None	HP	N/A	N/A	Libby	2
505	CGAR	Aspen_UST	HP	None	None	N/A	N/A	Buttermilk	14
600	PP	LFR	UB	None	HP	Any	Ground	Buttermilk	31
600	DFR	LFR	UB	None	HP	Any	Ground	Buttermilk	15
601	PP	LFR	UB	None	HP	Any	Ground	Libby	5

**Prescribed fire abbreviations are as follows: MP- machine pile and burn piles; HP- hand pile and burn piles; LP- landing pile and burn pile; UB- underburning; CHIP- chipping of material.*

Appendix B: Transportation Definitions and Proposed Changes

This appendix contains definitions of road types used in this analysis and proposed action.

Road Type Definitions

This analysis places roads on National Forest System lands into five categories:

1. Forest System Road (FSR)
   Also more formally known as a 'National Forest System Road'. A forest road other than any road which has been authorized by a legally documented right-of-way held by a state, county, or local public road authority (36 CFR 212.1). Note that a Forest Road is a road wholly or partly within or adjacent to and serving the National Forest System Lands (NFSL) that the United States Forest Service (USFS) determines is necessary for the protection, administration, and utilization of the NFSL and the use and development of its resources (36 CFR 212.1).

   NOTE: Only Forest System Roads have designated maintenance levels. The other roads (non-system, unauthorized, public and temporary) are not maintained by the USFS and thus do not have USFS maintenance levels assigned. Expected maintenance conditions should be identified in the road authorization, operating plan, or maintenance agreement associated with non-system, public or temporary roads. Maintenance levels (ML) of these roads include ML1 (closed) and ML2 – 4 (open to some level of use). ML2 Administrative roads are open for specific administrative uses only, such as those needed for management of a permit (i.e. water development or fence maintenance).

2. Non-System Road
   These are roads on the forest that are authorized by a legally documented right-of-way and are not needed by the USFS to manage the forest. These roads stay on the landscape for indefinite periods of time and thus do not meet the definition of a temporary road. Examples include utility access roads and private drive-ways. The authorized entity is responsible for all construction, operation, and decommissioning costs of these roads. The USFS cannot expend system road maintenance funds on non-system roads.

3. Unauthorized Road
   A road that is not a FSR, Public Road, Non-System Road or Temporary Road. These roads will have a road number that looks like this - 4300000-10.01L-1, where it has a letter and then another number. There are five options to deal with unauthorized roads on NFSL:

   - Convert to a Forest System Road
   - Convert to a Non-System Road
   - Convert to a Forest System Trail
   - Use as a temporary road and decommission at the end of the project
   - Decommission

4. Temporary Road
   A road necessary for emergency operations or authorized by contract, permit, lease, or other written authorization that is not a forest road and that is not included in a forest transportation

atlas. (36 CFR 212.1) Note that these roads are on the landscape for a relatively short and defined period of time and are associated with a specific project or mining plan of operations. Examples include timber sale roads, mining access roads, abandoned mine reclamation access roads, etc. Temporary roads are typically not open to the public.

5. Public Road
   A road that is not an FSR but instead is under the jurisdiction of the State, County or other public entity. This road may cross NFSL but is not the Forest Service's responsibility to maintain. It has some historic right-of-way or other authorization and is generally open to the public. The USFS may be able to use system road maintenance funds on these County roads if there is an active cooperative agreement with the associated County.

Closing or Decommissioning Roads

The IDT completed a thorough travel analysis prior to recommending decommissioning of roads in Alternative 2. One consideration in this process was whether there may be potential need for future access to an area accessed by a road; in these cases, it would be better to store the road in ML-1 closed condition rather than decommission it. Storing a road in ML-1 closed status is done to reduce environmental impacts of the road and is accomplished by excluding all over-the-ground motorized vehicular use and improving hydrologic conditions disrupted by construction of the road prism. It may still be used for wheeled non-motorized traffic or motorized over-the-snow traffic. Note that all motorized over-the-snow traffic will be assessed and regulated in Travel Management planning subpart C. Placing a road in ML-1 status is not intended to discourage people from using the road on foot, nor is it intended to make the road completely disappear.

The techniques used to place a road in ML-1 status or to decommission a road are tailored to fit the site conditions on each particular segment of road, and can range from scarifying the road surface a few inches deep to encourage grass growth and installing water bars to de-compacting the road bed, scattering large-woody-debris, removing culverts, and partial fill pull back. Engineering staff work with Hydrology and Soils specialists to determine the appropriate techniques to be used on each road segment. The process of converting a road from an ML-2 thru 5 status to storing it in ML-1 condition consists of the following steps:

1. Determining that the road is not needed in the near term for access but may be needed in the more distant future for access.
2. Determine if the road is encumbered by any easements, special use permits, or other authorizations.
3. Engineering and district specialists develop a closure plan that addresses relevant environmental, recreation, and transportation needs on the road.
4. If the road has any encumbrances in item #2 ensure any potential impacts are addressed in the closure plan developed in #3 and communicated to all affected parties.
5. Complete the NEPA planning process. There is no CE category for this action so it must be accomplished in an EA or EIS.

Timber Sale and Forest Restoration Project Temporary Road Management

Timber sale temporary road construction, maintenance, and decommissioning is the responsibility of the Timber Sale Administrator (TSA) under the guidance of the Forest Service Representative (FSR). If a TSA needs advice when dealing with the layout, construction,

maintenance, or decommissioning of a temporary road, Engineering will make a qualified engineer available to assist. This assistance does not constitute designing a temporary road.

Proposed Road Treatments

The table below displays proposed the maintenance level (ML) of each road in the project area during harvest and post-project in Alternatives 2 and 3. Some roads are proposed for decommissioning in such a way as to provide for continued use by stock to help facilitate their movement on existing paths.

Alternatives 2 and 3 Road Status

Route Number	Segment Length (miles)	Current ML	Alt2 During Harvest ML	Alt 2 Post Project ML[1]	Haul Route
4300000	7.09	3	3	3	Y
4300000	3.41	4	4	4	Y
4300000	5.25	3	3	3	Y
4300025	0.40	1	1	D	
4300025	0.10	1	1	1	
4300030	0.98	1	1	1	
4300030	0.14	1	1	1	
4300030	0.15	1	1	D	
4300050	1.61	2	2	2	
4300050	0.84	2	2	2	Y
4300050	0.88	2	2	2	Y
4300055	0.21	1	1	D	
4300057	0.13	1	1	1	
4300057	0.11	1	2	1	Y
4300060	0.34	1	1	1	
4300065	1.29	2	2	2	
4300070	0.69	1	2	D[1]	Y
4300070	0.07	1	2	1	Y
4300075	0.39	1	1	1	
4300075	0.30	1	1	D	
4300100	0.93	2	2	2	Y
4300100	1.35	2	2	2	
4300101	0.19	1	1	D	
4300103	0.20	1	1	D	
4300105	0.33	1	1	D[1]	
4300120	0.10	2	2	D	
4300120	0.76	2	2	2	Y

Route Number	Segment Length (miles)	Current ML	Alt2 During Harvest ML	Alt 2 Post Project ML[1]	Haul Route
4300120	0.08	2	2	2	
4300121	0.27	1	2	1	Y
4300121	0.19	1	2	D	Y
4300121	0.14	1	1	D	
4300122	0.81	1	2	1	Y
4300122	0.06	1	1	1	
4300123	0.28	1	2	1	Y
4300123	0.04	1	1	1	
4300124	0.23	1	2	D	Y
4300125	0.23	1	1	D	
4300130	1.38	1	1	D	
4300145	0.36	1	1	1	
4300145	0.25	1	1	D	
4300146	0.76	1	1	1	
4300150	2.11	2	2	2A	
4300150	0.19	2	2	2A	Y
4300152	0.10	1	1	D[1]	
4300157	0.15	2	2	D	
4300175	0.27	2	2	D	
4300180	0.40	1	1	D	
4300180	0.29	1	1	1	
4300182	0.62	1	1	D	
4300185	1.89	1	1	1	
4300185	0.84	1	2	1	Y
4300187	0.18	1	2	D	Y
4300189	0.20	1	2	1	Y
4300189	0.10	1	2	D	Y
4300200	0.38	1	2	2A	Y
4300200	0.16	1	1	D[1]	
4300200	0.33	2	2	2	Y
4300200	0.10	1	2A	2A	
4300215	0.59	1	2A	2A	
4300215	0.34	1	1	1	
4300220	1.02	1	2A	2A	
4300223	0.44	1	1	1	

Route Number	Segment Length (miles)	Current ML	Alt2 During Harvest ML	Alt 2 Post Project ML[1]	Haul Route
4300225	0.61	1	1	1	
4300225	0.06	1	1	D	
4300390	0.54	3	3	3	
4300400	2.80	2	2	2	
4300400	1.80	3	3	3	
4300417	0.16	1	1	D	
4300440	0.13	1	1	D	
4300450	0.10	1	1	1	
4300475	0.89	1	2	1	Y
4300475	0.49	1	1	D	
4300476	0.08	1	1	D	
4300477	0.48	1	2	1	Y
4300477	0.11	1	1	D	
4300477	0.05	1	1	1	
4300479	0.36	1	1	1	
4300479	0.12	1	2	1	Y
4300480	0.87	1	2	1	Y
4300480	0.58	1	1	1	
4300485	0.57	1	1	1	
4300500	2.08	3	3	3	
4300500	0.76	3	3	3	Y
4300515	1.61	1	2	1	Y
4300525	0.47	1	2	1	Y
4300530	0.80	2	2	2	Y
4300530	0.54	2	2	1	
4300530	0.25	1	1	1	
4300550	1.96	1	1	2	
4300550	1.27	1	2A	2A	
4300552	0.23	1	1	D	
4300553	1.58	1	1	1	
4300554	0.23	1	2A	2A	
4300554	0.20	1	1	D	
4300554	0.05	1	1	D	
4300555	0.93	1	1	1	
4300556	0.80	2	2	2A	

Route Number	Segment Length (miles)	Current ML	Alt2 During Harvest ML	Alt 2 Post Project ML[1]	Haul Route
4300556	0.59	2	2	1	
4300558	0.55	1	1	1	
4300560	2.29	1	1	2	
4300600	1.15	2	2	2	Y
4300610	0.80	1	2	2A	Y
4300615	0.44	1	2	2A	Y
4300615	0.72	1	2	1	Y
4300635	0.82	1	1	1	
4300635	0.30	1	2A	2A	
4300635	0.30	1	2	2A	Y
4300637	0.28	1	1	D	
4300639	0.26	1	2	D	Y
4300639	0.21	1	1	D	
4300645	1.30	1	2A	2A	
4300648	0.35	1	1	D	
4300648	0.09	1	2	D	Y
4300650	1.08	1	2A	2A	
4300650	0.21	1	1	D	
4300650	0.12	1	2	2A	Y
4300700	1.12	1	1	D	
4300710	0.34	1	2	D	Y
4300710	0.10	1	2	1	Y
4300710	0.18	1	1	D	
4300720	0.18	1	1	D	
4300800	0.68	2	2	2	
4300800	0.01	2	2	1	
4300810	0.45	1	1	1	
4300825	0.38	1	1	1	
4300825	1.10	1	1	1	
4300830	0.48	1	1	1	
4300832	0.23	1	1	1	
4300850	0.28	1	1	1	
4300856	0.75	1	1	1	
4300857	0.34	1	1	1	
4340000	2.74	3	3	3	

Route Number	Segment Length (miles)	Current ML	Alt2 During Harvest ML	Alt 2 Post Project ML[1]	Haul Route
4340000	1.17	3	3	3	Y
4340527	0.03	1	1	1	
4340675	0.16	2	2	2	
4340679	0.06	2	2	2	
4340680	0.52	1	1	D	
4340685	0.42	1	1	D	
4340685	0.06	1	1	2	
4340700	2.42	3	3	3	Y
4340700	1.74	1	1	1	
4340700	0.18	3	3	3	
4340710	0.32	2	2	D	Y
4340715	0.53	1	1	D	
4340715	1.20	1	2A	2A	
4340717	0.19	1	1	1	
4340719	0.15	1	1	D	
4340725	0.22	1	1	D	
4340727	0.22	1	1	D	
4340730	0.07	1	1	1	
4340730	0.03	1	1	1	
4340740	1.11	1	1	D	
4340742	0.43	1	1	D	
4340744	0.07	1	1	D	
4340750	0.64	3	3	3	
4340750	0.37	3	3	3	Y
4340755	0.26	1	1	D	
4340756	0.11	1	1	D	
4340757	0.24	2	2	D	
4340775	0.49	1	2	1	Y
4340775	1.70	1	2	D	Y
4340777	0.31	1	1	1	
4340778	0.08	1	1	2	
4340778	0.21	1	1	D	
4340779	0.28	1	2	D	Y
4340782	0.24	1	1	D	
4340783	0.05	1	1	D	

Route Number	Segment Length (miles)	Current ML	Alt2 During Harvest ML	Alt 2 Post Project ML[1]	Haul Route
4340785	0.83	1	2	1	Y
4340785	0.57	1	2	2A	Y
4340785	0.72	1	2	1	Y
4340785	0.20	1	1	1	
4340788	0.37	1	2	1	Y
4340790	0.18	1	2	D	Y
4340801	0.51	1	1	D	
4340803	0.37	2	2	D	
4342100	0.50	1	1	D[1]	
4342100	1.58	2	2	2	Y
4342100	0.23	2	2	2	
4342102	0.30	1	2	D	Y
4342200	1.73	2	2	2	Y
4342200	1.49	2	2	1	Y
4342200	0.15	2	2	D	
4342300	2.39	2	2	2A	Y
4342300	0.42	2	2	D	
4342300	0.21	2	2	D	Y
4300000_U50	0.44	1	2	D	Y
4300000_U69	0.18	1	2	D	Y
4300000-10.01L-1	0.14	1	1	D	
4300000-12.55R-1	0.12	1	1	D	
4300000-12.96L-1	0.07	1	1	D	
4300000-13.28R-1	0.11	1	1	D	
4300000-13.36R-1	0.07	1	1	D	
4300000-13.88L-1	0.11	1	1	D	
4300000-14.10R-1	0.26	1	2	D	Y
4300000-9.46R-1	0.17	2	2	3	
4300050-0.85R-1	0.25	1	1	D	
4300050-1.76L-1	0.47	1	1	1	
4300050-1.76L-1	0.20	1	2	1	Y
4300050-2.45R-1	0.12	1	1	D	
4300050-2.55R-1	0.03	1	1	D	
4300057-0.2-1	0.29	1	1	1	
4300065-0.24L-1	0.55	1	1	D	

Route Number	Segment Length (miles)	Current ML	Alt2 During Harvest ML	Alt 2 Post Project ML[1]	Haul Route
4300065-1.06L-1	0.33	1	1	D	
4300070-0.90-1	0.40	1	1	D	
4300070-0.90-2	0.20	1	1	D	
4300100-0.18L-1	0.12	1	1	D	
4300103-0.19-1	0.09	1	1	D	
4300123-0.26L-1	0.12	1	2	D	Y
4300150-1.22L-1	0.39	1	1	1	
4300185-1.23L-1	0.08	1	1	D	
4300185-1.82R-1	0.71	1	1	1	
4300185-1.82R-2	0.11	1	1	D	
4300185-1.82R-3	0.28	1	1	D	
4300185-1.88R-1	0.18	1	1	D	
4300220-0.03R-1	0.11	1	1	D	
4300220-0.30L-1	0.03	1	1	D	
4300220-0.69L-1	0.07	1	1	D	
4300225-0.48L-1	0.13	1	1	D	
4300390-0.41L-1	0.09	2	2	3	
4300390-0.63R-1	0.12	2	2	2	
4300390-0.63R-1	0.10	2	2	2	Y
4300400-0.53L-1	0.08	1	1	D	
4300400-0.78L-1	0.03	1	1	D	
4300400-1.96L-1	0.01	1	1	D	
4300400-2.52R-1	0.04	1	1	D	
4300400-4.20L-1	0.29	1	1	D	
4300475-0.75R-1	0.11	1	1	1	
4300475-0.75R-2	0.02	1	1	D	
4300475-0.75R-3	0.04	1	1	D	
4300475-1.42L-1	0.41	1	1	D	
4300477-0.25L-1	0.02	1	1	D	
4300479-0.27R-1	0.13	1	1	D	
4300500-0.13L-1	0.10	1	1	D	
4300500-1.36R-1	0.09	1	1	D	
4300530-0.8R-1	0.46	1	1	D	
4300550-2.26R-1	0.04	1	1	D	
4300550-2.67R-1	0.03	1	1	D	

Route Number	Segment Length (miles)	Current ML	Alt2 During Harvest ML	Alt 2 Post Project ML[1]	Haul Route
4300553-1.41R-1	0.03	1	1	D	
4300555-0.16R-1	0.04	1	1	D	
4300560-0.51L-1	0.02	1	1	D	
4300560-1.50L-1	0.07	1	1	D	
4300560-2.07R-1	0.10	1	1	D	
4300560-2.26R-1	0.06	1	1	D	
4300560-2.47-1	0.18	1	1	D[1]	
4300615-0.36R-1	0.24	1	1	D	
4300615-0.80L-1	0.08	1	1	D	
4300635-0.82R-1	0.04	1	1	D	
4300645-1.17R-1	0.24	1	2A	2A	
4300645-1.17R-3	0.00	1	1	D	
4300648-0.10L-1	0.38	1	1	D	
4300648-0.10L-2	0.08	1	1	D	
4300700-0.51L-1	0.14	1	1	D	
4300800-5.12R-1	0.02	1	1	1	
4300825-0.18L-1	0.11	1	1	1	
4300825-0.18L-2	0.07	1	1	1	
4300825-0.95R-1	0.18	1	1	1	
4300857-0.13L-1	0.03	1	1	1	
4340000-10.89L-1	0.22	1	1	D	
4340000-11.93L-1	0.06	1	1	D	
4340000-11.93L-2	0.33	1	1	D	
4340000-5.50L-1	0.08	1	1	D	
4340000-5.50L-2	0.12	1	1	D	
4340000-9.92L-1	0.05	1	1	D	
4340675-0.68R-1	0.08	1	1	1	
4340680-0.03R-1	0.16	1	1	D	
4340700-4.40R-1	0.14	1	1	D	
4340715-0.94R-1	0.16	1	1	D	
4340719-0.10-1	0.06	1	1	D	
4340740-0.60R-1	0.09	1	1	D	
4340750-0.49R-1	0.03	1	1	D	
4340750-0.71R-1	0.09	1	1	D	
4340775-1.53R-1	0.03	1	1	D	

Route Number	Segment Length (miles)	Current ML	Alt2 During Harvest ML	Alt 2 Post Project ML[1]	Haul Route
4340785-1.51R-1	0.36	1	1	D	
4340788-0.10R-1	0.11	1	2	D	Y
4340803-0.08L-1	0.02	1	1	D	
4342100-1.57R-1	0.13	2	2	2	
4342102-0.01R-1	0.26	1	2	D	Y
4342102-0.18L-1	0.45	1	2	D	Y
4342102-0.18L-1	0.05	1	1	D	
4342102-0.18L-2	0.05	1	1	D	
4342200 UB1	0.12	1	2	D	Y
4342200-0.53R-1	0.08	1	1	D	
4342200-1.38R-1	0.04	1	1	D	
4342200-1.54R-1	0.01	1	1	D	
4342200-1.70L-1	0.01	1	1	D	
4342200-1.77R-1	0.00	1	1	D	
4342300 UB1	0.17	1	1	D	
4342300-0.49L-1	0.14	1	2	D	Y
4342300-0.74R-1	0.28	1	2	D	Y
4342300-1.00R-2	0.39	1	2	D	Y
4345200-2.28R-1	0.05	1	1	1	
C-1051-1.78L-1	0.12	1	1	D	
Temp_Rd_3	0.26	TEMP	2	D	Y
Temp_Rd_4	0.02	TEMP	2	D	Y
Temp_Rd_5	0.02	TEMP	2	D	Y
Temp_Rd_10	0.09	TEMP	2	D	Y
Temp_Rd_11	0.11	TEMP	2	D	Y
Temp_Rd_14	0.04	TEMP	2	D	Y
Temp_Rd_15	0.13	TEMP	2	D	Y
Temp_Rd_16	0.32	TEMP	2	D	Y
Temp_Rd_20	0.19	TEMP	2	D	Y

[1]*Decommission in such a way as to provide for passage of stock.*

Appendix C: Proposed Soil, Road, Stream, and Beaver Habitat Treatments

This appendix contains parameters and prescriptions applicable to proposed soil restoration, culvert replacement, coarse woody debris (CWD) habitat enhancement, beaver habitat enhancement, rock armoring, and hardened ford treatments in the Mission Restoration project area. Proposed treatment areas are displayed in Appendix F.

Proposed Soils Treatments

Soil restoration treatments described in the table below would occur in both Alternatives 2 and 3 in areas within proposed soil treatment units where detrimental soil compaction exceeds Forest Plan standards. Some areas within the total acreage of proposed treatment units would not be treated because the soil compaction does not exceed standards or is an existing system road. Biochar production from landing piles would occur as an adaptive management strategy to burning landing slash piles where economically feasible.

Soil Restoration Treatments

Treatment Type	Treatment Name	Method	Amount	Purpose
Soil Restoration	Subsoil	Break up compacted soil while maintaining soil horizons & leaving subsurface roots and rocks in place.	Portions of 468 acres	P&N #2 Restore soil-related processes and functions where past management practices have created detrimental effects.
Biochar Production	Chipping or on-site Biochar Production	The production of chips for removal from the site and/or possible on-site production of Biochar would be considered. If it does not seem feasible, the piles would be burned as part of brush disposal post project.	Landings on open roads or that can be accessed from open roads.	P&N #2. An alternative to burning landing piles, thereby reducing particulate matter production. If produced on-site, provides a method of restoring the soil structure around landings.

Proposed Culvert, Stream Crossing, CWD, and Beaver Habitat Treatments

The proposed treatments described below would occur as noted. Six locations have been identified where roads that would be used for summer haul routes cross perennial streams. Plus an additional 27 crossings would be rocked with outside funding.

Road, Stream, and Beaver Habitat Treatments

Treatment Name	Treatment	Purpose	Amount	Alternative
Fish Culverts	Where full or partial fish barriers exist on fish bearing streams, replace the culverts	P&N #1 (Hydrologic and Aquatic Restoration)	8 culverts	2, 3

Treatment Name	Treatment	Purpose	Amount	Alternative
	with an appropriately sized pipe.	Remove fish barriers in some streams		
Undersized Culverts	Where undersized fishless stream culverts are impacting channel morphology and increasing the risk of culvert failure, replace the culvert with an appropriately sized (100-year flow capacity) pipe.	P&N #1 (Hydrologic and Aquatic Restoration) P&N #7 (Transportation System) Reduce the risk of road failures & the resulting sediment delivery to streams.	15 culverts	2, 3
Beaver Habitat Enhancement	Pound posts across the channel. Cut small amounts of shrubs/small trees to weave around posts. Install cattle exclusion fences around 3 beaver sites.	P&N #1 (Hydrologic and Aquatic Restoration) Increase sites available for beaver release in connection with current beaver relocation program, with resulting increase in water storage capacity.	34.6 acres in 6 sites	2, 3
Coarse Woody Debris (CWD) Enhancement	Fell live or dead conifers ≤ 21" DBH into streams.	P&N #1 (Hydrologic and Aquatic Restoration) Restore depleted levels of CWD in streams for fish habitat.	8.2 miles in 4 stream segments	2, 3
Rock Armoring	Where ML2 & ML3 roads cross streams with approaches >3% slope, put 1 ¼" minus rock, 6" deep on the road surface where the road slopes towards the channel, for a distance up to 300'.	P&N 1 (Hydrologic and Aquatic Restoration) Reduces the surface erosion of fine sediment into streams.	Alt 2: 6 stream crossings Alt 3: 33 stream crossings	2,3
Hardened Fords	Construct rocked open fords on ML2 crossings over small, intermittent and perennial streams in low gradient areas with shallow road fills.	P&N #1 (Hydrologic and Aquatic Restoration) (P&N #7 (Transportation System) Reduce the risk of road failures associated with heavier storm flows predicted with future climate change scenarios. Reduce the risk of	4 stream crossings	3

Treatment Name	Treatment	Purpose	Amount	Alternative
		sediment delivery to streams from road failures.		

Appendix D: Design Features, Best Management Practices, Mitigation, and Monitoring

The table below displays the design features, best management practices, mitigation measures, and monitoring applicable to this project. These features are generally listed by the benefitting resource, though in some instances are combined under one resource to avoid duplication in multiple locations. Applying these design criterion would require some level of assessment, inspection, or monitoring by resource staff before, during, and/or after implementation (as indicated by the column "Monitoring"). Further details on monitoring methods is available in resource specialist reports in the project file.

Mission Project Design Features

Number	Design Feature	Why Necessary	Monitoring Necessary?	Efficacy	Consequence of Not Applying
					Visual Quality
1	Visual Quality Objectives for retention or partial retention is required in MA-5 and MA-17. Monitor treatment design to manage the foreground of the travel route of FSR 4300 and Black Pine Lake Campground to minimize the visual impact of project activities. Repeating form, line, color, texture, pattern, and scale common to the valued landscape character being viewed is the most effective way to maintain scenic integrity in the High and Moderate Visual Quality Objective (VQO) Scenic Integrity Levels.	Retains natural form, line, color, texture, and pattern on the landscape.	Y	Moderate - High	Not compliant with the LRMP S&G- 10-1, MA5-20A & C and MA5-8B. Degradation of the Visual Quality Objectives of management Area 5 and Management Area 17 of the LMRP.
2	Methods used to control prescribed burns should not dominate naturally established form, line, color, and texture of the area in MA-5 and MA-17 viewsheds. Use vegetation screens or diminishing stark dozer or firelines along hillsides in the viewshed to retain the scenic integrity of the High or Moderate Quality Objective (VQO) Scenic Integrity Levels.	Reduces visual impact of fireline in Buttermilk Creek road corridor (FSR 4300) and Blackpine Lake Campground viewsheds.	Y	Moderate - High	Not compliant with the LRMP, S&G – 5-19C & MA5-8B. Degradation of the Visual Quality Objectives of Management Area 5 of the LRMP.
3	Minimize visual impacts of landings sites in the FSR 4300 corridor. When possible, locate landings out of the immediate foreground (or seen area) in MA-5 Retention allocation areas, or screen as much as possible where vegetation is available and consistent with fuel treatment objectives, or use existing landings where they exist and seed after project is complete.	Retain the scenic integrity of the High or Moderate Quality Objective (VQO) Scenic Integrity Levels by minimizing the scenic impact of landings.	Y	Moderate - High	Not compliant with the LRMP, S&G- 10-1 & 3. Degradation of the Visual Quality Objectives of Management Area 5 of the LMRP.

Number	Design Feature	Why Necessary	Monitoring Necessary?	Efficacy	Consequence of Not Applying
4	Winter logging operations shall be coordinated with winter sports activities to the extent possible. Provide an allowance of alternative routes during winter logging.	Minimizes impacts on snowmobile access.		Low - Moderate	Public concerns on being able to snowmobile in the area during harvest operations.
					Fire Management
5	Underburns may extend beyond planned burn boundaries to utilize a nearby road, cow trail, ridge line, or skid trail if doing so creates safer holding conditions and/or minimizes ground disturbance from fireline construction. Coordination with resource specialists would occur during burn planning to assure that required surveys are completed as necessary and relevant design criteria and burn objectives in this document are followed.	Minimizes hazards to burn crews, increase holding options, and minimize ground-disturbing fireline construction.		Moderate - High	Increased safety risk for burn personnel; increased risk of escape; increased impacts from fireline construction.
6	Fireline would utilize erosion control measures during construction and rehabilitation. Waterbars would be constructed when the fireline is created using Best Management Practices (BMPs) soils erosion slope designations. Use Minimum Impact Suppression Tactics (MIST) wherever feasible and defensible to reduce soil and vegetation disturbance, especially in Riparian Reserves. No hand fireline construction would occur within existing New Invader invasive plant patches. Populations near proposed containment lines would be identified on Burn Plan maps. In Riparian Reserves (RR), hand fireline may be constructed within 100 feet of a stream if the line is located outside/above the defined inner gorge. Fireline in RRs would not run perpendicular to the stream channel in the inner gorge of the RR. No machine fireline would be constructed in RRs. During machine fireline construction, surface vegetation would be scraped away, while minimizing damage to live root crowns of native grasses and shrubs. This would allow for rapid post-burning recovery of the fireline, with residual intact roots helping prevent soil displacement and reducing the potential for invasive plant introduction, establishment, and spread. Post-burn fireline rehabilitation needs would be reviewed by soils, botany, and/or invasive species staff and fuels staff. If seeding is necessary, firelines would be seeded using native species vegetation. Some small trees (generally < 10” DBH) and some down logs may be cut and/or moved along the fireline	Minimize soil and vegetation disturbance. Restore firelines to reduce erosion, inhibit invasive plant spread, minimize movement of wood, and inhibit use by the public for motorized and non-motorized recreation. Limit impact of fireline in RRs. Prevent excessive compaction and ground disturbance from machinery in RRs.	Y (rehabilitation needs)	Moderate - High	Increased soil erosion, invasive plant spread, and visual impacts. Increased soil disturbance and surface erosion in Riparian Reserves.

Number	Design Feature	Why Necessary	Monitoring Necessary?	Efficacy	Consequence of Not Applying
	to prevent undesirable fire spread but no material would be removed from the site. Where accessible from existing roads or trails, firelines would be rehabilitated using methods that prevent public use of firelines as hiking, biking, motorcycle, and/or ATV/UTV routes, as well as preventing use by stock to access riparian areas.				
7	Resource Specialists would be given a timely opportunity to review burn plans and contracts before implementation.	Ensures that design criteria and mitigation measures are included in contracts and burn plans; allows for consideration of new resource concerns that have surfaced since NEPA decision.		High	Burn plans may not meet NEPA intent thus causing undesired resource impacts.
					Invasive Species
8	Prescribed fire treatments would exclude shrub steppe habitat unless including these locations minimizes the amount of soil disturbance from fireline construction and decreases escape risk.	Minimizes the potential for invasive plant spread, particularly cheatgrass (Broomus tectorum).		Moderate	The potential spread of invasive plants, particularly cheat grass. May be increased.
9	Areas of heavily disturbed soils (including landings, main skid trails, decommissioned temporary roads, and constructed road cut and fill slopes) would be reseeded. The Rangeland Management Specialists, Invasive Plant Specialist, and Botany Specialist would determine the appropriate seed mix, application rates, locations and time of seeding to meet erosion control and invasive plant competition objectives. Native seed would be the first choice in revegetation in areas where the objective is to restore the site to the landscape setting, such as decommissioned roads. Non-native seed may be used to help prevent the establishment of invasive species, in permanently altered plant communities, and in situations where locally collected native seed is not available (USDA Forest Service 2005). Use of non-native seed should be considered an interim non-persistent measure designed to aid the re-establishment of native plants.	Restores disturbed soil to native plants and prevent spread of invasive plants.	Y	Moderate	The spread of invasive plants would be increased. Soil erosion would be increased.
10	Project actions that would operate outside the limits of the road prism require the cleaning of all heavy equipment (bulldozers, skidders, graders, backhoes, etc.) prior to entering National Forest System lands.	Minimizes the spread of invasive plant seeds from heavy equipment.	Y	Moderate	The spread of invasive plants would be increased.

Number	Design Feature	Why Necessary	Monitoring Necessary?	Efficacy	Consequence of Not Applying
11	Qualified Forest Service staff would inspect active gravel, fill, sand stockpiles, quarries, and borrow material for invasive plants before use and transport of the materials. Only gravel, fill, sand, and rock that is judged to be weed free by the qualified inspector would be used. Treat or require treatment of infested sources before any use.	Ensures that weed-free gravel, fill, sand, and rock would be used.	Y	Moderate	The potential spread of invasive seeds from gravel, fill, sand, and rock may be increased.
12	All known New Invader sites and areas with dense diffuse knapweed infestations in the project area and along access roads would be identified on the Timber Sale Area Map. Potential landing sites that are infested with dense diffuse knapweed or invasive plants classified as New Invaders would be prioritized for pre-treatment by the Invasive Plant Specialist. Landings would be constructed away from areas infested with New Invader weeds that have not been pretreated or on areas with dense diffuse knapweed populations.	Minimizes the spread of New Invaders and diffuse knapweed when developing landing sites.	Y	Moderate	The potential spread of invasive plants may be increased.
13	Road blading, brushing, and ditch cleaning in areas with high concentrations of invasive plants would be conducted in consultation with the District Invasive Plant Specialists, incorporating invasive plant prevention measures as appropriate.	Avoids spreading invasive plants with road reconstruction and maintenance.	Y	Moderate	The potential spread of invasive plants may be increased.
14	Pretreat dense knapweed populations where present within soil restoration treatments units in order to prevent seed production.	Avoids spreading invasive plants with soil restoration treatments.	Y	High	Seed bearing plants may be spread into infested areas.
					Range
15	Existing structural Range improvements (fences, gates, water troughs) would be protected under thinning and prescribed fire activities. No trees would be cut that are incorporated into the fence line. Known fences that are cut in order to facilitate logging operations would be repaired to preexisting condition by the purchaser. All fences and water troughs within the timber sale/treatment area boundary would be identified on the Timber Sale, thinning contract, or burn plan maps. Extra care should be taken to locate improvements during treatment activities occurring in the winter due to limited visibility because of the accumulation of snow. Existing improvements would have a 10’ area surrounding the improvements cleared of slash produced by harvest or post-harvest activities.	Protects range structural improvements while implementing thinning and prescribed fire treatments.	Y	Moderate	Existing structural range improvements may be damaged.

Number	Design Feature	Why Necessary	Monitoring Necessary?	Efficacy	Consequence of Not Applying
16	Contracts would require that specific gates would remain closed during work and non-work hours if and when project activities occur within a pasture when authorized cattle use is occurring. The range specialist would work with the FS contract administrators to identify when there is a need to keep specific gates closed.	Maintains cattle in authorized grazing areas.	Y	Moderate	Cattle may not be maintained within authorized areas and stray cattle may contribute to resource damage.
17	Road segments identified to be decommissioned that are necessary for cattle trailing or designated as stock driveways would be decommissioned in such a way that does not preclude travel by cattle and horses, but access by ATV's/UTV's would be prevented. The Range Permit would be modified to assign required maintenance of these pathways to the permittee. See Appendix B for list of these roads.	Maintains cattle access.		Moderate	Movement and gathering of cattle by Range Permittees would be much more difficult. A new trail/route would need to be built outside of the road prism creating additional soil disturbance.
18	Some roads would be closed in such a way to accommodate ATV/UTV access for maintenance of stock tanks and other legitimate reasons, and provide for use by cows and horses. An approximate 5-foot wide portion of the original road may be preserved to provide this access. ATV/UTV access would be authorized for administrative use only on roads identified in proposed transportation changes in Alternatives 2 and 3, and using methods including, but not limited to, those described in Appendix B. See Appendix B for list of these roads and methods of closure and/or decommissioning.	Provides for road closure but allows administrative use per Forest Service Manual 7731 Road Operation (roads can be closed to public use, yet used for administrative uses). Minimizes impacts of road use while allowing required administrative use by USFS personnel, contractors, or permittees while in the performance of required management responsibilities.	Y	High	Not compliant with the LRMP S&Gs, current decision for the grazing AMPs, current direction for management of Invasive Species, or 36 CFR 212.5, subpart A – Administration of the Forest Transportation System. Permittees and Forest Service would lose motorized access, reducing range management efficiency.
					Botany and Sensitive Plants
19	Where Region 6 Sensitive and Survey and Manage plants occur or are suspected to occur in harvest, thinning, and underburn units, maintain shading sufficient to protect the plant's micro-site conditions. In most cases, the equipment buffer zone for Riparian Reserves would be adequate. The District Botanist would assess the need for additional protection of sensitive sites during unit layout. All ground disturbing activities, including aquatic and beaver habitat enhancements within occupied Region 6 Sensitive and Survey and Manage plant habitats would be coordinated with the District Botanist. Maps and descriptions of specific avoidance areas would be provided for Units 16 and 503, and	Minimizes disturbance and maintain sufficient shading to protect Region 6 Sensitive and Survey and Manage microsite conditions	Y	Moderate	Existing Region 6 Sensitive and Survey and Manage plants and micro-site conditions would not be protected, which could lead to a loss of vigor, populations and species

Number	Design Feature	Why Necessary	Monitoring Necessary?	Efficacy	Consequence of Not Applying
	aquatic and beaver enhancement activities where Region 6 Sensitive species occur.				
20	In units with an Aspen Release prescription, conifer canopy closure would not exceed 10% following treatment. This would be accomplished by retaining, on an average, a maximum of 10 conifer stems per acre larger than 10" DBH following harvest treatment including the adjacent areas located within 50' of treated aspen tree stand perimeters. The minimum patch size of aspen stands considered for this treatment would have five or more healthy aspen that are at least, 5' tall and are within a 15' radius of each other. The largest conifers would be retained in aspen stands, including trees 21" DBH and larger and defective trees most favorable for wildlife. Douglas-fir and subalpine fir 21 – 24" DBH with an estimated age of less than 150 years would be harvested where needed to achieve desired conifer stocking levels.	Provides for reduction of conifer canopy closure in units with an Aspen Release prescription for overstory thinning to limit conifer competition with aspen and other deciduous trees and provide trees favorable for wildlife.	Y	Moderate	Competing conifers would suppress aspen overstory trees, and suppress growth of aspen suckers. Conifers would compete strongly with aspen for soil moisture, sunlight and nutrients.
21	In noncommercial thinning units, thinning to limit conifer competition on aspen would be considered in existing aspen stands with five or more healthy aspen, 5' tall, in a 15' radius and in a 50' wide buffer located adjacent to aspen stand perimeters. Desired treatment objectives include 10 percent or less canopy closure contributed by conifers following treatment within aspen stands and the adjacent buffer. Leave a maximum stocking level of approximately ten conifers per acre larger than 10" DBH following treatment within aspen stands and the buffer. Conifers 10" DBH, and smaller would be felled with chainsaws (no ground disturbing mechanized equipment) to reduce conifer encroachment. Conifers larger than 10" DBH and less than 21" DBH would be girdled with chainsaws and left standing to attain desired conifer canopy closure treatment objectives. All conifers 21" DBH, and larger, would be retained in aspen stands and the adjacent buffers, even if conifer stocking exceeds the desired maximum retention level.	Provides for non-commercial thinning and girdling treatment of conifers to release existing aspen trees from conifer encroachment and promote the establishment of aspen and other hardwood regeneration. Reduces conifer competition for sunlight and soil moisture, improves the vigor of existing aspen clones, and stimulates sprouting of new aspen stems where conifers have invaded or are shading out aspen stands.	Y	Moderate	Competing conifers would suppress aspen overstory trees, and suppress growth of aspen suckers. Conifers would compete strongly for soil moisture, sunlight, and nutrients with aspen.

Number	Design Feature	Why Necessary	Monitoring Necessary?	Efficacy	Consequence of Not Applying
22	Underburn treatments would retain 90% of existing coarse woody debris less than 6 inches in diameter in and around Region 6 Sensitive and Survey and Manage plant habitats.	Limits cattle access to Sensitive and Survey and Manage plant habitats.	Y	Moderate	Cattle access may become easier in R6 Sensitive and Survey and Mange plant habitats, causing trampling and browsing of plants.
23	In aspen overstory thin units 21, 22, and 24, a slash mat would be used during machine piling.	Minimizes soil compaction and disturbance in aspen stands.	Y	Moderate	Soil compaction in aspen stands could decrease water uptake to aspen and plants within aspen and plants within aspen stands. Plants and aspen roots could be damaged by mechanized equipment during implementation that could lead to decreased vigor and health.
24	Within certain harvest and aspen release units and aquatic enhancement activities, *Botrychium* populations would be flagged, identified and avoided by directional felling, equipment exclusion zones, or other skidding restrictions would be used. Underburning in one unit should occur at a time when soils within the population are saturated in order to limit fire spread into the population. Refer to internal Botany Design Criteria in Project File for site-specific design criteria.	Prevents impacts to botanical resources in units with known locations of Sensitive plants.	Y	Moderate	Populations of *Botrychium* may be lost to management actions.
					Vegetation Management
25	During thinning operations, retain five to ten suitable breeding partners within 120 feet of genetic select trees. Suitable breeding partners include vigorous, disease-free, well-formed, and cone producing trees 12” DBH and larger which are the same species as the select tree.	Provides breeding partners for genetic select trees, which require pollen from nearby trees of the same species to produce cone crops with viable seed. Suitable breeding partners possess desirable, heritable traits which may be passed on through pollen to seed produced by genetic select trees. When available, seed produced by select trees is preferred to grow seedlings for tree planting in reforestation projects on the Ranger District.	Y	Moderate	Cone crops and viable seed production of genetic select trees may be reduced by inadequate pollination. Genetic quality of seedlings produced from select tree seed may be diminished.

Number	Design Feature	Why Necessary	Monitoring Necessary?	Efficacy	Consequence of Not Applying
26	Avoid mechanical damage to the boles, live branches, and terminal leaders of designated residual trees during harvest and young plantation thinning operations.	Increases long-term retention and growth of residual trees that are intended to remain post-treatment.	Y	High	Vegetation management treatment objectives may not be fully accomplished.
27	Protect boles, crowns, and roots of genetic select trees from damage during harvest and prescribed fire treatment operations.	Increases retention of genetic select trees. Damage to boles, crowns, and roots is detrimental to the survival, growth, and long-term viability of genetic select trees.	Y	High	Damage leading to the mortality or reduced seed production of a select tree represents a lost opportunity for genetically diverse seed collection to support reforestation projects.
28	Discourage livestock grazing in regeneration harvest units for a period of three to five years following tree planting with the following measures: • Avoid placing salt blocks in or adjacent to tree planting units. • Avoid seeding grass species that would encourage grazing (forage mix) in or adjacent to tree planting units.	Increases survival and growth of seedlings by reducing potential damage from livestock trampling. Minimizes livestock damage to stocking plot markers needed for required survival and stocking level monitoring that occur post-planting for three to five years.	Y	Moderate	Seedling establishment may be detrimentally affected and desired tree stocking levels may not be promptly attained following planting.
	Areas with inadequate first year planting survival or third year stocking levels would be assessed and replanted as needed to ensure that minimum acceptable tree stocking levels of approximately 100 trees per acre, on average, are attained.	Ensure regeneration of trees in desired species and structure.	Y	High	Regeneration of desired tree species and structure may not occur and be corrected.
29	Individual openings created by harvest or plantation thinning or prescribed fire outside of regeneration harvest units would not exceed these limitations: • In Dry Forest Restoration Thin units: a maximum of one acre. • In Aspen Release and Dry Forest Thin with Dwarf Mistletoe Reduction units: maximum of 1 acre in the visual foreground, 2 acres in all other areas. • In Moist Forest units: maximum of one-quarter acre. • Total openings created by thinning or prescribed burning in any of these units would not exceed 5% of the total unit size. In units with only ladder fuel reduction understory thinning, openings created by thinning or prescribed fire would not	Limits openings in the forest canopy created by timber harvest in Dry Forest Restoration Thin, Dry Forest Thin with Mistletoe Reduction, and Aspen Release treatment units. Limits openings in the forest canopy created by timber harvest in Moist Forest Thin treatment units 1 and 65. Minimize openings in the forest canopy where visual foreground concerns exist.	Y	High	Forest canopy openings may exceed desirable levels in visual foreground and other areas. In units 1 and 65, Forest canopy openings may exceed desirable levels for Northern Spotted Owl habitat. Openings in forest canopy may exceed desirable levels in visual foreground and other areas.

Number	Design Feature	Why Necessary	Monitoring Necessary?	Efficacy	Consequence of Not Applying
	exceed 10% of the total unit size. Individual created opening sizes would be limited to: • One acre (approximately 200' X 200') in the visual foreground. • Five acres (approximately 470' X 470') in all other areas. One acre is approximately 200' x 200'; two acres is approximately 300' x 300'.				
30	During prescribed burning, treatments would be designed to retain all genetic trees, and at least 90 percent of other live trees and snags greater than 20" DBH (Wright et al. 2003). This would be measured on a per-burn-unit basis. Slash accumulations around these trees would be no deeper than one (1) foot within an 8 foot radius of the bole to reduce cambium heating and scorch during prescribed fire underburn treatments.	Minimize mortality of all genetic trees and snags, and live conifer trees > 20 inches in diameter at breast height (DBH)	Y	Moderate - High	Loss of genetic and large structure trees.
31	In regeneration units where post-harvest tree planting would occur, planting survival exams would be conducted by the district silviculturist or their designee following existing protocols to assess the survival of planted seedlings and natural regeneration.	Ensure that regeneration of trees occurred as planned in regeneration units.	Y	High	Regeneration of desired tree species and structure may not occur and be corrected.
32	Before implementation of reforestation or prescribed fire treatments, thinning units would be monitored by district silviculturist or designee to evaluate accomplishment of silvicultural treatment objectives and confirm planned treatment needs.	Ensure that post-thinning treatments are modified as needed based on results of thinning to accomplish project vegetation and fuels treatment objectives.	Y	Moderate – High	Site preparation prior to tree planting may have limitations. Retention objectives in post-thinning stand structure may be incompatible with prescribed fire.
					Recreation
33	Log Haul would be prohibited on weekends from Friday 6 p.m. until Monday 2 a.m., and Federal Holidays unless approved by recreation staff and the sales administrator.	Reduces potential conflicts between haul traffic and local residential/forest visitor traffic on weekends and holidays.	Y	Moderate	Reduced safety for the recreating public and contractors working on the project.
					Soils

Number	Design Feature	Why Necessary	Monitoring Necessary?	Efficacy	Consequence of Not Applying
34	Soil under machine piles in harvest and fuels treatment units would be seeded after burning if post-burn inspection indicates that vegetative recovery is unlikely. Rehabilitation of hand and machine burn piles (not including landing piles) following prescribed burning treatments may include seeding, use of coarse woody debris if bare soil is exposed, weed treatment, etc. The need for rehabilitation would be assessed post-burn by staff from fuels, soils, and/or botany/invasive plant resource areas. Soil damaged by burning debris in landing piles in harvested units would be mechanically rehabilitated and revegetated with certified weed-free seed. Damage determinations would be made according to guidelines established by the Soil Scientist. Seeding on landings would be done by the timber sale purchaser prior to pile burning. Seeding and rehabilitation under the burn pile footprint would occur post-burning by District fuels, botany, or invasive plant staff. Seeding need determinations would be made according to guidelines established by the Soils Scientist, District Botanist, and/or Invasive Weeds Coordinator. De-compact landings, seed and place woody debris on landings. Slash would be placed over 65 – 70% of the landing surface to a depth of 2 – 3 inches (approximately 22 – 25 tons/acre).	Minimizes invasive weed colonization of burn piles and soil erosion as needed following burning. Prevents soil erosion and support vegetation recovery. Reduces compaction from treatments.	Y	Moderate	Not compliant with National and Region 6 Soil Standards. Reduction of soil productivity.
35	Ground based logging operations outside of winter operating season would occur over a slash mat and restoration activities would be performed following implementation in order to ensure compliance with Regional and Forest Plan soil Standards. Restoration activities could include: seeding or planting skid trails; coarse woody debris placement on skid trails (placed over 65 – 70% of the skid trail surface to a depth of 2 – 3", about 22 – 25 tons/acre; slash and coarse woody debris on the skid trail would be compacted so that it is in contact with the soil surface; litter, duff, soil, and woody debris displaced from the trail would be placed on the skid trail). Other possible restoration activities: tilling or subsoiling (could be applied on a site specific basis but may not be feasible with soil types found in the project area); spreading forest litter or topsoil over skid trails.	Avoids disturbing soils while not impacting winter recreation (Treatment units 1-4, 6-16, 19-24, 26-46, and 48-52).	Y	High	Reduction of soil productivity and Region 6 soil standards.
36	Logging over a slash mat would occur under the following conditions: there is enough slash to consistently keep ~ 6 inches of slash over 65 – 70% of the footprint of the skidder and	Provides for effective use of slash mats to mitigate soil concerns	Y	High	Reduction of soil productivity and Region 6 soil standards.

Number	Design Feature	Why Necessary	Monitoring Necessary?	Efficacy	Consequence of Not Applying
	following treatment there would be 2 – 3 inches of slash left on skid trails.				
37	During felling operations in harvester/forwarder units, available slash would be placed on approved log removal routes. Forwarder equipment would operate on placed slash during log removal.	Reduces compaction of soil during felling and forwarding.	Y	High	Reduction of soil productivity and Region 6 soil standards.
38	Winter operations are required in treatment units 47, 53-60, and 62-65 to minimize soil impacts unless the purchaser can present an Operating Plan that allows for no more than 2% detrimental soil compaction conditions per unit. An alternative Operating Plan from winter harvest conditions must be approved by the soil scientist before operations can begin. The snow depth, distribution, and air temperature conditions must be such that ground-based operations maintain the following combination of snow depth and frozen soils conditions under the wheels or tracks/treads of equipment at all times. Winter soil specifications are: Require 8 inches compacted snow or a combination of compacted snow and hard, frozen ground equaling 8 inches. Prior to approval of winter logging operations, an assessment of suitable snow and soil conditions would be conducted by the North Zone Soil Scientist (or the Timber Sale Administrator following an initial site visit with a Soil Scientist). Periodic assessments would be conducted during the winter operating period, especially during warming trends. Overnight temperatures should drop to 25º F, or lower, and afternoon temperatures should stay below 35ºF to maintain frozen conditions. Afternoon temperatures can exceed 35ºF for short periods if previous night time temperatures are below 20ºF. If skid trails begin thawing and show signs of rutting and water runoff, relocate main skid trails to suitable snow and frozen soil conditions.	Limits detrimental soil compaction and displacement and provides an alternative to limitations and requirements of summer operations (over snow harvest).	Y	Moderate	Maintenance of some snowmobile routes for winter users. Public concerns on being able to snowmobile in the area throughout the winter.
39	Active soil restoration measures would be used as needed on detrimentally compacted soils in treatment units where greater than 15% of the area has been affected such as landings, portions of multiple-pass skid trails that converge into landings, portions and other segments that incur heavy compaction.	Reduces the level of detrimental soil disturbance and restore compacted and displaced soils toward more desirable conditions.	Y	High	Reduction of soil productivity and failure to meet Region 6 soil standards.

Number	Design Feature	Why Necessary	Monitoring Necessary?	Efficacy	Consequence of Not Applying
	Decompaction may be done with an excavator or other equipment approved by the Soil Scientist and/or Timber Sale Administrator. Post-treatment assessment and confirmation of active restoration needs would be made by a Forest Service Soil Scientist during harvest activities.				
40	Waterbars would be installed on fireline during construction, and on skid trails with bare soil or very thin vegetative cover at the end of harvest operations or prior to entering into seasonal shutdowns or periods of extended inactivity. Timely completion of waterbars would divert runoff from seasonal rain or snow fall. Construct to a minimum of 1.5 to 2 feet in height (2 feet high on the steeper skid trails), and a minimum depth of 18 inches, without using pushed-up soils. Some variation in waterbar size may occur but they must be large enough to function properly. Install at a 45 degree angle to either the left or right of the trail to disperse water on the down slope or lower side of the trail. A herringbone pattern of alternating water bars may be necessary on steeper slopes. Driving on or damaging waterbars with heavy equipment would be avoided to minimize the potential for failure. If damage occurs, waterbars would be repaired to bring them back up to the minimum design height. % slope and spacing: 2 – 10% slope = 150' spacing. 11 – 20% slope = 120' spacing. 21 – 34% slope = 90' spacing. > 35% slope = 80' spacing.	Mitigates erosion risk by using waterbars and ensure waterbar effectiveness.	Y	Moderate – High	Reduction of soil productivity and failure to meet Region 6 soil standards.
41	Place woody debris on skid trails where necessary. Site factors that would indicate a need for woody debris include, but are not limited to, continuous grades, water concentrating topography, proximity to wet or riparian areas, and ground disturbance that bares soil.	Limits erosion and sediment delivery	Y	Moderate – High	Reduction of soil productivity and failure to meet Region 6 soil standards.
42	Tractor skidder/forwarder operations would be confined to slopes that are 35%, or less, except pitches of 150 feet, or less, on steeper ground. No side hill travel of skidder/forwarder equipment would take place on these steeper pitches to avoid excess soil damage. Machinery would be excluded from any areas with extended pitches greater than 150 feet that exceed 35 percent. Operation on short, steep pitches would only occur if adequate ground vegetation is present.	Avoids excess skidder damage.	Y	High	Reduction of soil productivity and failure to meet Region 6 soil standards.

Number	Design Feature	Why Necessary	Monitoring Necessary?	Efficacy	Consequence of Not Applying
43	Summer harvesting operations would be conducted during periods of sufficient and not excessive soil moisture, as assessed by a Soils Scientist and Timber Sale Administrator, to provide adequate soil stability (See Appendix A of the Soil Resource Report in the administrative record). The following requirements apply to summer logging operations and are intended to maintain the level of detrimental soil disturbance within harvest units to 15 percent or less: Single-pass felling equipment trails would be located a minimum of 40 feet apart. Designated skid trails would be used for all ground based logging. Skid trails from prior harvest would be used to the maximum extent possible except where skid trails are located on slopes 35%, or greater. Slash would be applied on skid trails to extent feasible to operate equipment on. Multiple-pass skidding equipment trails would be designated and approved by the Timber Sale Administrator prior to operations and would be located a minimum of 100 feet apart except where they converge at landings, unless approved by the Soil Scientist and Timber Sale Administrator. Scatter slash on the first 100' of skid trail entrances, including where skid trails access landings.	Provides adequate soil stability. Minimizes soil disturbance from skidding.	Y	Moderate – High	Reduction of soil productivity and failure to meet Region 6 soil standards
44	Organic debris would be placed along margins of landings as needed to prevent erosion.	Prevents erosion at landings.	Y	Moderate – High	Reduction of soil productivity and failure to meet Region 6 soil standards.
45	When determining landing locations, the Timber Sale Administrator shall consider that use of existing sites, especially those currently causing resource damage, would provide for immediate mitigation and post-use rehabilitation of landing locations and associated roads/skid-trails within the constraints of timber harvest contract administration.	Rehabilitates previous disturbance.		Moderate	Reduction of soil productivity and failure to meet Region 6 soil standards.
46	Hand and machine piles may be up to 6 - 8 feet in diameter to localize areas of soil disturbance to less than approximately 50 square feet. Pile burning should occur when soils are moist to minimize duff consumption and high-severity burn impacts on soils. Where feasible, build piles where soil disturbance already exists (i.e. on old landings, roads, or skid trails) to prevent new areas of detrimental soil disturbance. Machine piling in Aspen release units needs to be done over a slash mat to minimize soil compaction and rutting.	Minimize detrimental soil disturbance (DSD) created by machine piling and burning and speed the recovery time for vegetation establishment.	Y	Moderate – High	Reduction of soil productivity and failure to meet Region 6 soil standards.

Number	Design Feature	Why Necessary	Monitoring Necessary?	Efficacy	Consequence of Not Applying
47	Keep units under Region 6 detrimental soil disturbance measures and reduces bare soil post-project by reccontouring slash where material is readily available. Seed and block entrance to skid trails and temporary roads. After prescribed burning, desired outcome includes retention of organic matter across at least 80% of the unit within a burn unit within 2 years following treatment implementation. Machine and hand-pile burning should be done during times of high soil moisture when post-burn conditions would result in no more than 20% bare soils (excluding natural conditions) within 2 years following treatment implementation.	Minimize detrimental soil disturbance (DSD), speed recovery of soil, limit unauthorized motor vehicle access. Retains organic matter to protect the soil from rain splash impacts, erosion, soil moisture holding capacity, and solar surface heating (especially on south-facing slopes).	Y	Moderate – High	Units may go above Region 6 DSD standards and have excessive erosion. Reduction of soil productivity.
48	During skyline harvest, suspend one end of logs on line. Some areas will be designated full suspension.	Minimizes detrimental soil disturbance, erosion, and speed recovery time for vegetation establishment.	Y	Moderate – High	Units may go above Region 6 DSD standards and have excessive erosion and invasive plant colonization.
49	Machine piling within harvest units would be accomplished by piling debris (i.e. using an excavator or grapple-piler), not by pushing debris with bladed equipment. Machine-piling equipment would use existing skid trails, whenever possible, and make single passes to collect debris that is reachable from skid trails. Machinery would operate on slash whenever possible and should operate in linear passes to avoid soil displacement from turning. No new detrimental soil disturbance would occur from machine-piling and burning. Leave coarse woody material on site in all forested portions of units at the following post-treatment rates as follows: • Warm/dry ponderosa pine and Douglas-fir habitat types: 5-10 tons/acre • Cool dry and Cool/Moist Douglas-fir habitat types: 10-20 tons/acre • Cool lodgepole pine & subalpine fir habitat types: 8-24 tons/acre. In all zones, mechanically scarred trees would be left standing to provide wood recruitment. These trees, as well as snags, would be counted as down woody material. Where total debris up to 9” in diameter is <10 tons/acre, no machine piling would occur to help retain wood for soil productivity.	Minimizes new detrimental soil disturbance from machine piling equipment. Meets coarse woody debris objectives.	Y	Moderate – High	Reduction of soil productivity and failure to meet Region 6 soil standards.

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50	Livestock entry into unburned units would be regulated by the Range Specialist implementing the grazing allotment Annual Operating Instructions.	Prevents soil erosion and weed invasion and promote vegetation recovery.	Y	High	Reduction of soil productivity and failure to meet Region 6 soil standards.
51	Coarse Woody Material (CWM) larger than 15" in diameter would not be intentionally ignited during lighting operations. Fire may creep into CWM and combust various pieces.	Provides for coarse woody debris retention during prescribed fire activities.	Y	Moderate	Reduction of soil productivity and failure to meet Region 6 soil standards.
52	Leave debris from thinning through one winter after cutting to allow for initial decomposition and nutrient leaching.	Provides for nutrients to enhance soil.		High	Reduction of soil productivity and failure to meet Region 6 soil standards.
53	Where possible, separate limbs from tops at processing sites to provide material for biochar and to reduce burn pile sizes.	Provides material for biochar.		Moderate	Would not be able to use slash material for biochar production to return nutrients to the soil.
54	Proposed sub-soiling would occur on native soil surfaces and would not impact any road prism in the project area. No equipment would be allowed on riparian soils. If riparian soils needs treated, it would be accomplished using the extent of the equipment boom. Identified weed infestations would be avoided and/or treated by the District Invasive Weeds Specialist before sub-soiling treatments. Upon completion of sub-soiling activities, the Soil Scientist and District Botanist would assess the need for native plant seeding.	Maintains existing road prisms; minimizes impacts on riparian soils and the spread of invasive weeds; provides for re-seeding as necessary.	Y	Moderate	Roads could be impacted, weeds spread, and native plant colonization may be reduced.
					Air Quality
55	Coordinate burning activities through compliance with the current Washington State Smoke Implementation Plan (SIP).	Provides for smoke approval and the means to coordinate ignitions, consider current and potential air quality impacts. Helps schedule burns for periods of good air ventilation, minimizing air quality impacts to local communities and Class I airsheds.		Moderate - High	Non-compliance with SIP. Public parties may be adversely effected by impacts from smoke. Additional restrictions may be placed on fuels treatments utilizing burning.
56	Target burning for periods of favorable ventilation conditions of adequate length for ignition. Evaluate smoke dispersal conditions before, during, and after ignition. Monitor smoke impacts on air quality during and after ignition. Document air quality impacts from prescribed burning using monitors in	Gives local, site-specific evaluation of air quality conditions that may be missed during smoke approval process. Provides potential trigger to stop further ignitions if possible.	Y	Moderate – High	Non-compliance with agency direction. Ignition may occur or continue when air quality impacts are increasing and ventilation conditions are unfavorable or deteriorating with an increased

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	Twisp or Winthrop, photographs, and/or records of comments & complaints.	Helps assess, analyze, and address air quality issues.			potential for air quality impacts. Subjective determinations on air quality impacts.
57	Notify the public of prescribed fire activities and recommended actions to reduce impacts, using applicable contacts and methods listed in the current District Prescribed Fire Public Information Plan. Burn planners would contact residents adjacent to burn unit boundaries during the planning process and include them in burn notification process as requested.	Notifies the public of plans for burning to provide awareness of prescribed fire activities and opportunity to minimize or avoid air quality impacts.		Moderate – High	Non-compliance with agency direction. Public has little time to prepare for potential health and visual impacts of prescribed fire smoke.
58	If smoke from prescribed burning impacts visibility on local roads, implement the current District Traffic Visibility Guide.	Reduces risks associated with reduced visibility caused by smoke from prescribed burning.	Y	Moderate – High	Non-compliance with agency direction. Increased risk to drivers using roads with limited visibility near prescribed burn units.
59	Minimize smoke emissions by allowing public firewood collection for one year after commercial and ladder fuel reduction thinning treatments have been completed except where biomass is proposed for use commercially or debris is inaccessible by motorized vehicles. Except for landing piles, firewood collection would not be allowed where slash is hand- or machine-piled. All firewood gathering must be consistent with current forest firewood policy. Where cost-effective and feasible, chip debris from thinning activities or remove through biomass utilization or other means if consistent with effects analyzed for this project.	Reduces emissions through firewood collection, biomass utilization, chipping, and other fuels treatment methods where feasible. Provide firewood opportunities for the public.		Low – Moderate	Slight increase in emissions during prescribed burning. Public not able to gather firewood from debris piles.
60	If ignition is underway and ventilation conditions deteriorate with no potential for improvement during the burn period, or if ignition is delayed to periods with unfavorable conditions, cease ignition at the earliest and safest opportunity.	Limit particulate matter impacts to air quality during prolonged periods of poor ventilation that occur after ignition begins with no potential for improvement.	Y	Moderate	Potential increased and prolonged levels of particulate matter may impact human health.
					Cultural Resources and Historic Properties
61	Activities would avoid eligible and unevaluated cultural resources. Burn plans and contracts would contain clauses allowing the Forest Service to modify or cancel portions of the operations to protect known and newly discovered cultural resources.	Protects cultural and heritage resources.	Y	High	Adverse effects to cultural resources.

Number	Design Feature	Why Necessary	Monitoring Necessary?	Efficacy	Consequence of Not Applying
	If cultural resources are discovered as a result of project activity, all work in the vicinity of the discovery would cease until assessment by a cultural resource specialist.				
					Transportation
62	Temporary roads would be constructed to minimal standards necessary for safe use and decommissioned/rehabilitated following completion of harvest activities. Rehab activities shall include decompaction, reccontouring, slashing (as materials are available), and seeding to speed recovery of soil and blocking entrances to prevent unauthorized OHV use. These actions would occur as soon as access is no longer needed, preferably in the same season of use. Temporary stream crossings would be designed to handle expected flows during the life of use and would be installed to minimize disturbance to stream banks and channels with material placed there removed following use of the channel and crossing and placed in a stable location to prevent sediment from entering the stream. Erosion control measures would be in place during and after use of the crossing.	Minimizes soil impacts from temporary roads and temporary road stream crossings.	Y	Moderate - High	Not compliant with the LRMP S&Gs for soils. Reduction of soil productivity and failure to meet Region 6 soil standards.
63	Stream crossings would be decommissioned by: • dewatering the site or isolating it from flowing waters to prevent delivery of sediment to watercourses in accordance with the WDFW/FS MOU; • excavating the fill and restoring slopes and stream channels to mimic the natural stream channel and banks and restore the natural valley configuration; • placing and shaping excavated material into cutbanks near the crossing in such a way that sediment-laden runoff can be confined; • and/or placing large woody material and/or large rocks, as necessary, for streambed and downstream of the crossing removal.	Ensures road decommissioning at stream crossings provide a natural hydrology.	Y	High	Failure to comply with BMPs, Federal & State laws, or meet with the MOU agreement between the WDFW and the Forest Service
64	Closing roads (changing to Maintenance Level 1) may include these activities: blading and shaping the road surface to restore proper cross-slope, reinstalling drain dips and installing waterbars, spreading slash or debris over the road surface,	Ensures appropriate level of road closure (ML 1) activities.	Y	High	Not compliant with the LRMP

Number	Design Feature	Why Necessary	Monitoring Necessary?	Efficacy	Consequence of Not Applying
	and/or placing an effective restriction device. Specific activities would be evaluated by engineering staff or their designee.				
65	Roads placed in ML-1 (closed) status would have culverts removed unless engineering staff or their designee determine that: • culverts were recently installed and adequately designed to pass a 100-year storm event and any expected debris; • the culvert is in good condition and has a very deep fill; • culvert is on a loop road with potential need for fire egress; • the road is below a recently burned area.	Defines the circumstances when a culvert would not be removed from a road for long-term closures.	Y	High	Compliance with the Aquatic BMPs, BAs
66	Roads identified for decommissioning would be evaluated by engineering staff and site specific prescriptions for decommissioning developed with input from other resource specialists, as appropriate. Evaluation would include existing drainage structures, slope stability of fill and cut slopes, signs of erosion, adequacy of vegetation, etc. If no issues are identified that need to be addressed, further decommissioning activities would not occur and road records would be changed to indicate the road segment is decommissioned.	Ensures site-specific evaluation and application of appropriate level of road decommissioning activities.	Y	High	Would not comply with Aquatic BMPs
67	Snow plowing would include water drainage outlets appropriately spaced, constructed and maintained in the dike of snow or berm caused by snow removal operations. Water drainage holes would be placed to obtain surface drainage without discharging on erodible fills. Typically, snow removal would be conducted in such a way as to keep the blade a minimum of 2 inches above the road surface.	Facilitates logging operations and safe use, and identifies the usable travel way.	Y	Moderate	Log trucks would not be able to access area or haul resources out of area.
68	Where culvert replacement and/or Aquatic Organism Passage installations occur, design stream culverts for a 100-year storm event and any associated debris. Follow the WDFW/Region 6 Forest Service MOU Design Criteria for instream work (WDFW & USDA 2012).	Makes roads more resilient to failure and minimize impacts to fish and their habitat		High	Roads at high risk of failure that can lead to excessive impacts to fish habitat.

Number	Design Feature	Why Necessary	Monitoring Necessary?	Efficacy	Consequence of Not Applying
	Roads scheduled for closure would be monitored prior to October 1st each year that closures are scheduled to ensure that the work is completed and that the drainage facilities are adequate and self-maintaining.	Ensures roads are treated to prevent impacts of weather and runoff.	Y	High	Inadequate road closures may leave roads at high risk for failure that may adversely impact habitat and increase repair and maintenance costs.
					Wildlife
69	In harvest units, retain complex patches, clumps, canopy gaps and snags in accordance with the Forest Restoration Strategy	Provides cover, diversity, connectivity, and a variety of food resources.	Y	High	Reduction in diversity across the landscape, ability of some species to disperse across the area and fewer food sources.
70	During post-harvest ladder fuel reduction thinning, retain complex patches, clumps, and gaps and snags retained in the harvest units.	Provides cover, diversity, connectivity and variety of food resources	Y	High	Reduction in diversity across the landscape, ability of some species to disperse across the area, and fewer food sources.
71	During ladder fuel reduction thinning outside of harvest units, retain clumps of un-thinned patches of trees from 0.1 to multiple acres.	Provides cover, diversity, connectivity, and variety of food resources.	Y	High	Reduction in diversity across the landscape, ability of some species to disperse across the area, and fewer food sources.
72	Limit diameter of large trees cut in stands providing NRF habitat (commercial thin units 1 and 65) to 21" DBH. Retain snags and defective trees. Maintain canopy closure of 60%, and create no openings greater than ¼ acre. Maintain groups of large trees, including large Douglas-fir in proximity to large pines and clumps of large trees with canopy interaction sufficient to provide habitat elements for owls. In NRF stands, where LFR treatment would occur (units 1, 24, 65, 73, 403, 406, 407, 410, 418, 419, 420, 421, 423), maintain canopy closure of 60%, and create no openings greater than ¼ acre.	Balances the reduction of competition on large trees with retaining large trees and canopy closures in NRF stands. Canopy closures and medium/large trees would be reduced but stands would become better NRF in the future, and risk of high severity wildfire reduced. In NRF stands where LFR treatment would occur, maintains habitat status as NRF	Y	High	Habitat would be degraded or downgraded to dispersal or no habitat.
73	Implementation of some activities would be restricted from March 1 to August 1 in un-surveyed areas where adequate Nesting-Roosting-Foraging habitat is present. Refer to wildlife biologist's project file for locations.	Reduce potential for disturbance to spotted owls.	Y	High	Disturbance to spotted owls may occur.
74	If goshawk nests are found prior to contract award, nest stands and post-fledgling areas (PFAs) would be delineated and managed by retaining high canopy closures, diversity of stand	Protects active nest and fledgling areas. Reduce potential for disturbance to nesting goshawks.	Y	High	Reduction in suitable habitat which could result in reduced carrying capacity for sensitive

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	structures, and large overstory trees. Refer to wildlife biologist's project file for locations. If goshawk nest is found after contract award, major project activities such as thinning and underburning should be avoided from the onset of nesting until the young are fledged (mid-August).				species. Potential disturbance to nesting goshawk and young
75	Treatments would not occur near active goshawk nest stands and PFAs from March 1 through August 15. Refer to wildlife biologist's project file for locations. These locations would be shown on the Sale Area Map.	Reduces disturbance to goshawks.	Y	High	Potential for nest abandonment by adult goshawks, and subsequent loss of young of a sensitive species.
76	Avoid disturbance of western gray squirrels between March 1 and August 31 within 400' of natal nests. Refer to wildlife biologist's project file for locations. Retain denser forest in riparian areas and in clumps and patches across the landscape for western gray squirrels. In harvest and ladder fuel reduction thinning units, retain groups of trees with interlocking canopies and more open areas to balance fungal and mast crop production. Provide stringers of trees with interlocking crowns between natal nest sites, forage areas, and water for western gray squirrels. During thinning operations, if western gray squirrel natal nests are found, buffer with a 50-foot no-cut zone and retain at least 50% canopy closure within 350 feet of the nest.	Reduces the potential for nest abandonment Facilitates arboreal travel to reduce predation by ground-based predators. Provide a variety of food sources. Protects nest sites and reduces potential of mortality to young.	Y	High	Increased mortality of a sensitive species and reduced variety of foods. Potential disturbance to nesting gray squirrels and young.
77	In ladder fuel reduction thinning units, retain areas of dense multistoried canopy cover across 20% of the fuels treatment footprint in patches from 0.1 acre to multiple acres for mule deer.	Provides thermal and hiding cover for mule deer.	Y	High	Reduced diversity, connectivity, and food resources across the landscape for deer and other wildlife species.
					Aquatic and Hydrologic
78	For any thinning within ephemeral draws: No buffer required. Do not skid up-down low point of draws; minimize/mitigate crossings. Avoid new landings or any piles directly within low point of draws.	Prevents compaction of ephemeral draws and forcing sub-surface flow to the surface	Y	High	Reduced base flows in fish bearing streams, which reduces fish habitat quality.
79	Where commercial harvest occurs near intermittent streams, operations would occur in winter or, if outside of winter, no equipment would be allowed in Riparian Reserves (RR). The following buffers apply to commercial harvest operations in	Minimizes soil disturbance, surface erosion, and stream sedimentation. Protect stream temperatures by avoiding new	Y	Moderate-High	High ground disturbance, surface erosion, and stream sedimentation. Reduced shade on perennial streams and increased

Number	Design Feature	Why Necessary	Monitoring Necessary?	Efficacy	Consequence of Not Applying
	these areas; no commercial harvest would occur within these buffers: • Buffer stream channel 50 feet on 0-10% slopes. • Buffer stream channel 70 feet on 11-25% slopes. • Buffer stream channel 90 feet on 26-35% slopes. Where commercial harvest occurs near perennial streams, ponds, lakes, and wetlands, operations would occur in winter or, if outside of winter, no equipment would be allowed in Riparian Reserves (RR). Buffer stream channel, lake, wetland, or pond by 100 feet.	openings in inner RRs, provide sediment filtration, as well as other resource functions.			stream temperature. Reduction in fish habitat quality.
80	In commercial thinning units 1, 8, 9, 13, 19, 22, and 24, machinery may operate in RRs over frozen ground during winter operations; if operating outside of winter, equipment would not enter RRs except where harvest would occur to an existing road and be at least 100 feet from a stream.	Limits machine use in Riparian Reserves	Y	High	Increased soil disturbance including compaction, rutting, and potential sediment delivery to streams
81	Landings in Riparian Reserves (RRs): • New landings would not be constructed within RRs unless other practicable locations outside the RR (first priority) or existing landings inside the Riparian Reserve (2nd priority) are not available. The Timber Sale Administrator shall weigh the relative ground disturbance area considering skid distance, landing size, slope of landing area, slope and vegetated cover condition of riparian buffer strip, and other factors. There may be cases where total number of landings within RRs is not the best metric for reducing impacts via ground disturbance within RRs. • Areas would not be approved for landing in an RR if mean site slope exceeds 5%; if the riparian buffer strip is not well-vegetated or is in a disturbed condition; or if the site is located downslope of a road that forms the unit boundary in the RR. • Organic debris would be placed along margins of landings as needed to prevent erosion. • Landings in RRs would have suitable erosion control measures such as silt fences or other retention tools	Minimizes soil disturbance, surface erosion, and stream sedimentation. Protects shade on perennial streams	Y	Moderate-High	High ground disturbance, surface erosion, and stream sedimentation. Collectively, this reduced fish habitat quality.

Number	Design Feature	Why Necessary	Monitoring Necessary?	Efficacy	Consequence of Not Applying
	installed before construction of the landing. These measures would remain in place during harvest operations. Landings within RRs would be scarified, seeded, and scattered with organic debris after harvest activities are complete. • The Timber Sale Administrator shall weigh the relative ground disturbance area considering skid distance, landing size, slope of landing area, slope and vegetated cover condition of riparian buffer strip, and other factors. There may be cases where total number of landings within RRs is not the best metric for reducing impacts via ground disturbance within RRs.				
82	The Timber Sale Administrator or other authorized personnel shall consider the requirement to place slash in drainage features to provide additional sediment trapping/filtration function. These locations may include natural drainage swales in the unit or below the road, ditch lines where anticipated flows would not put the roadway prism at risk of failure, skid trails, etc.	Filters and traps sediment.	Y	Moderate	Increased soil disturbance and surface erosion.
83	No more than 20% of any 6th field sub-watershed would be burned in any single year (Beche et al.2005).	Limits cumulative impacts of prescribed fire on RR resources.	Y	Moderate	Burning more than 20% of a watershed per year can lead to increased fire effects on aquatic and riparian resources.
84					
85	During harvest operations outside of winter, perennial stream crossings would be armored by applying rock to the running surface of road segments on summer haul routes with a grade greater than 3% that could potentially deliver sediment at the stream crossing. This treatment would be applied to perennial stream crossings and intermittent stream crossings within 300 feet of a perennial stream. All locations would be subject to field verification as needed by engineering staff with input from aquatic or hydrologic specialists as appropriate. See map in Appendix F for locations of proposed locations where rock armoring may occur.	Reduces road-related sediment.	Y	High	Increased surface erosion

Number	Design Feature	Why Necessary	Monitoring Necessary?	Efficacy	Consequence of Not Applying
86	Noncommercial thinning (ladder fuel reduction, pre-commercial thinning, etc.) would use these stream channel buffers in RRs: • Intermittent Streams: 25-foot no-treatment buffer or inner gorge (>35%), whichever is greater. • Perennial Streams: 50-foot no-treatment buffer or inner gorge (>35%), whichever is greater.	Maintains understory instream-wood recruitment and shade along perennial streams	Y	High	Reduced wood recruitment and increased stream temperatures
87	Hand or Machine Piling: Minimize machine crossings of ephemeral draws; cross at perpendicular angle; do not use low point of ephemeral draws as a travel way for equipment. Avoid hand or machine piles directly within the low point of draws. Machine piling is permitted in outer 50' edge of the 150' RRs in unit 347; as an Adaptive Management Strategy, it may also be used in outer edge of RRs in units 019, 064, and 066 if the original proposed treatments are not selected. Not permitted anywhere where mesic riparian vegetation dominates.	Avoids removing ground cover and prevents surface erosion	Y	High	Increases risk of surface flows and sedimentation of streams downslope
88	For all activities in Riparian Reserves, retain 95% of overstory trees, ~66% of understory/shrub layer, and 50% of existing ground cover/organic material on surface. Underburning in intermittent RRs may use active lighting up to 25 feet from the channel, and underburning in perennial or wetland RRs may use active lighting up to 100 feet from the channel; this would provide for low-intensity fire behavior. Creeping fire beyond the active ignition zone is acceptable. Wetlands would be excluded from burning.	Increases ability to provide for low-intensity fire behavior in RRs. Avoids removing ground cover and prevent surface erosion. Limits disturbance of burning on wetlands.	Y	High	Increases risk of surface flows and sedimentation of streams. Noncompliance with NWFP ACS Objectives
89	During prescribed fire treatments, fire effects within the RRs would be closely monitored. If fire effects becomes unfavorable within RR's, Minimum Impact Suppression Tactics (MIST) would be utilized to suppress fire as long as safety of personnel is assured. If prescribed fire in RRs is not meeting RR prescribed fire objectives, ignition may continue if needed to bring the unit to a reasonable safe holding feature, then further ignition in RRs would cease until aquatics, hydrology, and/or soils staff can	Minimizes soil disturbance, canopy removal, and mortality of deciduous species in RRs	Y	Moderate	Increased soil disturbance and potential sediment delivery to streams

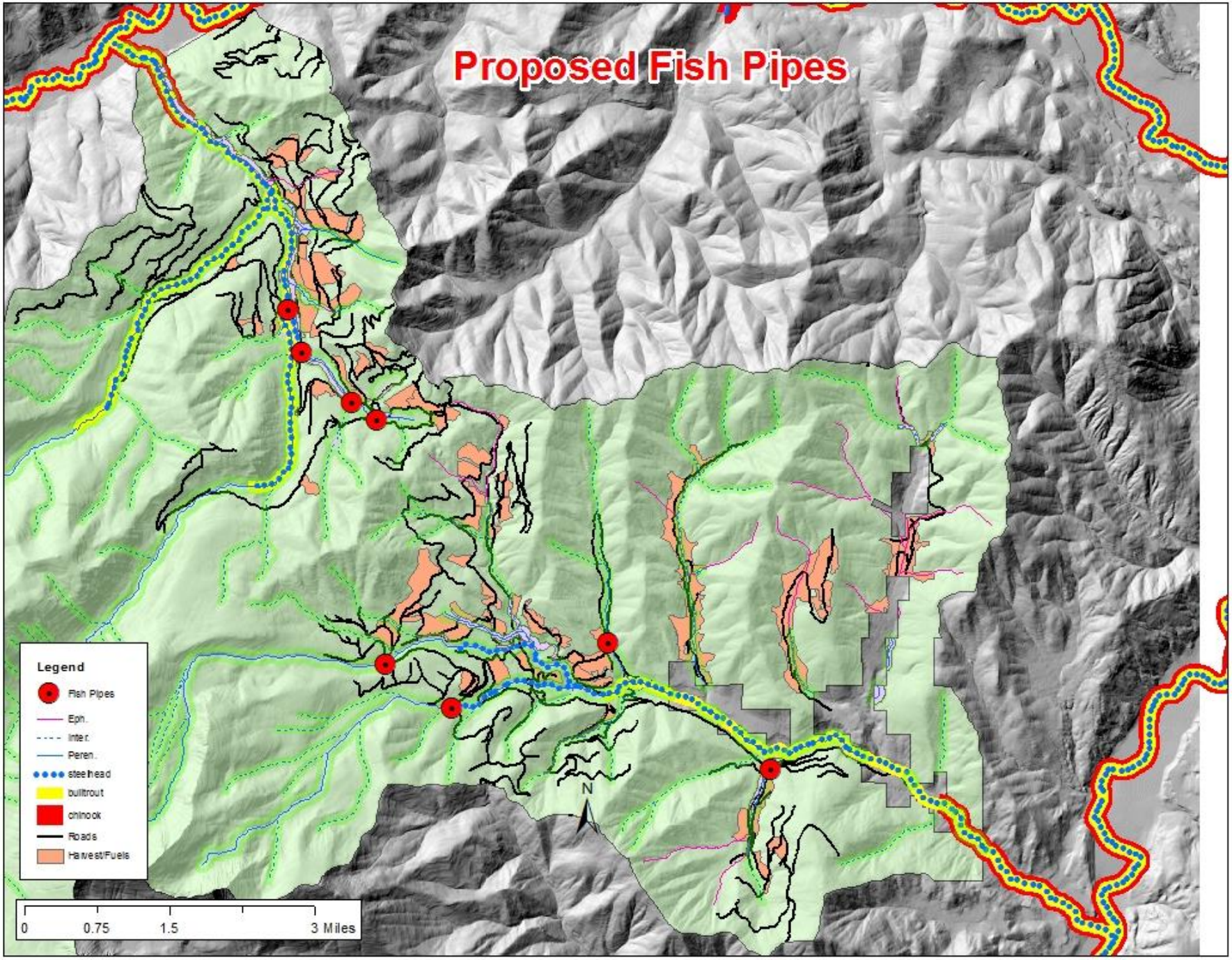
Number	Design Feature	Why Necessary	Monitoring Necessary?	Efficacy	Consequence of Not Applying
	assess effects and determine need for mitigating measures to reduce erosion and sedimentation potential from the site. Mitigation may include scattering coarse woody debris, spreading weed free hay, installing straw waddles, etc. Application of these measures would be determined according to anticipated resources at risk, burn severity observed, and other factors.				
90	During prescribed fire operations, surfactants and foams in water would not be used within 100 feet of the edge of wetted channels, lakes or wetlands. Engines which have had surfactant in their tanks must use an auxiliary pump to fill.	Avoids contamination of surface water with surfactants.	Y	High	Chemical contamination of surface water. Sensitive fish mortality
91	Water drafting sites for dust abatement, road compacting or prescribed fire use would occur at drafting locations in the project area designated by hydrology and/or aquatic resources staff. In the Libby Creek drainage the following sites are: Libby Creek at FSR 4300 road, near intersection with County road - mile post 0.06, Libby Creek at FSR4300100 - mile post 0.45, South Fork Libby Creek- FSR4300 - mile post 5.18, and North Fork Libby Creek at FSR 4300 - mile post 5.5. In the Buttermilk drainage there is only one approved site. This is Buttermilk Creek at FSR 4300500 – mile post 0.12. It holds a restriction that it may only be used prior to August 15th annually. Other approved sites must be used after that date. Screen mesh openings for all intake screens shall not exceed 3/32 inch (2.38 mm) for woven wire or perforated plate screens, or 0.0689 inch (1.75 mm) for profile wire screens, with a minimum 27% open area. The screened intake would consist of enough surface area to ensure that the velocity through the screen is less than 0.4 feet per second. Screen maintenance would be adequate to prevent injury or entrapment of juvenile fish and the screen would remain in place whenever water is withdrawn from the stream through the pump intake. The location, pumping rate, and duration of water withdrawals shall be designed to minimize aquatic impacts. Limit water withdrawals to 10 percent of stream flow or less at the point of withdrawal, based on a visual assessment by a fish biologist or hydrologist or qualified staff. The channel must not be dewatered to the point of isolating fish.	Prevent fish taken into water pumps. Minimize reductions in stream flow during base flows	Y	Moderate-High	Noncompliance with Washington Department of Fish and Wildlife MOU with the Region 6 Forest Service for projects occurring in waters of the State of Washington. Reduced habitat quality for fish.

Number	Design Feature	Why Necessary	Monitoring Necessary?	Efficacy	Consequence of Not Applying
92	OHVs used for administrative purposes would not leave existing roadways within Riparian Reserves.	Limit impacts of administrative use of motor vehicles in RRs		High	Increased soil disturbance and potential sediment delivery to streams
93	Identify wetlands in units before operations to ensure that activities are consistent with applicable design criteria that implement Riparian Management Objectives.	Ensure activities in wetlands are consistent with ACS objectives.	Y	High	Noncompliance with NWFP ACS Objectives
94	All danger tree mitigation taking place within the Riparian Reserve would be done without off-road use of heavy equipment. Trees would be left on site when needed to meet coarse woody debris objectives. Any yarding would be done in a manner which does not cause soil or riparian vegetation damage, which may include winter conditions (snow/frozen ground).	Avoid soil or riparian damage.	Y	High	Noncompliance with NWFP ACS Objectives
95	For all operations using heavy machinery, equipment, or gas-powered tools, measures would be in place to contain accidental spills of hazardous materials and petroleum products. Any fuels cans for pumps, etc. would be refilled outside of RRs or on a road and pumps would be placed on absorbent cloth to capture any leaks or spills. Helicopters would only use existing landings and all refueling sites would be outside RRs.	Prevent drainage to streams from leaks or spills of hazardous materials and petroleum products.	Y	High	Chemical contamination of surface water. Sensitive fish mortality
96	Coarse woody debris enhancement treatments would follow the WDFW/Region 6 Forest Service MOU Design Criteria for instream work (WDFW & USDA 2012).	Complies with ESA and Clean Water Act laws by minimizing impacts to aquatic and riparian resources. Follows Conservation Measures for Fish Passage Culvert and Bridge Projects described in the 2014 FWS and NMFS Washington State Fish Passage and Habitat Enhancement Restoration Programmatic Consultation Biological Opinions.	Y	High	Potential impacts to aquatic habitat and possible non-compliance with ESA and Clean Water Act laws.

Appendix E. Mission Aquatic Road treatments.

Mission Restoration Fish Culvert Replacements: Eight stream culverts within the Mission Restoration project area were identified that fully or partially block fish passage. These culverts are located on Black Pine Creek, North Fork and South Fork Libby Creek, Ben Canyon Creek, and Hornet Draw. Species affected include steelhead, resident trout, and possibly bull trout. The proposed action would replace the barrier culverts with Aquatic Organism Passage structures that provide full access for all aquatic and riparian dependent species at all life stages. Restoring full fish passage at these sites would improve access on about six miles of suitable habitat. Work associated with replacing barrier culverts would be consistent with design criteria outlined in the 2013 ARBO II under **#21. Fish Passage Restoration**.

RoadID	Lat	Long	Constriction	Plugged	Other Problems	Dia_inch	undersized	Notes	SiteNo
4300000	48.30849	-120.285	Yes	No	Yes	36	Yes	BFW 5.5', fish barrier, undersized, erosion	3
4300000	48.31591	-120.296	No	No	No	60	Yes	BFW 5.25', undersized slightly, poss fish barrier	2
4300500	48.32227	-120.299	Yes	Crushed	Yes	48	Yes	BFW 5.4', undersized, fish barrier, drop	1
4340000	48.26296	-120.262	Yes	No	Yes	96	Yes	BFW 11.6', fish barrier, undersized	6
4340700	48.26944	-120.277	Yes	Partial	Yes	60	Yes	BFW 11.3', NF Libby Cr, fish barrier, pipe crushed	5
4300000	48.25389	-120.191	Yes	No	Yes	48	Yes	Undersized, needs fish pipe	8
4300100	48.27275	-120.227	Yes	No	Yes	36	Yes	Undersized, fish barrier	7
4300400	48.30584	-120.279	Yes	Yes	Yes	24	Yes	Undersized, dble pipe, needs fish pipe	4


Proposed Fish Pipes
Legend
Fish Pipes
Eph.
Inter.
Peren.
steelhead
bulltrout
chinook
Roads
Harvest/Fuels
N
0
0.75
1.5
3 Miles

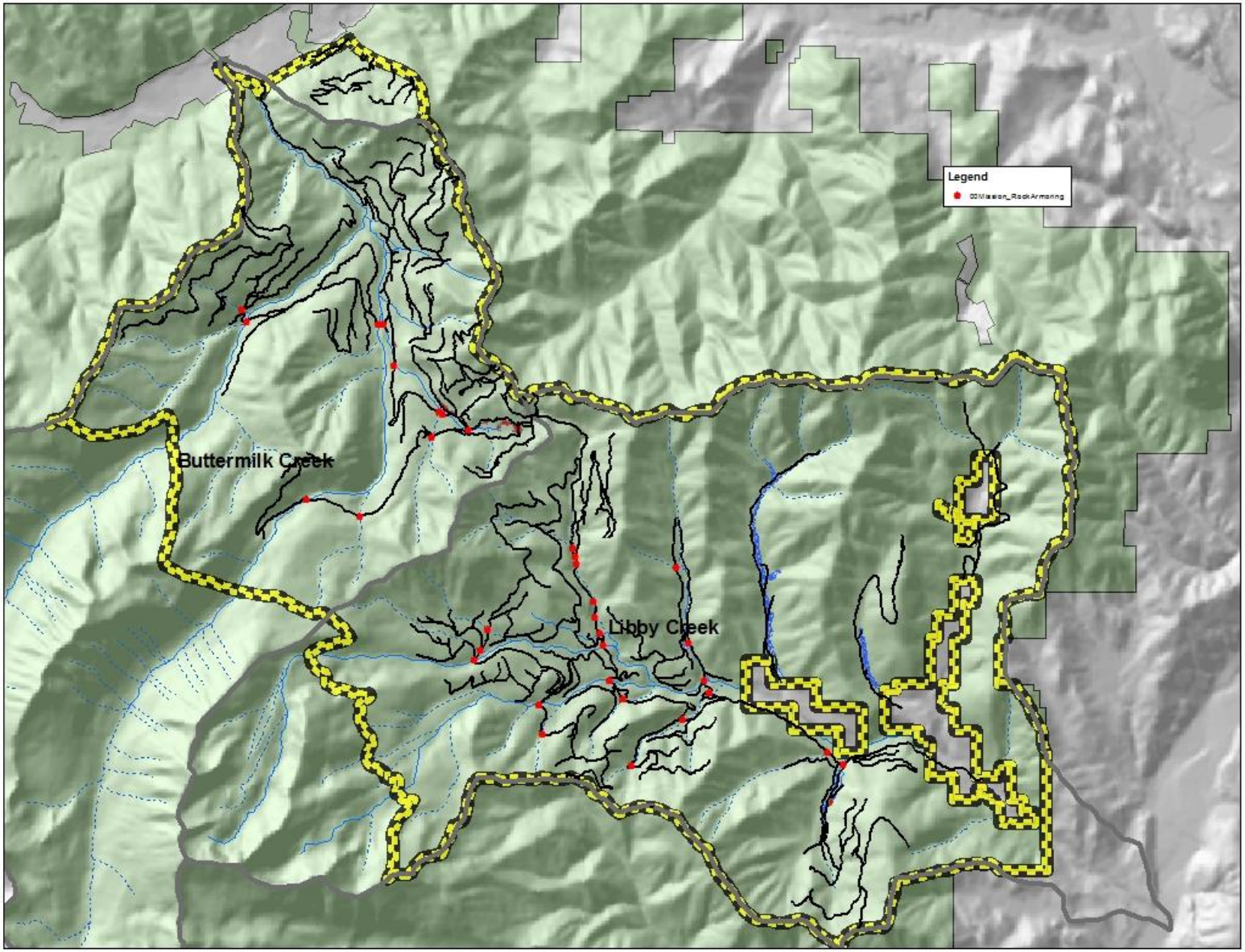
Mission Restoration Undersized Culvert Replacements: Fifteen stream culverts within the Mission Restoration project area were identified as being undersized and not meeting current stream culvert standards. These culverts are located throughout the Libby Creek and West Fork Buttermilk Creek drainages. The proposed action would replace the undersized culverts with appropriately sized stream pipes that pass 100-year flow events. Replacing undersized stream pipes would reduce the risk of road failures that would damage fish habitat.

RoadID	Site#	Lat	Long	Constriction	Plugged	Problem	Dia_inch	undersized	Notes
4300400	6	48.29233	-120.304	Yes	No	Yes	36	Yes	BFW 9.5', shotgun pipe, undersized, erosion to cr
4300400	5	48.30484	-120.287	Yes	Crushed	Yes	24	Yes	BFW 3.5', shotgun pipe, undersized
4300000	14	48.25584	-120.195	Yes	No	Yes	30	Yes	BFW 3.5', shotgun, upsize
4342300	15	48.27102	-120.208	Yes	No	Yes	42	Yes	Sqsh Pipe, BFW 5.8', shotgun, underszd, upsize
4300000	12	48.26389	-120.242	Yes	No	Yes	18	Yes	BFW 4', culvert way undersized, recommend upsizing
4300000	1	48.33376	-120.297	Yes	Partial	Yes	18	Yes	BFW 2.8', undersized, cow impacts
4300000	2	48.32576	-120.298	Yes	No	Yes	18	Yes	BFW 2.8', undersized, shotgun
4300000	7	48.28468	-120.254	Yes	No	Yes	30	Yes	BFW 3', undersized
4340700	11	48.27158	-120.276	Yes	No	Yes	36	Yes	BFW 3.7', erosion at crossings, cow trs, upsize
4340700	10	48.27471	-120.274	Yes	Partial	Yes	24	Yes	BFW 2.8', partially plugged, aggrading above pipe
4300000	4	48.30869	-120.286	Yes	Partial	Yes	24	Yes	BFW 3.7'", shotgun pipe, undersized, erosion
4300500	3	48.32289	-120.301	No	Partial	Yes	18	Yes	Spring, but culvert is filling in with sediment
4300000	13	48.26483	-120.222	Yes	No	Yes	30	Yes	BFW 4.4', undsz, shotgun, HD cut below, agrd above
4300000	9	48.27424	-120.248	Yes		Yes	0	Yes	Undersized pipe
4300000	8	48.27661	-120.249	Yes		Yes	0	Yes	Undersized pipe

Rock Armoring

Rocking roads has proven to reduce road surface erosion into streams by 80%. We propose rock armoring <33 road-stream crossings within the project area. This involves covering the immediate area of road-stream crossings where the road drains directly toward the creek with a six-inch lift of 1 ¼ minus crushed gravel. Road crossings with visible surface erosion would be prioritized for treatment. At this point, aquatics and hydrology is proposing all perennial haul route crossings would be rocked within the Libby Creek drainage prior to log hauling as mitigation for increased fine sediment. This amounts to 6 crossings.

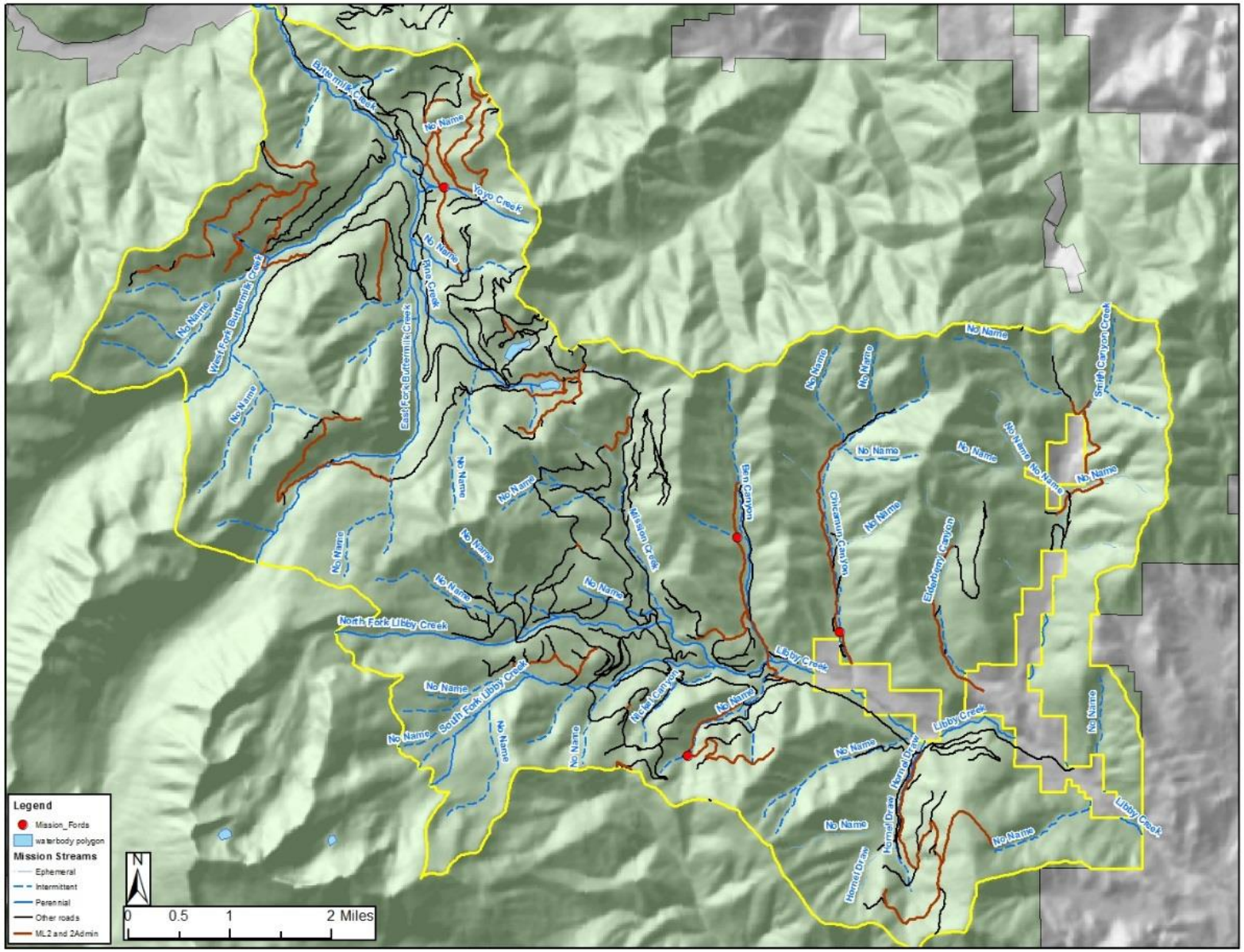
RTE_NO	Alt2_PostM	Alt3_PostM	Haul	FLOW	Lat	Long
4300150	ML2	ML1		I	48.25337502	-120.2403688
4300100	ML2	ML2	Yes	P	48.26674652	-120.2234855
4300100	ML2	ML2	Yes	I	48.26482247	-120.2220805
4300400	ML2	ML2		I	48.29239202	-120.3040643
4300400	ML2	ML2		P	48.29490256	-120.316723
4300100	ML2	ML2		I	48.28446048	-120.2298852
4300100	ML2	ML2	Yes	P	48.27273466	-120.2271529
4300550	ML2	Decom		I	48.32468334	-120.332011
4300550	ML2	Decom		P	48.32268635	-120.3308964
4340000	ML3	ML3		P	48.26301106	-120.2619785
4340000	ML3	ML3		I	48.25837998	-120.2613376
4300000	ML3	ML3	Yes	P	48.31600926	-120.296148
4300000	ML3	ML3	Yes	P	48.30840783	-120.2848956
4300000	ML3	ML3	Yes	I	48.30866942	-120.2856737
4300000	ML3	ML3	Yes	P	48.27421829	-120.2478871
4300000	ML3	ML3	Yes	P	48.2722152	-120.2471155
4300000	ML3	ML3	Yes	P	48.26670993	-120.2456178
4300000	ML3	ML3	Yes	I	48.26385591	-120.2424742
4300000	ML3	ML3	Yes	I	48.26069101	-120.2285205
4300000	ML3	ML3	Yes	I	48.25571564	-120.1945215
4300000	ML3	ML3	Yes	P	48.25373523	-120.1909491
4340700	ML3	ML3	Yes	I	48.27470229	-120.2740614
4340700	ML3	ML3	Yes	I	48.27145468	-120.2758862
4340700	ML3	ML3	Yes	P	48.26986484	-120.2771627
4300500	ML3	ML3	Yes	P	48.32237663	-120.300016
4300500	ML3	ML3	Yes	P	48.32230619	-120.2988585
4300400	ML3	ML3		P	48.30583102	-120.2789568
4300400	ML3	ML3		I	48.30471214	-120.2873691
4300000	ML3	ML3	Yes	I	48.28742344	-120.2543147
4300000	ML3	ML3	Yes	I	48.28610467	-120.2537409
4300000	ML3	ML3	Yes	I	48.28505467	-120.2532721
4300000	ML3	ML3	Yes	I	48.27914451	-120.2492232
4300000	ML3	ML3	Yes	I	48.27662271	-120.2490478


Legend
00Mission_RockArmoring
Buttermilk Creek
Libby Creek

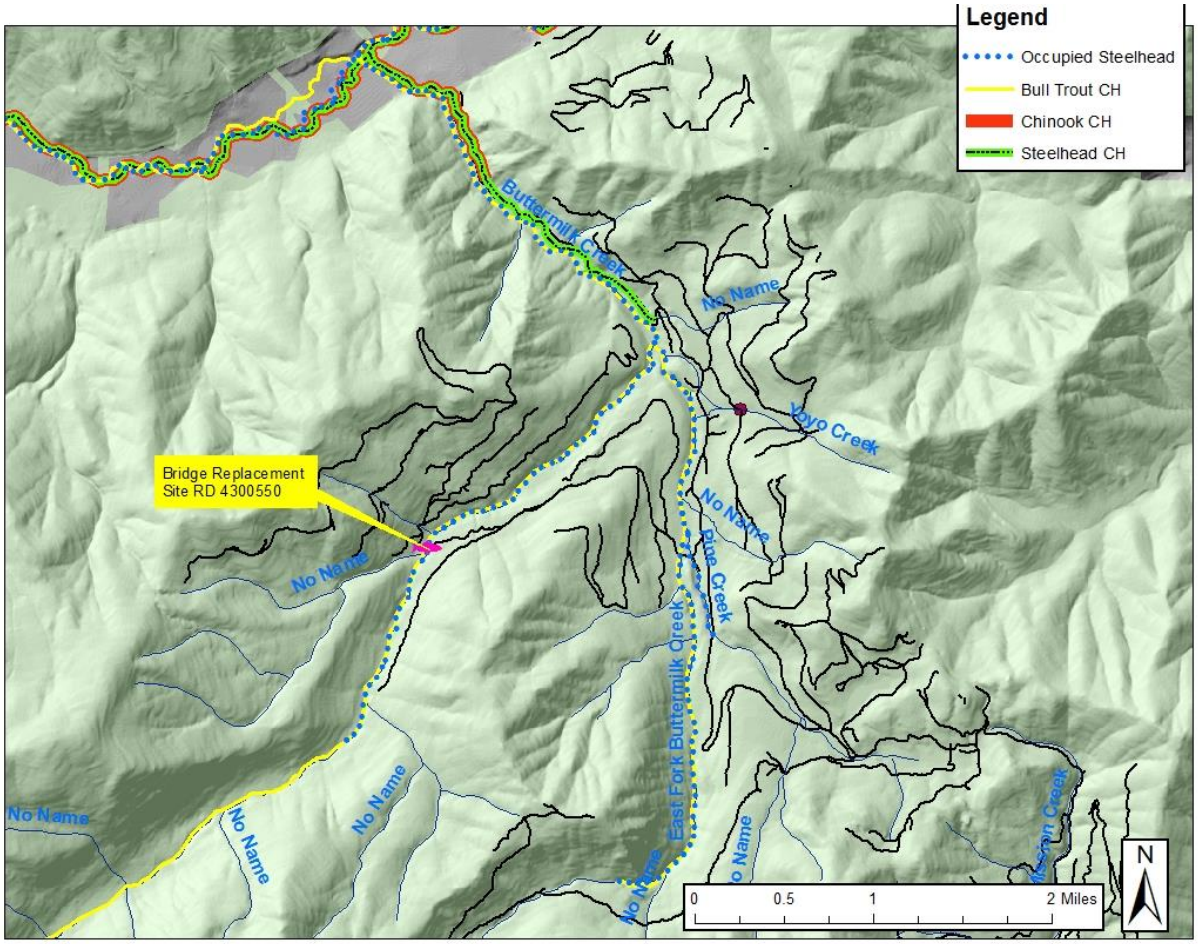
Hardened Ford

Road-stream crossings with culverts and fill are inherently at risk for plugging and failing during storm events. Climate change is expected to increase peak flows across the Pacific Northwest that put stream culverts at greater risk for failure. Building more resilient watersheds includes modifying road networks to withstand flashier, higher peak flows. This includes converting road-stream crossings into hardened fords with low risk of failure during peak flows. Four ML2 road-stream crossings would have the crossings removed including pulling the culvert and fill in the road. A hardened ford would be constructed to allow peak flows to pass roads without failure.

RTE_NO	SiteNo	Alt2_PostM	Alt3_PostM	FLOW_REGIM	Long	Lat
4300150	1	2 - HIGH CLEARANCE VEHICLES	1 - BASIC CUSTODIAL CARE (CLOSED)	I	-120.24	48.25338
4300610	2	ML2 Admin	ML2 Admin	P	-120.293	48.33417
4342300	3	ML2 Admin	D - DECOMMISSION	I	-120.208	48.27103
4300100	4	2 - HIGH CLEARANCE VEHICLES	2 - HIGH CLEARANCE VEHICLES	I	-120.23	48.28446


Buttermilk Creek
Yoyo Creek
Rita Creek
West Fork Buttermilk Creek
East Fork Buttermilk Creek
Mission Creek
Ben Canyon
Chicamin Canyon
Elderberry Canyon
Smith Canyon Creek
North Fork Libby Creek
South Fork Libby Creek
Nicar Canyon
Libby Creek
Hornet Draw
No Name
Legend
Mission_Fords
waterbody polygon
Mission Streams
Ephemeral
Intermittent
Perennial
Other roads
ML2 and 2Admin
N
0 0.5 1 2 Miles

Bridge Replacement – FS road 4300550 has an old wooden bridge over WF Buttermilk Creek that has decayed to the point of being condemned. This bridge is over WF Buttermilk Creek, within bull trout spawning and rearing habitat and potentially occupied steelhead habitat. The proposal is to replace using desin criteria consistent with bridge design criteria outlined in the 2013 ARBO II under #21. Fish Passage Restoration. See Appendix F for more details. The proposed site coordinates is 48.323/-120.331 and the road would be ML2.



Bridge in 2011. Log stringers have rotted out and can no longer be driven on.

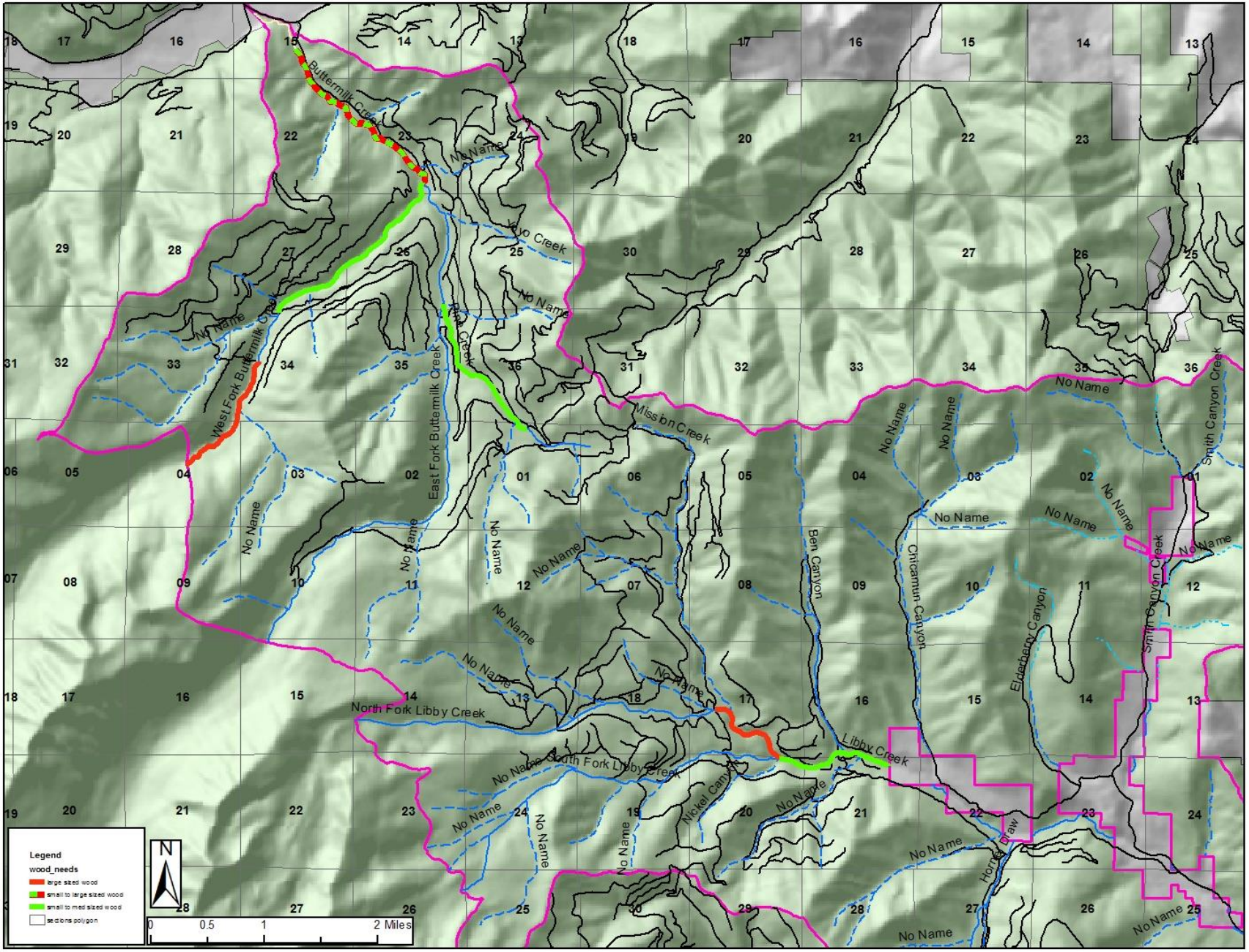
Appendix F. Aquatic/Watershed Restoration Treatments.

LWD Placement - The MVRD proposes to increase channel complexity in the Buttermilk and Libby Creek drainages. Currently, steelhead spawn and rear in Buttermilk Creek and Libby Creek and bull trout use East and West Fork Buttermilk Creeks for spawning and rearing. Recent aquatic habitat surveys identified small to large sized wood levels are below desired amounts in certain reaches where spawning and rear occurs. Instream wood is the primary agent to create spawning habitat and to form pools for rearing in the project area streams. Past riparian harvest has limited the potential for natural wood recruitment. Accordingly, there is a need to add wood to increase pool habitat, fish cover, and spawning gravel in the Mission Project area.

The desired amount of large wood for project area fish streams is set from the Okanogan Forest Plan (USDA 1989) and from a recent report by Fox and Bolton (2007). From these data sources and considering similar streams on the District in un-managed or wilderness areas, the desired density of wood greater than 6 inches diameter is in the range of 90 to 240 pieces per mile. Desired large, key wood pieces is a range of about 5-30 pieces per mile. Key piece sized wood for these streams is 18-20 inch diameter trees. Proposed quantities of small to large wood this treatment would fell into target reaches are detailed in the table below. The table below defines the locations where the wood treatments would occur.

The proposed treatment is to fell dead and live trees into key locations in the below reaches. All wood would be individually identified for use and directionally fell by hand and chainsaw in key locations to interact with the channels. Dead trees would be targeted, but live trees in high concentration areas would be selected as well. Tree species include Douglas fir, spruce, and ponderosa pine.

Stream	Reach	Proposed Treatment	Length (mi)	# and size of trees
Buttermilk Creek Mainstem	From RM 0.8 to the confluence with NF an SF Buttermilk Creek	Hand fall live and dead small to large sized conifers into creek with chainsaw	1.8	up to 20 trees 12-20 inch dbh and up to 30 trees 6-12 inch dbh
West Fork Buttermilk Creek	From the confluence with Buttermilk Creek mainstem to the 550 road	Hand fall live and dead small to medium sized conifers into creek with chainsaw	1.8	up to 10 trees 12-20 inch dbh
	From 1/2 mile above the 550 road crossing to the wilderness boundary.	Hand fall live and dead large sized conifers into creek with chainsaw	1.2	up to 4 trees 18-20 dbh
Black Pine Creek	From the confluence with EF Buttermilk Creek to above the second 43 road crossing	Hand fall live and dead small to medium sized conifers into creek with chainsaw	1.4	up to 30 trees 6-12 inch dbh
Libby Creek Mainstem	From 0.45 miles below the confluence with Ben Canyon Creek to the confluence with NF and SF Libby Creek	Hand fall live and dead small to medium sized conifers into creek with chainsaw	1	up to 10 trees 12-20 inch dbh and up to 20 trees 6-12 inch dbh
North Fork Libby Creek	From confluence with SF Libby to the 43 road crossing	Hand fall live and dead large sized conifers into creek with chainsaw	0.8	up to 4 trees 18-20 dbh


Buttermilk Creek
West Fork Buttermilk Creek
East Fork Buttermilk Creek
Rock Creek
Kyo Creek
Mission Creek
Ben Canyon
Chicamun Canyon
Elderberry Canyon
Smith Canyon Creek
North Fork Libby Creek
South Fork Libby Creek
Libby Creek
Nickel Canyon
Horse Draw
No Name
Legend
wood_needs
large sized wood
small to large sized wood
small to med sized wood
sections polygon
N
0 0.5 1 2 Miles

Beaver Enhancement

Background:

Before hunting and trapping decimated population levels, beaver (*Castor canadensis*) were once an integral part of the Cascade mountain landscape. Historically, beavers created stream systems with slow, deep water and floodplain wetlands that play an important role in maintaining and diversifying stream and riparian habitat. Benefits of beaver in a watershed include increased water storage and base flows, creating pool habitat, increasing wetland area, fine sediment retention, moderating stream temperatures, expanding riparian areas, and connecting streams to floodplains. Many drainages in the Methow River watershed, including Libby Creek and Buttermilk Creek basins, once had abundant beaver populations that are now substantially reduced. These drainages are managed for multiple use including timber harvest, livestock grazing, roads, and recreation. Areas like these, where past and present land management activities have been or is currently heavy, aquatic habitat can be limited and less than desirable for fish production. The loss of beavers exacerbates limited habitat quality by simplifying stream channels that provide limited habitat for salmonids, reduces base flows and riparian area, and increases water temperatures.

Private irrigation ditches in the Libby Creek and Buttermilk Creek drainages remove stream flow during the summer and fall resulting in low base flows. Low base flows reduce habitat available for salmonids that includes decreased refugia from predators and areas of elevated water temperatures, reduced migratory habitat, reduced availability of food and increased competition for space. Late season migratory bull trout move up into tributaries in August and September to spawn and lower flows can limit passage in channels. Hence, there is a need to increase summer and fall stream flows.

Project:

Beaver can help restore many aspects of a heavily managed watershed. The goal for this project is to increase base flows by creating natural water storage with beavers. Beaver dams impound water in ponds and pools, and these impoundments slow the flow of the stream, which holds the water within the stream reach for longer periods and can increase base flows.

The Proposed beaver enhancement (BSE) project includes reintroduction of beaver within the Mission Project area along with some active treatments to make the BSE site successful for establishing a functioning beaver habitat. BSE sites have been selected based on exhibiting suitable gradient, presence of surface water and an identifiable stream channel, availability of forage and dam building materials, and potential for long-term success and restoration. BSE activities include, but are not limited to the following:

1) Beaver reintroduction: A beaver pair or family would be introduced into selected sites. This reintroduction may include the building of a small lodge and weekly monitoring of the beaver pair. Each identified site would have beaver released.
2) Beaver dam analogs (BDA): To help establish a successful beaver pond complex, it may be necessary to manually build a small dam to help the introduced beaver pair succeed. This includes using natural wood posts woven with local wood

materials (logging slash or small branches of hardwood riparian species) to simulate a dam. BDA sites include Chicamun Creek, Ben Canyon Cr (upper and lower), Black Pine Creek Tributary, and Hornet Draw. Black Pine Meadow and North Libby Creek would not have BDAs installed.

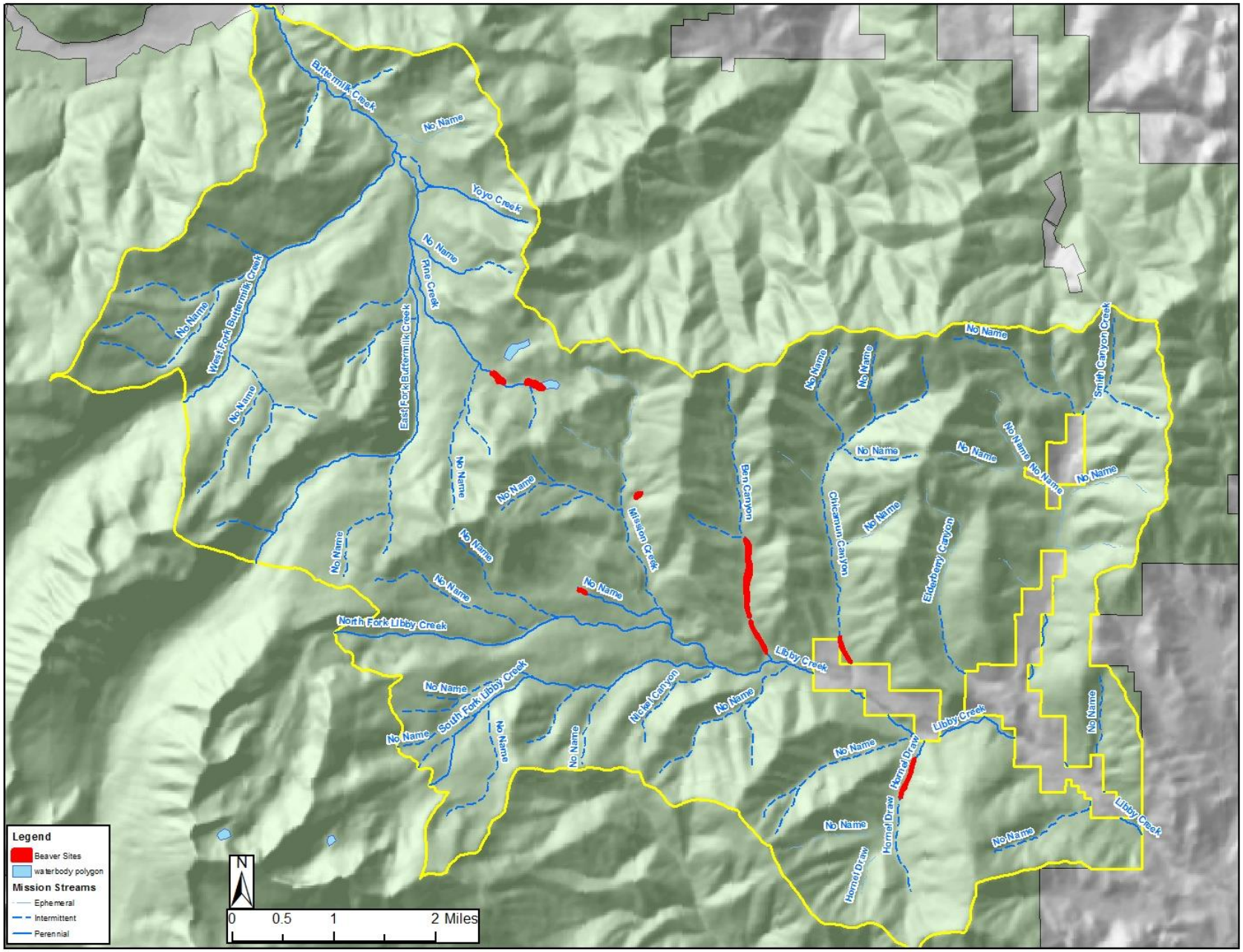
3) Fencing/BE protection: Beaver are grazers and need access to a large amount of riparian grasses. In areas where cattle grazing is a concern, the riparian area would need to be fenced using either permanent fencing materials or seasonal electric fences during grazing season. Fencing is proposed at four sites: Hornet Draw, North Fork Libby Creek, Black Pine Creek Tributary, and Mission Creek Tributary. As an adaptive strategy, fencing would occur on Upper and Lower Ben Canyon if livestock grazing is compromising site conditions.
4) Woody debris placement: small trees would be placed in the Chicamun Creek and Ben Canyon sites to add channel roughness to support beaver dam development.

Methods and effects:
Beaver reintroduction would follow protocol already established by USFS beaver crew and would include transporting beaver pairs on established roads and using foot paths to reach final release locations. Multiple trips for follow up monitoring would occur. Beaver reintroduction crew might use local dead woody material to build a temporary lodge for the introduced pair. Riparian disturbance would be minimal and short term during transport of beavers and construction of.

BDAs would be constructed by driving untreated wooded posts into the streambed and floodplain using a hydraulic post driver, transported and operated by hand. Posts would be placed 0.3 – 0.5 meters apart and streambed disturbance would be minimal and highly localized. Woody material would be woven through posts by hand and would include small diameter material obtained from logging slash piles or local hardwood material trimmed from branches of healthy trees. Up to four BDAs would be constructed in a single BSE site about 100 – 200 feet apart, depending on availability of suitable construction sites.

Fencing or other protection of BSE sites would be coordinated with the range management team and fences would be constructed using appropriate materials, as established by current range management practices. Where beaver would be released at an existing wetland area, the fence would encompass the wetland area. On Hornet Draw and the tributary to Mission Creek, the fence would encompass an area suitable for beaver pond construction. On Ben Canyon, if needed, beaver habitat would be fenced off.

Wood levels in Chicamun Creek and Ben Canyon Creek are low. Small trees removed from nearby ladder fuel reduction would be placed in the BSE areas to increase channel structure and complexity. This will increase the success for beaver dam development. BSE sites and types of treatments are shown below.


Buttermilk Creek
No Name
Yoyo Creek
No Name
Pine Creek
West Fork Buttermilk Creek
East Fork Buttermilk Creek
No Name
No Name
No Name
No Name
No Name
No Name
No Name
No Name
Mission Creek
Ben Canyon
Chicamun Canyon
Elderberry Canyon
Smith Canyon Creek
No Name
No Name
No Name
No Name
No Name
No Name
No Name
No Name
North Fork Libby Creek
Libby Creek
No Name
South Fork Libby Creek
No Name
No Name
No Name
No Name
Nickel Canyon
No Name
Libby Creek
No Name
Hornet Draw
Hornet Draw
Hornet Draw
No Name
No Name
Libby Creek
Legend
Beaver Sites
waterbody polygon
Mission Streams
Ephemeral
Intermittent
Perennial
N
0
0.5
1
2 Miles

Beaver enhancement sites in the Mission Restoration Project area.

Name	**Site #**	**Acres**	**BDAs proposed?**	**Comments**	**Fencing Length Estimate (17.5K/mi)**
Ben Creek, Lower	1	3.3	Y	Site is located below and above the 100 road-stream crossing. Beaver release and BDAs. Small diameter wood would be place in channel prior to beaver release. Use livestock fencing as an adaptive strategy if livestock impacts occur.	None proposed
Ben Creek, Upper	2	14.6	Y		
NF Libby Meadow	3	0.9	N	Site is located north of NF Libby Creek in an old beaver dam complex. Beaver release and livestock fence construction around complex.	~0.7 miles of fence (~$12,300)
Hornet Draw	4	2.6	N	Site appears to not need fencing, but monitor.	None proposed
Chicamun Creek	5	3.2	Y	Site is located below grazing allotment boundary fence, no fence needed. Beaver release and BDAs. Small diameter wood would be place in channel prior to beaver release.	
Tributary to Mission Creek	6	1.2	N	Site is located east of Mission Creek, on a perennial stream with suitable beaver forage. Fence construction proposed.	~0.35 miles of fence (~$6,200)
Black Pine Meadow	7	4.8	N	Site is located above the 43. Already fenced. Beaver release only.	None proposed
Tributary to Black Pine Creek	8	3.6	Y	Large wetland complex adjacent to the 43 road; only 1 BDA proposed; fence construction proposed	~0.6 miles of fence (~$11,000)

APPENDIX G. Landing Location Operational Guidelines

1. Provide enough room for equipment and personnel to work safely (avoid power lines and snags)
2. Have the landing at a 2-5% slope for logging trucks to leave the landing safely.
3. The landing must be able to suit the logging system and the terrain.
4. Haul direction from log trucks must be accounted for.
5. Log plan maps will be developed to show anticipated skid trail and yarding patterns as well as anticipated landing locations.
6. Use natural breaks in the landscape to minimize construction excavation.
7. Avoid landings near bad soils and streams.
8. Coordinate proposed season with soil conditions (winter or summer).
9. Use existing landings if possible to limit soil impacts.

Additional Landing Location Guidelines for RR units

To ensure that Riparian Management Objectives are not retarded in Riparian Reserves, the following additional guidelines were established for selecting and using landings near or inside RRs.

1. New landings will not be constructed within RRs unless other practicable locations outside the RR (first priority) or existing landings inside the RR (2nd priority) are not available.
2. The Timber Sale Administrator shall take into consideration that use of existing sites, especially those currently causing resource damage (as identified by project hydrologist, soil scientist, or fish biologist), will allow for immediate mitigation and post-use rehabilitation of landing location and associated roads/skid-trails within the constraints of timber harvest contract administration.
3. The Timber Sale Administrator shall weigh the relative ground disturbance area considering skid distance, landing size, slope of landing area, slope and vegetated cover condition of riparian buffer strip, and other factors. There may be cases where total number of landings within RRs is not the best metric for reducing impacts via ground disturbance within RRs.
4. Areas where mean site slope exceeds 5% will not be approved for use as landings.
5. Areas where the riparian buffer strip is not well vegetated or is in a disturbed condition will not be approved for use as landings.
6. If a harvest unit occurs within a RR and utilizes an existing road as its downslope unit boundary, landings below that roadway will not be approved for use as landings.
7. If landings are constructed or re-constructed in RRs, suitable erosion control measures such as silt fences or other retention methods will be installed prior to landing construction and will remain in place during harvest operations. Any landings used within RCHAs will be scarified, seeded, and organic debris will be scattered over them after harvest activities are complete.

APPENDIX H. Road Effects to Watershed and Aquatics Summaries

		Current Condition	During Harvest	Post Harvest (funded by harvest $$)	Funded net Change (mi)	Post Project – full proposal	Full proposal net Change
1	Total Road miles (includes system, unauthorized, open, closed, temp, everything)	134.6	135.82	127.5	-7.1	100.9*	-33.7
2	Total system road	118.86	123.08	117.35	-1.51	100.9	-17.96
3	Total open system road (ML 2 and up)	56.05	74.67	50.19	-5.86	50.69	-5.36
4	Total open crossings (count) for all system, non-system, and unauthorized roads	39	47	40	+1	42	+3
5	Total ML-1	62.8	45.4	32.13 (11.76)**	-30.67	34.88	-27.92
6	Total unauthorized road	15.77	12.73	9.5	-6.27	0	-15.77
7	Unauthorized hydrologically stable	0	0	0	0	0	0
8	Unauthorized closed to traffic	15.16	12.22	12.04	-3.12	0	-15.16
9	Unauthorized "open"	0.61	0.51	0.51	-0.1	0	-0.61
10	Unauthorized "open" crossings (count)	0	0	0	0	0	0
11	Total temp roads	0	1.18	0	0	0	0
12	Total road Density (using row 1 by project area or by watershed)	1.74	1.76	1.65	-0.09	1.30	-0.44
13	Open road density (using sum of rows 3, 9, and 11) for all roads system, non-system and unauthorized	0.72	1.00	0.66	-0.06	0.65	-0.07
14	Open road density (or **miles**) for all roads (system/unauthorized) in riparian areas	11.48	14.71	10.93	-0.55	10.21	-1.27
15	Decommission	0	0	7.1	-7.1	31.7	-31.7

*** Roads to non-motorized cow trail were treated as decommissioneds**

**** Roads newly put into hydrologic storage from timber sale.**

HUC Name	HUC Area	Existing		During Harvest		After Harvest		Post-Project	
	(square miles)	Open Road Miles	Open Road Density (mi./sq. mi.)	Open Road Miles	Open Road Density (mi./sq. mi.)	Open Road Miles	Open Road Density (mi./sq. mi.)	Open Road Miles	Open Road Density (mi./sq. mi.)
Buttermilk Creek	37.2	19.51	0.52	28.58	0.77	19.51	0.52	21.83	0.59
Libby Creek	40.12	36.47	0.91	48.95	1.22	31.87	0.79	28.19	0.70
Sub-Wa Combined All roads, system, nonsystem, and Uas	77.32	55.98	0.72	77.53	1.00	51.38	0.66	50.02	0.65

APPENDIX I. MPI Tables for the Mission Project Area Watersheds

Lower Methow River Watershed

The table below summarizes the existing Methow Sub-basin population, Lower Methow River habitat/watershed indicators, and the anticipated changes from the proposed Mission Project. The Carlton Complex and the Black Canyon fires burned close to half of the Lower Methow River Watershed (~49%) that altered soils across the landscape, changing runoff and drainage network patterns. Following the fire, heavy rainstorms caused debris flows that increased the drainage network and stream sediment levels in the mainstem Methow River, Gold creek, and Black Canyon Creek areas. Some habitat indicators degraded at the watershed scale showed in grey. These changes are expected to be short-term and last 3-5 years. Once hillslopes stabilize and stream sediment levels are sorted out, the increase in wood inputs, sediment levels are expected to improve and return to pre-fire levels. Some of the actions will result in small, insignificant short-term effects that are described under the effects section. Likewise, the improvements to the watershed would be insignificant and would not change habitat indicators at the watershed scale.

Diagnostic/Pathway: Indicators and associated PCE/PBFs	**Existing conditions**	**Restore**	**Maintain**	**Degrade**
Subpopulation Characteristics:				
Subpopulation Size	**FAR, FAR, FAR**		**X**	
Growth & Survival	**NPF, NPF, NPF**		**X**	
Life History Diversity & Isolation	**NPF. FAR, NPF**		**X**	
Persistence & Genetic Integrity	**NPF, NPF, FAR**		**X**	
Water Quality:				
Temperature	**NPF**		**X**	
Sediment	**NPF**	**X (Ins-Lt)**		**X (Ins-St)**
Chemical Contamination/Nutrients	**FAR**		**X**	
Habitat Access:				
Physical Barriers	**FAR**		**X**	
Habitat Element:				
Substrate Embeddedness	**NPF**	**X (Ins-Lt)**		**X (Ins-St)**
Large Woody Debris	**FAR**	**X (Ins-Lt)**		**X (Ins-St)**
Pool Frequency & Quality	**NPF**	**X (Ins-Lt)**		**X (Ins-St)**
Large Pools	**NPF**	**X (Ins-Lt)**		**X (Ins-St)**
Off-Channel Habitat	**NPF**		**X**	
Refugia	**NPF**		**X**	
Channel Condition & Dynamics:				
Wetted Width/Depth Ratio	**NPF**		**X**	
Streambank Condition	**NPF**		**X**	
Floodplain Connectivity	**FAR**		**X**	
Flow Hydrology:				
Change in Peak/Base Flows	**NPF**	**X (Ins-Lt)**		**X (Ins-St)**
Drainage Network Increase	**NPF**	**X (Ins-Lt)**		**X (Ins-St)**
Watershed Conditions:				
Road Density & Location	**FAR**	**X (Ins-Lt)**		**X (Ins-St)**
Disturbance History	**FAR**	**X (Ins-Lt)**		**X (Ins-St)**
Riparian Conservation Areas	**FAR**	**X (Ins-Lt)**		**X (Ins-St)**
Disturbance Regime	**NPF**	**X (Ins-Lt)**		**X (Ins-St)**
INTEGRATION OF SPECIES AND HABITAT CONDITION	**NPF, NPF, NPF**	**X (Ins-Lt)**		**X (Ins-St)**

NPF – Not properly functioning, FAR – functioning at risk, PF – properly functioning.
Ins = Insignificant Effect, Lt = long-term, St = short-term

Twisp River Watershed

The table below summarizes the existing Methow River Sub-basin population, Twisp River habitat/watershed indicators, and the anticipated changes from the proposed Mission Project. The Little Bridge Creek and Twisp River Fires burned less than 10 percent of the Twisp River Watershed and most of the acres were low severity. Following the fires, rain events hit over the burned areas that caused a couple debris flows that increased sediment levels in Little Bridge Creek and the Twisp River that were short lived. Some habitat indicators degraded at localized scale, but did not change at the watershed scale. These changes are expected to be short-term and last 3-5 years. Some of the actions will result in small, insignificant short-term effects that are described under the effects section. Likewise, the improvements to the watershed would be insignificant and would not change habitat indicators at the watershed scale.

Diagnostic/Pathway: Indicators and associated PCE/PBFs	Existing Conditions	Restore	Maintain	Degrade
Subpopulation Characteristics:				
Subpopulation Size	**FAR, FAR, FAR**		**X**	
Growth & Survival	**NPF, NPF, NPF**		**X**	
Life History Diversity & Isolation	**NPF. FAR, NPF**		**X**	
Persistence & Genetic Integrity	**NPF, NPF, FAR**		**X**	
Water Quality:				
Temperature	**FAR**		**X**	
Sediment	**FAR**	**X (Ins-Lt)**		**X (Ins-St)**
Chemical Contamination/Nutrients	**PF**		**X**	
Habitat Access:				
Physical Barriers	**FAR**		**X**	
Habitat Element:				
Substrate Embeddedness	**FAR**	**X (Ins-Lt)**		**X (Ins-St)**
Large Woody Debris	**NPF**	**X (Ins-Lt)**		**X (Ins-St)**
Pool Frequency & Quality	**FAR**	**X (Ins-Lt)**		**X (Ins-St)**
Large Pools	**FAR**	**X (Ins-Lt)**		**X (Ins-St)**
Off-Channel Habitat	**FAR**		**X**	
Refugia	**FAR**		**X**	
Channel Condition & Dynamics:				
Wetted Width/Depth Ratio	**FAR**		**X**	
Streambank Condition	**PF**		**X**	
Floodplain Connectivity	**FAR**		**X**	
Flow Hydrology:				
Change in Peak/Base Flows	**FAR**	**X (Ins-Lt)**		**X (Ins-St)**
Drainage Network Increase	**FAR**	**X (Ins-Lt)**		**X (Ins-St)**
Watershed Conditions:				
Road Density & Location	**FAR**	**X (Ins-Lt)**		**X (Ins-St)**
Disturbance History	**FAR**	**X (Ins-Lt)**		**X (Ins-St)**
Riparian Conservation Areas	**FAR**	**X (Ins-Lt)**		**X (Ins-St)**
Disturbance Regime	**FAR**	**X (Ins-Lt)**		**X (Ins-St)**
INTEGRATION OF SPECIES AND HABITAT CONDITION	**NPF, NPF, NPF**	**X (Ins-Lt)**		**X (Ins-St)**

NPF – Not properly functioning, FAR – functioning at risk, PF – properly functioning
Ins = Insignificant Effect, Lt = long-term, St = short-term

APPENDIX J. Detailed ACS Consistency

Project Consistency with the Aquatic Conservation Strategy Objectives [Note – this assessment includes all the treatments proposed in the Mission Project, including the ARBO II treatments].

The Northwest Forest Plan identifies nine Aquatic Conservation Strategy Objectives (USDA and USDI 1994) on page B-11 that are reviewed for each proposed project. The following discussion states the objective, describes relevant existing conditions and effects and determines if the project would maintain the existing conditions or lead to improved conditions in the long-term.

1. Maintain and restore the distribution, diversity, and complexity of watershed and landscape features to ensure protection of aquatic systems to which species, populations, and communities are uniquely adapted.

Past timber harvest, road construction, fire suppression, and grazing have altered aquatic systems and landscape scale processes in the Buttermilk and Libby Creek sub-watersheds. Past timber harvest and fire suppression within the dry forest vegetation types converted forest conditions from a structure and composition typical of high frequency, low intensity fire to over-stocked forest conditions with high intensity stand replacement fires.

Forest fire regime, road densities, climate, and the distribution of soil types and plant communities are some of the landscape-scale features affecting aquatic systems in project area. The objective for the thinning and hazard fuel reduction is to compensate for an altered fire regime and restore certain plant communities. The project objective is to restore the function of landscape-scale processes, such as wildfire, in order to protect the complexity and distribution of plant communities (including riparian areas) across the landscape. The Mission Project is expected to maintain and slightly improve the distribution, diversity and complexity of watershed and landscape features.

2. Maintain and restore spatial and temporal connectivity within and between watersheds.

Several barrier culverts were replaced in the last 10 years improving aquatic connectivity within the Buttermilk and Libby Creek sub-watersheds. Several barrier pipes remain and this project proposes to fix these crossings to allow for full aquatic and riparian species passage. The proposed actions would not create any barriers for fish within the project area. The proposed project would improve and move towards attainment of ACS Objective 2.

3. Maintain and restore the physical integrity of the aquatic system, including shorelines, banks, and bottom configurations.

Removing culverts through road decommissioning, improving road storm-proofing, and road closure will eliminate some artificial constraints on the shape of small streams in the project area. This will help restore the physical integrity of these streams. Some activities would result in a minor temporary increase in fine sediment levels within project area streams. Improvements to coarse wood levels would increase channel stability and create more desirable channel conditions. Projects are expected to maintain the physical integrity of the aquatic system,

including shorelines, banks, and bottom configurations.

4. Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems.

Water temperature and sediment (turbidity) levels are the main water quality indicator functioning at risk across the project area. The proposed commercial harvest would maintain shade levels and not affect stream temperature.

Most underburning in Riparian Reserves associated with perennial streams has roads as control lines. In these areas, the roads are at least 100 feet from adjacent streams and active lighting would stop within 100 feet of perennial streams and 25 feet of intermittent streams. Within Riparian Reserves, active lighting has a resource objective of maintaining 95% survival of overstory trees, 2/3 survival (~66%) of understory/shrub layer, and 50% ground cover/organic material on surface. Fire would be allowed to back towards streams when resource objectives can be met. Consequently, vegetation mortality levels are expected to be low. It is very unlikely that measurable change in stream shade levels would occur, especially where fish occur. However, some localized shade reduction could occur, but it is expected to be insignificant to stream temperatures, especially where listed fish occur, miles downstream. Therefore, proposed fuels treatments would result in an insignificant negative effect to temperature. The proposed projects are expected to maintain water quality necessary to support healthy riparian, aquatic, and wetland ecosystems at the project and watershed scale. See the discussion below for effects to turbidity.

5. Maintain and restore the sediment regime under which aquatic ecosystems were formed.

Thinning within the outer portion of Riparian Reserve has a low probability of introducing sediment to streams. About 60 percent of the harvest within RRs would occur over frozen ground with little ground disturbance and no sediment delivery to streams. The other 40 percent would be optional summer or winter harvest. Protection buffers along streams would be applied along with winter harvest. Where summer harvest could occur in the outer edge of RRs, buffers of at least 100 feet would applied. Sweeney et al. (2014), who did consider suspended sediment, suggests 30 meter (98ft) buffers are necessary to trap ultra-fine sediment from reaching streams. Based on these measures and recent research, we expect little to no sediment delivery to occur on the units potentially harvested during the summer months. Activities outside of Riparian Reserves, such as tree harvest using mechanical equipment and fuels reduction, are unlikely to contribute sediment to the streams because the full reserve widths would prevent sediment from reaching streams. Design details that minimize erosion and sediment movement throughout the units are listed in Appendix D.

The proposed road maintenance, decommissioning, closure, and log hauling would increase sediment yield. Due to hydrologic connectivity with roads, sediment could reach fish habitat. Design Features and Mitigation Measures, listed in Appendix D would minimize sediment delivery to streams. Measures like rock armoring perennial stream crossings prior to log hauling and working under dry weather conditions would minimize fine sediment mobilization. The

amount of sediment reaching streams, using design features and BMPs would be minor. Once the road construction, maintenance, and decommissioning sites stabilizes and log hauling ceases, the net sediment yield for the Buttermilk and Libby Creek drainages would reduce. The reduction in sediment delivery to streams, coupled with other efforts across the watershed, would act cumulatively to provide long lasting improvements to watershed health in the project area. At the watershed scale, the short-term increase in sediment delivery and long-term reduction would improve the sediment regime.

6. Maintain and restore instream flows sufficient to create and sustain riparian, aquatic, and wetland habitats and to retain patterns of sediment, nutrient and wood routing.

The current road network increases the stream drainage network by ~ 30%. Additionally, historic beaver colony were abundant and the wetland habitat they created provided important natural water storage that sustained higher summer and fall base flows. Currently, base flows are reduced due to irrigation withdrawals off National Forest lands.

The proposed harvest, fuels treatment, and road management activities would change the drainage network. Collectively, with the miles of skid trails and firelines, there would be a temporary increase in the drainage network. Most new temporary drainages would be disconnected to the stream network. In the long-term, once the skid trails and fire lines recover, the miles of road decommissioning would result in a net decrease in the miles of artificial streams associated with roads.

An objective of this project is to improve base stream flow within the Buttermilk and Libby Creek sub-watersheds. Establishing eight beaver sites work to improve base flows and move towards a more natural flow regime. The beaver colony sites would function as 'sponges' soaking up early spring runoff and delivering that water from underground storage where releases it slowly, resulting in increased summer and fall flows. Previous beaver release sites in the Methow Valley Ranger District were monitored and documented to show increased water storage and improved summer flows downstream (Pollock et al. 2003).

The negative effects associated with harvest and fuels activities and the associated road work, when considered collectively with the beaver release sites, would remain an insignificant negative affect for a few years, then an insignificant positive effect in the long-term. This project element is expected to maintain instream flows sufficient to create and sustain riparian, aquatic, and wetland habitats and to retain patterns of nutrient and wood routing.

7. Maintain and restore the timing, variability, and duration of floodplain inundation and water table elevation in meadows and wetlands.

Existing meadows and wetlands would be protected with the project design features. Releasing beavers at eight sites would increase the amount of wetland habitat in the project area. Proposed projects are expected to maintain the timing, variability, and duration of floodplain inundation and water table elevation in meadows, wetlands and floodplain development.

8. Maintain and restore the species composition and structural diversity of plant communities in riparian areas and wetlands to provide adequate summer and winter thermal regulation, nutrient filtering, appropriate rates of surface erosion, bank erosion, and channel migration and to supply amounts and distributions of coarse woody debris sufficient to sustain physical complexity and stability.

Most Riparian Reserves would be untreated; therefore, the overall current condition would mostly be maintained. The limited amount of commercial and non-commercial thinning and/or underburning in Riparian Reserves is designed to restore the species composition and structural diversity of riparian plant communities that would occur under natural fire regimes in dry forests. This includes forbs, grasses, shrubs and trees; snags, "old-growth," and thickets of young trees; rotten logs and newly-downed wood of various sizes. Thinning competing small-diameter Douglas fir from larger riparian trees may improve the long-term supply of coarse woody debris at a few sites. Decommissioning riparian roads would increase the amount of vegetated riparian area. Therefore, the proposed harvest, prescribed burning, and road management would not retard the area from maintaining or restoring species riparian composition and structural diversity of plants capable of providing the above protection and complexity at the project scale.

9. Maintain and restore habitat to support well distributed populations of native plant, invertebrate and vertebrate riparian-dependent species.

Riparian Reserves treatments were chosen carefully to restore habitat and riparian function at those sites. A majority of the Riparian Reserve acres remain untreated and riparian dependent species would be undisturbed over about 90 percent of the total RRs in Buttermilk and 80 percent in the Libby Creek sub-watershed. The commercial and non-commercial thinning and underburning (in shrub communities) are designed to restore the species composition and structural diversity of riparian plant communities. Projects are expected to maintain habitat to support well-distributed populations of native plant, invertebrate and vertebrate riparian-dependent species.