SOW Hydrology Soils:

Deliverables for each project:

1. Hydrology Report
    a. To including analysis of activities regarding water quantity/quality issues. The usual concern is sediment delivery to waterbodies. If herbicides are added they can trigger further analysis. Included below is the document "PNF Soil and Water Effects Briefing Paper" that includes most of our current standard operating procedures for conducting analysis. Use this document as a general guide with some specifics here:
        i. Analysis will consider direct, indirect, and cumulative effects of alternatives considered in detail. Cumulative Effect Analysis will utilize R5 ERA method.
        ii. Field data will be collected on the road and trail system accessing and within units with the resulting data used to create a table and map of SEPES (Significant Existing or Potential Erosion Sites) This will be supplied to PNF watershed personal and contractor will meet with PNF and Central Valley Waterboard personal. Fixes for erosion sites will eventually be included in the Proposed Action. This survey may coincide with engineering road conditions survey needed for commercial haul.
        iii. Non-system roads and trails in treatment units will be mapped and considered for SEPES etc.
        iv. It is likely that treatments will occur in Riparian Conservation Areas (RCAs). This triggers an RCA analysis.
        v. Beneficial uses will be considered.
        vi. Stream location and type will be mapped in mechanical treatment units using LiDAR and field checks, this is needed to accurately determine equipment exclusion zones (EEZs) and buffer required for wildlife.
2. Soils Report
    a. See "PNF Soil and Water Effects Briefing Paper" for general guidance
    b. Existing conditions on compaction, displacement etc.)
        i. Field checks needed in each of the soil types in mechanically treated units. Erosion Hazard (EHR) will be determined for all mechanical treatment units. Design features for ground cover and water bar spacing are based on this.
3. After initial (existing condition) analysis and the Proposed Actions are finalized a meeting will be scheduled with consultants, PNF proponents, and PNF watershed and engineering personal to finalize design features (equipment exclusion zones, transportation system changes, strategy for permanent fuel breads, etc.)

Project specifics:

Hand treatments and prescribed burns are generally considered low risk for water and soils with just a few buffers etc required for design features.

Mechanical treatments using grapple piling and mastication are also generally considered low risk with more attention paid to roads and EEZs.

a. Permanent Fuel Breaks will either need to be added to system or design features will be needed to prevent motorized travel
b. Commercial activities require SEPES table and potential corrective activities included in NEPA. This would likely be combined with need for road condition survey for engineering.

Plumas National Forest

Soil and Water Resource Effects for Common Vegetation Management and Road / Motorized Trail Treatments

(PNF Soil and Water Effects Briefing Paper)

Version 1.0

June 25, 2021

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Introduction

The USDA Forest Service (USFS), Plumas National Forest (PNF) has produced this report to present the current understanding of effects to soil and water resources associated with common PNF vegetation management and National Forest System (NFS) road and motorized trail treatments, as well as the current regulatory framework that guides these activities. This report is designed to support National Environmental Policy Act (NEPA) analyses of soil and water resource effects for current and future projects proposed on Plumas National Forest. The soil and water resource effects presented are based upon dozens of NEPA analyses that have been prepared over the past two decades for PNF projects, including NEPA analyses for projects covered under Environmental Impact Statements, Environmental Assessments, and Categorical Exclusions. These effects analyses have been based upon the application of current peer-reviewed scientific research as well as extensive monitoring efforts that have been performed by USFS and other land management agencies on PNF lands and other similar landscapes.

In producing these past NEPA analyses, PNF soil and water specialists have observed that, when standard design features commonly used on the Forest for protection and improvement of soil and water resources are utilized, predicted and resulting resource effects are quite similar across the Forest for typical vegetation management and road and trail treatments. The purpose of this report is to prevent the need to re-state these effects for future project NEPA analyses that propose essentially the same type of treatments as past PNF projects. These common treatments are briefly described in this report, as well as the treatment design features typically used to protect soil and water resources.

For future NEPA project that involve these common treatments, the project soil and water specialist will evaluate whether project-specific site conditions or treatment variations require a closer look to determine whether soil and water resource effects would be substantially different from those presented in this report. If so, further project-level analysis will be provided by the PNF specialist to assure that predicted effects would satisfy applicable law, regulation, and policy requirements for protection of soil and water resources for the proposed project activities. This report will be updated when new scientific research or monitoring information is available that affects the effects discussions or when new law, regulation, or policy requirements applicable to PNF soil and water management are prescribed.

The typical PNF vegetation management and road and motorized trail treatments that are the subject of this report are listed below and briefly described in the report. The expected soil and water resource effects presented in the report are only for PNF projects located in landscapes that have not been subjected to recent wildfire. NEPA analyses for post-wildfire projects, such as salvage logging, would require additional project-specific soil and water effects analysis since those landscapes and treatments can present greater and less common challenges for protection of soil and water resources.

Common vegetation and road and motorized trail treatments that are the subject of this report include:

- Mechanical Thinning
- Mechanical Fuels Treatments (grapple piling and mastication)
- Hand Thinning and Pile Burning
- Mastication
- Prescribed Fire
- Meadow and Aspen Stand Restoration (via removal of encroaching conifers)
- Herbicide Treatment of isolated invasive plant species populations
- Construction of new NFS road or motorized trail
- NFS road maintenance and reconstruction and drainage feature construction or improvement

- Temporary Road construction and post-treatment stabilization
- Decommissioning and obliteration of NFS roads or motorized trail and non-system routes

Relevant Laws, Regulations, and Policy (Regulatory Framework)

USFS Direction

National Forest Management Act (NFMA) of 1976

This act amended The Forest and Rangeland Renewable Resources Planning Act of 1974. As described in Forest Service Manual Chapter 2550 (USDA 2010), this authority requires the maintenance of productivity and protection of the land and, where appropriate, the improvement of the quality of soil and water resources. NFMA specifies that substantial and permanent impairment of productivity must be avoided.

Plumas National Forest Land and Resource Management Plan (LRMP)

Forest Plan standards and guidelines provide the relevant substantive standards to comply with NFMA. The PNF LRMP (USDA 1988) establishes standards and guidelines to prevent significant or permanent impairment of soil productivity, including:

During project activities, minimize excessive loss of organic matter and limit soil disturbance according to Erosion Hazard Rating (EHR): for low to moderate EHR, conduct normal activities; for high EHR, minimize or modify use of soil disturbing activities; for very high EHR, severely limit soil-disturbing activities.

Determine adequate ground cover for disturbed sites during project planning on a case-by-case basis. Suggested levels of minimum effective cover are: for low EHR, 40 percent; for moderate EHR, 50 percent; for high EHR, 60 percent; and for very high EHR, 70 percent. These suggested levels are typically adopted as the LRMP ground cover standard for PNF vegetation management projects.

To avoid land base productivity loss due to soil compaction, dedicate no more than 15 percent of timber stands to landings and permanent skid trails. Permanent landings and skid trails do not exist within the project area and the Butterfly Twain Project does not propose such permanent features.

Implementation of BMPs.

Establishment of Streamside Management Zones (SMZs) per guidelines in Appendix M of the LRMP. These guidelines were mostly replaced by the recommendations for Riparian Conservation Areas (RCAs) described in the Sierra Nevada Forest Plan Amendment (SNFPA) Record of Decision (ROD). Recommended SMZ widths for ephemeral swales that lack annual scour are not discussed in the SNFPA ROD and are typically proposed to range from 0 to 50 feet for PNF vegetation management projects, depending upon the stability of the swale channel and side-slope. Equipment exclusion near streams and other aquatic features are prescribed for this project and described in the project design features. A project-specific SMZ plan for activities proposed within SMZs is prepared for PNF projects.

The PNF LRMP includes 43 defined Management Areas that cover the entirety of PNF lands. In general, the LRMP does not include specific standards for soil and water resource management in these Management Areas except for isolated areas such as Special Interest Areas. If applicable, these standards are discussed in project-specific NEPA analyses.

Sierra Nevada Forest Plan Amendment (SNFPA) Record of Decision (ROD)

The SNFPA ROD (USDA 2004) amended the Plumas National Forest LRMP. RCA widths recommended in the ROD are presented below in the typical design features section. The ROD specifies Riparian Conservation Objectives (RCOs) for management activities within RCAs. A general discussion of compliance with RCOs for is presented in Appendix B of this briefing paper. The SNFPA ROD also includes a standard and guideline for large down wood and snags:

> Determine retention levels of large down woody material on an individual project basis. Within westside vegetation types, generally retain an average over the treatment unit of 10-15 tons of large wood per acre. Within eastside vegetation types, generally retain an average of three large down logs per acre.

National Forest Service Manual for Soil Management

Forest Service Manual 2550 (USDA 2010a) establishes the management framework for sustaining soil quality and hydrologic function while providing goods and services outlined in Forest land and resource management plans. Primary objectives of this framework are to inform mangers of the effects of land management activities on soil quality and to determine if adjustments to activities and practices are necessary to sustain and restore soil quality. Soil quality analysis and monitoring processes are to be used to determine if soil quality conditions and objectives have been achieved; project-specific soil monitoring plans are prepared for PNF projects. Soil management standards and guidelines are not applied to administrative sites or dedicated use areas such as roads and campgrounds.

Region Five National FSM Supplement for Soil Management

Region 5 FSM 2500 chapter 2550 Supplement (USDA 2017a) establishes soil functions (support for plant growth (productivity) function, soil hydrologic function, and filtering and buffering function) that the region will use to assess soil conditions. Soil filtering and buffering function is the function of immobilizing, degrading, or detoxifying chemical compounds or excess nutrients.

PNF Public Motorized Travel Management Record of Decision (ROD)

The Plumas National Forest Public Motorized Travel Management Record of Decision (USDA 2010b) documents the decision to implement Alternative 5 of the Plumas National Forest Public Motorized Travel Management Final Environmental Impact Statement (FEIS). The purpose of this travel management project was to implement provisions of the 2005 Travel Management Rule (36 CFR Part 212, Subpart B) designed to enhance management of National Forest System lands; sustain natural resource values through more effective management of motor vehicle use; and provide opportunities for motorized recreation experiences on National Forest System (NFS) lands. The ROD prohibited cross-country motorized travel off designated National Forest Transportation System roads and trails and areas by the public. Table 2 of the ROD lists motorized trails that were added to the National Forest Transportation System (NFTS) but are not open to public use until certain mitigations are completed. Each National Forest maintains a Motor Vehicle Use Map (MVUM) identifies those roads, trails, and areas designated for motor vehicle use. The current MVUM for Plumas National Forest can be viewed on the PNF website (https://www.fs.usda.gov/detail/plumas/maps-pubs/?cid=fseprd534972).

Federal Law

Clean Water Act of 1948 (as amended in 1972 and 1987)

The Clean Water Act establishes as federal policy the control of both point and non-point source pollution and assigns to the states the primary responsibility for control of water pollution. In response to this law, the Forest Service has developed best management practices (BMPs) in coordination with the

State of California Water Quality Resources Control Board, with BMPs certified by the United States Environmental Protection (USEPA).

Non-point source pollution on Plumas National Forest has been managed for the past two decaded through the water quality management program contained in *Water Quality Management for Forest System Lands in California* (USDA 2000a). The Best Management Practices (BMPs) contained in that document have recently been improved and replaced by a national Forest Service BMP manual, *National Best Management Practices for Water Quality Management on National Forest System Lands* (USDA 2012a). The 2000 California water quality management manual contains the 1981 Management Agency Agreement (MAA) between the California State Water Resources Control Board and the USDA, Forest Service. The State Board has designated the Forest Service as the management agency for all activities on National Forest lands and the MAA constitutes the basis of regional waivers for non-point source pollution.

Section 303(d) of the Clean Water Act

This section requires the identification of water bodies that do not meet, or are not expected to meet, water quality standards or are considered impaired. The list of affected water bodies, and associated pollutants or stressors, is provided by the State Water Resources Control Board and approved by the USEPA. The most current 303(d) list is presented in the *2014 and 2016 California Integrated Report Clean Water Act Sections 202(d) and 305(b)* (CSWRCB 2017). The 303(d) list water bodies specific to PNF projects are presented in project NEPA analyses.

Wild and Scenic Rivers Act of 1968

The National Wild and Scenic Rivers System was created by the Wild and Scenic Rivers (WSR) Act of 1968, which was enacted by the U.S. Congress to preserve certain rivers with outstanding natural, cultural, and recreational values in a free-flowing condition for the enjoyment of present and future generations. The entire 78-mile length of the Middle Fork of Feather River was designated by Congress as a WSR in 1968. The PNF LRMP (section Rx-2) established standards and guidelines for management of this river. Designated lands are to be managed by PNF according to their appropriate Recreation Opportunity Class (Wild, Recreation, or Scenic). Wild Trout habitat for reaches designated by State of California are to be protected and improved. Within the designated river corridor, timber is to be harvested only to maintain or enhance safety, scenic quality, special habitats, or to prevent insect or disease epidemic. Forest Service Manual 2354.42 directs that a river found to be eligible and suitable must be protected as far as possible to the same extent as a designated study river (USDA 2020). However, no other stream reaches on PNF have been submitted to Congress for consideration or designation as being WSR eligible and suitable rivers

State and Local Law

California Central Valley Regional Water Quality Control Board

Waste Discharge Requirements General Order for Discharges Related to Timberland Management Activities for Non-Federal and Federal Lands

The California Regional Water Quality Control Board (CRWQCB)—Central Valley Region adopted General Order No. R5-2017-0061 to serve as general waste discharge requirements for waste discharges related to timberland management activities (CRWQB 2017). The order applies to commercial activities relating to forest management, which includes most PNF vegetation management NEPA projects. The order requires that PNF commercial timber projects be enrolled under a Notice of Applicability prior to initiating operations. A primary condition of the order is identification of site-specific Significant Existing or Potential Erosion Sites (SEPES) that potentially impact the quality of state waters, as well as a plan for treating those sites. To date, all SEPES locations identified for PNF projects have involved existing or potential sedimentation issues associated with NFS roads or motorized trails.

Beneficial Uses identified by the CA Water Resource Control Board

Beneficial uses are defined under California State law in order to protect against degradation of water resources and to meet state water quality objectives. The Forest Service is required to protect and enhance existing and potential beneficial uses (CVRWQCB 1998). Beneficial uses of surface water bodies that may be affected by activities on the Forest are listed in Chapter 2 of the Central Valley Region's Water Quality Control Plan (commonly referred to as the "Basin Plan") for the Sacramento and San Joaquin River basins (SWRCB 1998), and are described in the project-specific NEPA analyses.

Geographic Context

Project-specific geography and affected environment are described in project level NEPA analyses. Plumas National Forest lands total 1,146,000 acres and vary in elevation from approximately 1,200 feet at Lake Oroville to nearly 8,400 feet at the summit of Mount Ingalls. The topography is generally defined by relatively gentle plateaus, broad valleys, and some steeper drop offs and small but steep drainages. Nearly all watersheds on PNF drain to the South, Middle or North Forks of Feather River, with the exception of the North Yuba River watershed east of La Porte, CA and small amount east of the Diamond Mountains that drain to Honey Lake.

Climate

Weather on Plumas National Forest follows a Mediterranean pattern of wet winters and dry summers. Over 95% of the precipitation occurs during winter months. Average annual precipitation ranges from 15 inches on the eastside of the Sierra crest, to as much as 90 inches on the westside. Most of this precipitation falls in the winter as a mix of rain and snow. Winter temperatures below 0°F and summer temperatures above 100°F have been recorded. Snowpack is common from December through May at elevations above 4,000 feet, although individual winter storms may bring rain to the highest elevations. Thunderstorms generally occur during the summer months and most frequently on the eastside of the range.

Watershed Condition

Streamflow on Plumas National Forest lands corresponds to seasonal precipitation and snowpack from recent seasons, with very low flows during summer and fall, and higher flows during winter and spring. Floods can occur throughout winter and spring, with large peak flows causing major flooding. Storm events that cause these peak floods occur approximately every 1 to 10 years (Department of Water Resources: California Climate Facts, circa 1960). Warm winter rainstorms on snowpack generate most large floods.

PNF watersheds are composed of a variety of soil types that influence the timing of water movement to streams. Some soils contribute to rapid runoff and abrupt increases in streamflow during storm events. Other soils moderate runoff and streamflow. Shallow soils usually generate quicker winter and spring runoff than deeper soils do. Deep soils not only absorb and store more water than shallow soils, they also release more to summer flows. The deep soils of large alluvial areas, such as meadows, not only store and release water, but moderate high flows and increase late season flows (USDA 1999- OHV S&W Report).

Streams in the planning area range from high gradient (usually headwater channels that are sources and transporters of sediment, water, nutrients, and large wood), to low gradient channels (usually in riparian ecosystems), which can be very sensitive to changes in the amount of water and sediment delivered to them. The low gradient channels of the east and central areas generally flow through large, wide meadows. On the westside, channels more often flow through narrow valley bottoms. Degradation of Sierra Nevada streams, and their aquatic and riparian ecosystems, has been linked to dams, reservoirs, water diversions, livestock grazing, invasive species, mining, water pollution, roads, historic logging, direct changes to stream channels and stream flows, and recreational and residential developments (USDA 1999- OHV S&W Report).

Existing Condition

Existing conditions reflect the aggregate impact of prior human actions and natural events such as wildfire that have affected watersheds. Current watershed conditions on PNF have been impacted by many actions over the last century—specifically wildfire, livestock grazing, mining, timber harvest, and the transportation system associated with all these activities.

The existing watershed condition for proposed PNF vegetation management projects are described in the Affected Environment section of project-specific NEPA documents and informed by the project specific soil and water resource condition surveys described below. In addition to site-specific survey data, several sources of Forest-wide soil and watershed condition information are available.

The PNF Soil Resource Inventory (SRI) (USDA 1989) describes and characterizes important, chemical, physical, and biological indicators of soil quality, including soil texture, soil depth, geologic substratum, soil drainage rate, permeability, compaction potential, typical vegetation, forest survey site class (FSSC), and maximum erosion hazard rating (EHR). The SRI delineates soil map units throughout PNF. FSSC is a measure of site productivity in cubic feet of wood per acre per year; site class 1 is the most productive, while FSSC 7 is the least productive. EHR (USDA 2017) predicts the potential for sheet, rill, and gully erosion if vegetation and litter are removed. The SRI is a reconnaissance level survey that needs to be field verified by a qualified soil specialist for project level analyses (USDA 2005a).

The National Hydrologic Dataset (USDI 2013) and past PNF surveys of streams, springs, fens, and meadows are used to identify the location of stream channels and special aquatic features. Some of these data include brief descriptions of stream channel condition, particularly at road crossings. Watershed sensitivity analyses were reported in Appendix N the Herger-Feinstein Quincy Library Group (HFQLG) Forest Recovery Act Final Environmental Impact Statement (USDA 1999). Variables considered for that watershed sensitivity analysis included soil erosion hazard rating, rain-on-snow potential, vegetation recovery potential, and the slope of the watersheds.

Existing Soil Condition

Soil quality measurement indicators analyzed are soil productivity and soil hydrologic function (USDA 2017a). The USFS Pacific Southwest Region (Region 5) FSM Supplement (USDA 2017a) describes several soil quality measures that have been developed to support analysis of these indicators. These measures are to be used for those lands dedicated to growing vegetation. However, appropriate erosion control and soil stabilization measures are to be followed for areas dedicated to other specific uses such as roads, trails, and recreation and administrative sites.

Effective Soil Cover

Effective soil consists of living biomass (plant roots, microorganisms, invertebrates, and vertebrate fauna), woody material (dead biomass > 3 inches in diameter), fine organic matter (dead biomass < 3 inches in diameter including plant and tree litter), surface rock fragments, and may also include applied mulches (straw or wood chips). Without effective soil cover, an intense storm can generate large quantities of sediment from hill-slopes (Cawley 1990). Vegetative cover mitigates accelerated soil erosion by dissipating the energy of falling raindrops through interception.

Soil Compaction

For PNF vegetation management projects, areas of existing detrimental compaction are typically those occupied by skid trails and landings, although not all measurements at skids and landings indicate detrimental compaction. The degree and extent of susceptibility to compaction is primarily influenced by soil texture, soil moisture, coarse fragments, depth of surface organic matter, ground pressure weight of the equipment, and whether the load is applied in a static or dynamic fashion. Detrimental compaction can reduce soil infiltration and permeability capacity that causes increased overland flow during high precipitation events. Soil compaction can cause slowed plant growth and can cause plant nutrients to be relatively immobile or inaccessible (Poff 1996). Research suggests that the effect of severe compaction on biomass productivity is highly dependent upon soil texture (Powers et al., 2005).

The extent of detrimental soil compaction should not be of a size or pattern that would result in a significant change in production potential for the activity area and should not result in common occurrences of overland flow and erosion within treated units (indicating that the infiltration and permeability capacity of the soil has been exceeded for the local climate).

Surface Organic Matter

Organic matter consists of living biomass (plant roots, microorganisms, invertebrates, and vertebrate fauna) and dead biomass (bark, large woody debris, litter, duff, and humus materials). Organic cover helps promote site productivity and prevent soil loss from erosion. Soil organic matter is the primary source of plant-available nitrogen, phosphorous, and sulfur; provides habitat for the diverse soil biota that carry out energy transformation and nutrient cycles; contributes to soil structure and porosity of soils; protects soils from erosion; and enhances infiltration and hydrologic function (Neary et al., 1999).

Fine organic matter consists of plant litter, duff, and woody material less than 3 inches in diameter. The desired condition is typically at least 50% fine organic matter well distributed over the unit, with less than 30% areal extent of fine organic matter representing a poor condition.

Large woody material consists of down logs that are at least 12 inches in diameter and at least 10 feet long. The applicable standard for large down wood is in the PNF LRMP as amended by the SNFPA ROD. Within eastside vegetation types, an average of three large down logs per acre is to be retained. Within westside vegetation types, an average over the treatment unit of 10-15 tons of large wood per acre is to be retained. A recently fallen 40 foot long white fir log with a small-end diameter of 14 inches would likely weigh 1 ton; a 30 inch diameter tree may weigh upwards of 3 tons (USDA 2000b).

Soil Displacement

Detrimental soil displacement is defined as areas where either 4 inches or ½ the total thickness of the humus-enriched topsoil (A horizon) is removed from a contiguous area larger than 100 square feet. Detrimental displacement of the upper soil layer can adversely affect the productivity of desired plant species. Since organic and nutrient rich top layer of soil typically takes decades to develop, detrimental soil displacement is a long-lasting affect to soil quality.

Soil Moisture

The desired condition for this measure is to maintain the inherent soil moisture regime, particularly in special aquatic features such as wetlands, wet meadows, springs, and fens.

Chemical Application

Forest soils acts as a filter and buffer to protect the quality of water and other resources. Soil filtering and buffering is the function of immobilizing, degrading, or detoxifying chemical compounds or excess nutrients. Effectiveness of soil filtering and buffering is dependent upon the natural physical, chemical, and biological properties of the soil types involved, properties of any applied chemicals or herbicides, and the climate or leaching environment.

PNF vegetation management projects commonly use borax, a fungicide that is applied to conifer stumps in treated units within one day of cutting, to prevent the introduction and spread of Heterobasidion root disease. The average application rate for borax in thinning areas is less than 1 pound per acre (approximately 0.5 pounds per acre) with a range of 0.1 lbs/acre to 1.1 lbs/acre. Herbicide treatments on PNF lands typically involve spot chemical treatment of invasive plant species and, in recent years, spot treatment of shrub species to prevent competition to conifer seedlings that have been planted in areas impacted by high severity wildfire.

Soil Survey Methodology

As stated above, the Region 5 FSM 2500 chapter 2550 Supplement establishes the soil functions for NEPA analyses, including support for plant growth (productivity) function, soil hydrologic function, and filtering and buffering function. Table 1 shows the soil quality measures that are typically used to support the assessment and analysis of these soil function indicators.

Table 1: Soil functions, indicators, and measures used for soil quality analyses in USFS Region 5.

Function	Indicator	Measure
Support for Plant Growth	Soil Stability	Effective Soil Cover
	Surface Organic Matter	Effective Soil Cover
	Soil Organic Matter	Soil Disturbance and Erosion
	Soil Strength	Soil Compaction
	Soil Moisture Regime	Soil Moisture
Soil Hydrology	Soil Stability	Effective Soil Cover
	Soil Structure and Macro-porosity	Soil Compaction
Filtering - Buffering	Soil Properties	Chemical Application Rate

Soil characteristics described by the soil map unit designations in the PNF SRI are field verified for project NEPA analyses. Quantitative measurement of soil quality indicators utilizes randomly located linear transects that traverse slopes within proposed vegetation management treatment units. Representative samples of soil types and stand structure condition combinations are surveyed. Soil quality measurements on PNF can be performed using the *Forest Soil Disturbance Monitoring Protocol* (USDA 2009) or the protocols developed for the HFQLG monitoring plan. For the 2009 USDA protocol, the presence and type of soil disturbance or surface erosion is categorized at each point along the survey transects. Slight levels of soil disturbance exhibit faint tracks or slight depressions but duff and litter are observed to generally be in place, with minimal mixing and compaction. Moderate levels of soil disturbance are characterized by clear tracks or depressions with duff displaced and some level of compaction observed.

Under the HFQLG soil monitoring protocol, a minimum of 25 points along each transect are sampled, with intensive data (soil structure/texture and soil bulk density) collected at every fifth point. At each point along the transect, yes/no determinations are made regarding whether or not the following characteristics exist at that point: effective soil cover, surface fine organic matter, soil displacement, detrimental compaction, and wet soils or A-horizon soil coler that indicates the presence of special aquatic features. Dividing the number of “yes” responses by the number of points on the transect yields a measure that describes the soil condition for that particular characteristic along the transact. For detrimental compaction, a spade test is used. The resistance felt from sticking a spade shovel at the transect point is correlated with measured soil bulk density and soil porosity samples from the project area, with samples collected at depths of 4 to 8 inches. Soil porosity is the volume of pores in a soil that can be occupied by air, gas, or water and varies depending on the size and distribution of the particles and their arrangement with respect to each other. A 10 percent reduction in total soil porosity indicates detrimental soil compaction (USDA, 2008a). Subsequently, an 8-12 inch deep and 6-12 inch wide hole is excavated with the spade at each point to assess whether detrimental compaction exists based upon visible indicators of soil compaction. Although the HFQLG pilot project funding ceased in 2012, continued use of the HFQLG protocol allows comparison of conditions observed in the project area with the large volume of pre- and post-treatment data that exists for past HFQLG projects on PNF.

Existing Hydrologic and Water Quality Condition

Effects to water resources focus on water quality and impacts to downstream beneficial uses. These include aquatic habitat, hydroelectric power generation, and domestic water supplies. Near-stream disturbances, when compared with upslope disturbances, are more likely to cause site-specific biological effects, as well as downstream physical effects (Menning 1996, McGurk 1995).

Hydrologic and Water Quality Survey Methodology

USGS NHD is used to locate streams within PNF project areas. A subset of stream channels within proposed PNF treatment areas are field surveyed to verify flow regimes (ephemeral, intermittent, or perennial). NHD and field surveys, and aerial photo interpretation are used to identify special aquatic features such as wetlands, seasonally wet meadows, springs, and fens within and adjacent to proposed treatment areas. Existing water drafting locations that would potentially be used for projects are identified and are investigated in the field to determine if additional BMPs are necessary.

With the exception of high severity wildfire, unpaved roads are often considered the primary source of sediment to stream channels in western forests (MacDonald 2008, Goode 2011). Per CRWQCB General Order No. R5-2017-0061 for the Central Valley Region, surveys of NFS roads and motorized trails are conducted during the NEPA planning phase for all PNF commercial vegetation management projects, with particular emphasis placed on roads to be used for the project. These survey efforts usually include all NFS roads within the project area, including roads not planned for use by the project, and often include open non-system motorized routes as well.

As described above, the result of these surveys is production of a list of SEPES sites that are currently causing, or have potential to cause, direct sedimentation to area streams or water bodies. A treatment plan is developed for these SEPES lists and included in the project Notice of Intent for General Order R5-2017-0061. SEPES sites typically include road drainage issues that are hydrologically connected to the stream network such as rills on the road surface or fill slope or eroding ditches, stream crossing sites that have potential to divert the stream down the road if a culvert fails, and unstable crossing structures. Typical treatments are described below. If an NFS problem road or motorized trail is determined to have low value for future management or public recreation, project NEPA may propose to decommission the road and remove it from the PNF system. Project NEPA may also propose to obliterate non-system motorized routes that are causing erosion and sedimentation issues or are not needed for the NFS road and trail system.

Typical Design Features for PNF Vegetation Management Projects

Project design features (also known as design elements) described here are protection measures that are typically used on PNF vegetation management projects to reduce or eliminate detrimental effects to soil and water quality. These design features are presented in detail in the Appendix A of this report. Integrated design features ensure the project is consistent with PNF standards and guidelines as well as other applicable laws, regulations, and policies. Design features are parameters that are incorporated into treatment contracts or agreements or used to guide Forest Service personnel in implementing treatment. When a PNF project proposes design features that are less restrictive than those presented in Appendix A, effects associated with those changes are discussed in the project level NEPA analysis.

Listed below are abbreviated versions of several of the typical design features utilized on the PNF vegetation management projects. The effects analyses presented in this report presume that these design features are incorporated in vegetation management projects. For full description of design features, see Appendix A of this report.

To the extent possible, existing landings, temporary roads, and skid trails are re-used

Unless District Watershed staff and sale administrators determine that subsoiling could exacerbate soil erosion, skid trail and temporary road approaches within 200 feet of landings would be subsoiled and/or recontoured. Design features also require that all landings be subsoiled. Recommendations for effective subsoiling treatments are included in a 2006 letter from the USFS R5 Regional Office (USDA 2006).

Mechanical equipment traffic is prohibited when soils in the upper 8 inches of the ground are not sufficiently dry

Within eastside vegetation types, an average of three large down logs per acre is to be retained. Within westside vegetation types, an average over the treatment unit of 10-15 tons of large wood per acre is to be retained.

Mechanical equipment traffic is restricted to slopes less than 35 percent, with traffic allowed on short pitches (less than 100 feet) up to 45 percent slope.

In addition, mechanical treatment and equipment traffic is allowed in the outer portions of the RCAs (Table 2). Equipment exclusion zones (EEZs) provide an essentially undisturbed buffer of forest ground, which is effective at capturing any potential sediment that may be mobilized during treatment (Sweeney 2014). Mechanical equipment booms may reach into EEZs to thin timber and remove excessive fuel loadings. There is added risks of detrimental effects when ground disturbing activities are conducted nearer to aquatic features, but there are also significant benefits to reducing fuel loads in RCAs to decrease the risk of high severity wildfire (USDA 2016). Use of these equipment exclusion zones, along with BMPs and the design features presented in Appendix A, have demonstrated that Riparian Conservation Objectives (RCOs) will be met on PNF vegetation management projects and water quality will not be significantly impaired.

Table 2: Riparian Conservation Area widths, mechanical equipment exclusion zone widths and minimum distance to active ignition for underburning activities in timber, aspen, and meadow treatment units. Burn pile minimum distance from streams and aquatic features.

Riparian Conservation Area (RCA)	RCA Designation Width	Equipment Exclusion Zone (EEZ) Minimum Distance		Burn Pile & Active Ignition Minimum Distance
		General Forest	Aspen & Meadow	
Perennial Streams	300 feet	50 feet*	25 feet*	25 feet*
Intermittent Streams	150 feet	50 feet*	25 feet*	25 feet*
Ephemeral Streams	150 feet	15 feet	15 feet	15 feet
Swales, Hydrologic Depressions, Riparian Features, Dry Meadows, Seasonal Wetlands	150 feet	15 feet	15 feet	15 feet

Special Aquatic Features (Reservoirs, Wetlands, Fens, and Springs)	300 feet	50 feet*	25 feet*	25 feet*

*Note: EEZs of 82 feet are commonly used on PNF projects for perennial and intermittent streams and special aquatic features when prescribed by the project Wildlife Biologist, usually to protect amphibian habitat for special status species.

Expected Effects to Soil and Water Resources

Effects or impacts, as defined in 40 CFR 1508.1 (g), means changes to the human environment from the proposed action or alternatives that are reasonably foreseeable and have a reasonably close causal relationship to the proposed action or alternatives, including those effects that occur at the same time and place as the proposed action or alternatives and may include effects that are later in time or farther removed in distance from the proposed action or alternatives. Effects include ecological, including the effects on natural resources and on the components, structures, and functioning of affected ecosystems; aesthetic; historic; cultural; economic; social; or health effects; Effects may also include those resulting from actions that may have both beneficial and detrimental effects, even if on balance the agency believes that the effect will be beneficial. A ‘‘but for’’ causal relationship is insufficient to make an agency responsible for a particular effect under NEPA. Effects should generally not be considered if they are remote in time, geographically remote, or the product of a lengthy causal chain. Effects do not include those effects that the agency has no ability to prevent due to its limited statutory authority or would occur regardless of the proposed action.

Erosion and adverse effects to soil productivity due to project activities would typically occur following the first one to two winters after treatment but resulting soil issues could persist for decades. Effects to soil resources would generally affect only units where treatments are performed. To a limited extent, adverse effects associated with changes to soil hydrologic function could potentially extend outside of the units. Similarly, adverse and beneficial effects to water quality are typically confined to areas near and in the close vicinity of the proposed activities. Given adequate precipitation, adverse effects to hydrology and water quality are usually evident soon after implementation, then during and after the first winter runoff season. Therefore, implementation monitoring of BMPs occurs during or immediately after implementation of actions and effectiveness monitoring occurs after the first winter.

Vegetation Management Treatments

PNF vegetation management treatments are designed and implemented to improve forest stand structure. Treatments include mechanical thinning; mechanical fuels reduction treatments such as grapple piling and mastication; hand thinning and pile burning of smaller-diameter vegetation to reduce fuel loading; and prescribed fire only treatments. Areas treated by mechanical thinning could receive concurrent or follow-up mechanical fuels treatments. Typically, all treated areas are considered for prescribed fire as a follow-up treatment.

Mechanical Thinning

On PNF, trees to be removed for mechanical thinning treatments are typically selected using variable density thinning prescriptions as previously described. Shade-intolerant, fire-resistant tree species are promoted. Mechanical equipment used for removal may include tracked or wheeled feller bunchers and skidders. The design features refenced above and describe in Appendix A are followed for mechanical thinning treatments, including EEZs, slope restrictions, and reuse of existing skid trails, temporary roads, and landings. Trees are cut as close to the ground as practicable and no live branches remain on the stump. Trees are then moved along skid trails to a landing for processing. Landings are open areas used for processing and stacking logs and biomass products before they are loaded onto log trucks and chip vans. Landing placement generally depends on topography, safety, accessibility to treatment units, and proximity to roads. Landings typically range from one half acre to one acre in size.

For the vegetation management treatments that are the subject of this report, mechanical thinning has the greatest risk of impacts to hydrology and soils. Mechanical thinning would cause associated disturbances from skid trails, landings, and temporary roads. many of which already exist on the landscape and would be re-used. These ground disturbances would render harvested areas more susceptible to erosion and sediment mobilization.

Effects of mechanical thinning on soil quality are well documented due to several years of pre- and post-project soil quality monitoring for effective soil cover, soil compaction, surface organic matter, and soil displacement that occurred for the HFQLG Pilot Project, as well as available scientific literature. Similarly, several years of Best Management Practice (BMP) effectiveness monitoring has documented that properly implemented BMPs are highly effective for protection of water quality. Potential sedimentation to nearby stream channels due to soil erosion resulting from mechanical thinning activities and features such as landing, skid trails, and temporary roads is the primary concern for water quality.

Effective Soil Cover

After an initial reduction in effective soil cover due to mechanical treatments, soil cover is expected to increase substantially over the 2 years following treatment due to needle cast and natural re-vegetation of the treated units. A significant reduction in soil cover would temporarily increase the risk of surface soil erosion in affected areas. While the average areal extent of effective soil cover for a unit is a good measure for analyzing soil productivity effects, actual soil erosion would be highly dependent upon the size and distribution of bare areas as well as site specific factors such as soil erodibility, slope magnitude, topographic variations that limit slope length, and configuration of the unit.

Effects of short-term reductions in soil cover due to mechanical thinning would generally be inconsequential to soil erosion and productivity because contiguous bare areas would be isolated, relatively small, and well dispersed across the treated unit. Concentrated and contiguous removal of soil cover is most likely to occur in areas such as landings, skid trails, and temporary roads. BMPs for these features, such as frequent waterbars on skid trails and temporary roads, are effective at preventing concentrated runoff that could cause rill erosion. Where necessary, the addition of slash mulch is effective in providing additional erosion protection for landings, skid trails, and temporary roads (Olsen 2020) and is considered for areas that are exceptionally prone to erosion, such as steeper slopes, near stream areas, and highly erodible soils.

Effects of mechanical thinning on effective soil cover are well documented. Soil monitoring for the Herger-Feinstein Quincy Library Group (HFQLG) pilot project documented a statistically significant average decrease of 12 percent for effective soil cover in 2007 (USDA 2008). A similar average decrease was reported for a larger sample size in 2011 but only 1 of the 73 mechanical thinning units monitored had less than 50 percent soil cover post-treatment (for this unit, the lack of cover was attributed to duff consumption from follow-up prescribed burning) (USDA, 2012b).

Typically, PNF areas proposed for mechanical thinning exhibit robust levels of pre-project effective soil cover, due to live vegetation, surface rock content, and duff and forest litter that naturally occur in forested stands. A slight decrease in soil cover may occur immediately following mechanical thinning treatments due to skid trail and landing construction and mortality of live ground vegetation due to equipment traffic. Effective soil cover is expected to return to pre-project condition within a few years due to natural forest processes such as needle scatter and re-growth of vegetation in disturbed areas. Therefore, the soil cover standard, based upon Erosion Hazard Rating, required in the 1988 PNF LRMP is expected to be met in all mechanical thinning units. Exceptional areas that exhibit poor pre-project soil cover are discussed in project specific NEPA, with additional design features prescribed where necessary.

Soil Compaction

The use of heavy equipment and repeated stand entries increases the potential for a reduction of soil porosity and increase of soil compaction. The degree of soil compaction varies with soil texture and moisture content, while plant responses to compaction depend strongly on changes in the soil water regime (Gomez et al., 2002).

Ongoing research has focused on the effects of soil compaction to long term soil productivity. The ten-year results of the Long Term Soil Productivity (LTSP) study, a study initiated in 1989 and comprised of more than 60 sites, including sites in the Sierra Nevada (Powers 2005). The study focuses on two soil condition indicators readily affected by management activities, soil compaction and surface organic matter. One acre plots were clear-cut and re-vegetated with native species under different levels of soil compaction and retention of surface organic matter. The national ten-year results indicate that soil compaction effects on total biomass productivity (all vegetation within a site, not just tree growth) differs depending upon soil texture, along with other factors such as initial bulk density, rock content, and climate. On soils characterized as sandy, compacted plots had greater biomass productivity than uncompacted plots. On soil characterized as loamy, severe compaction resulted in little change in biomass productivity. On soils characterized as clayey, compaction resulted in up to a 50% reduction in biomass productivity at sites in the Southern Coastal plains, primarily in areas with poor soil drainage or high-water table. The ten-year results included results from 6 California sites. These test plots were subjected to extreme levels of compaction that would occur under normal timber operations only in areas of highly concentrated traffic (such as landings or heavily used skid trails); for the LTSP study, soils were wetted to near field capacity and a mechanical roller, typically used for compaction of highway subgrades, was utilized. Despite the severity of compaction, significant adverse effects to soil productivity were not observed for sites with sandy or loamy soils and positive tree biomass response was observed at most monitoring sites, presumably due to improved water-holding capacity (USDA 2016).

Soil porosity/compaction monitoring results reported in the 2007 HFQLG Soil Monitoring report stated that a review of monitoring data indicates that legacy compaction is commonplace (USDA 2008). Most of the detrimental compaction observed post-project also existed pre-project. Statistical analysis for 40 thinned units and 11 group selection units determined that the mean post-project areal extent of detrimental compaction was not statistically different from the pre-project mean. Confidence intervals indicated broad ranges that suggested both a trend toward increasing the extent of detrimental compaction and a trend toward decreasing extent.

The pre-project areal extent of compacted soil for proposed mechanical thinning units on PNF typically varies widely, depending upon whether previously used skid trails, landings, and temporary roads exist within the units. Temporary haul roads are commonly necessary on PNF mechanical thinning units to provide access to the landings from system roads. Design features for PNF projects state that, to the extent possible, existing landings, temporary roads, and skid trails would be re-used. Additionally, design features require that, unless District Watershed staff and sale administrators determine that subsoiling could exacerbate soil erosion, skid trail and temporary road approaches within 200 feet of landings would be subsoiled and/or recontoured. Design features also require that all landings be subsoiled. For units that indicate widespread compaction under the pre-project condition, subsoiling design features would likely result in a decrease in the extent of detrimentally compacted soil.

For any mechanical harvest, the extent and degree of compaction depends on site-specific soil conditions such as texture and stoniness, moisture content at the time of operations, and harvest equipment features. Clayey soils are particularly susceptible to detrimental compaction when soil moisture content is near field capacity. PNF design features for wet weather operations minimize soil compaction in those units. The Powers LTSP study indicates negligible effects to soil productivity for sites with sandy or loamy soils, even under extreme compaction. By following the design features and utilizing existing skid trails where feasible, effects associated with detrimental compaction due to project activities are not expected to be of a size or pattern that would result in a significant change to soil production potential or soil hydrologic function.

Surface Organic Matter

Similar to effective soil cover, surface organic matter would be affected by mechanical thinning treatments due to landing, skid trail, and temporary road construction and utilization, equipment traffic associated with the removal of trees, and treatment of slash material. Treatment effects on surface fine organic matter are likely consistent with those observed for effective soil cover in the 2007 HFQLG soil monitoring report (described above). Given the modest and short-term reductions of fine organic matter that may be experienced due to mechanical thinning treatments, those reductions would not significantly change the soil production potential for plant growth within the treated units. These reductions would be ameliorated in a short timeframe (1-3 years) as live vegetation and duff and litter accumulate. The post-treatment depth and distribution of the organic layer depends on the slash treatment method selected to attain the ground cover and fuel loading design elements of the project.

Reductions in large woody material would cause minor, localized changes to soil microhabitat. Where pre-project levels of large down wood exceed desired fuel loadings, PNF mechanical thinning projects are design to reduce these loadings while maintaining the minimum level of large down wood required by the SNFPA ROD. Project design features require that, within eastside vegetation types, an average of three large down logs per acre is to be retained. Within westside vegetation types, an average over the treatment unit of 10-15 tons of large wood per acre is to be retained.

Soil Displacement

Operation of equipment within the harvest units is expected to disturb or overwhelm discontinuous areas of shrubs and grasses and displace existing surface fine organic matter. Humus-enriched topsoil (A horizon) is often cast aside where new skid trails or temporary roads are carved into hillsides. Additionally, when tracked and rubber-tired heavy harvest equipment turns abruptly within forest stands, the topsoil layer could be displaced, particularly on steeper slopes. Detrimental soil displacement is defined as areas where either 4 inches or ½ the total thickness of topsoil (A horizon) is removed from a contiguous area larger than 100 square feet. Since topsoil removal can cause a long-lasting reduction in nutrient availability for plants, large areas of topsoil displaced by mechanical thinning treatments can significantly affect soil productivity within a forest stand.

Outside of some of the legacy skid trails and temporary roads that exist on steeper slopes in PNF forest stands, existing soil displacement levels are typically low, with the thickness and color of the upper soil layer within the normal range of characteristics for the site and distributed normally across the area. Localized areas of displacement are often observed to have occurred but are typically not widespread enough to affect the productivity of desired plant species. Design features for mechanical treatments on current PNF vegetation management projects typically restrict mechanical equipment traffic to slopes less than 35 percent, with traffic allowed on short pitches (less than 200 feet) up to 45 percent slope. Soil displacement monitoring on PNF projects has demonstrated that this design feature is effective in preventing the detrimental soil displacement that can occur when heavy equipment turns on steeper slopes. HFQLG soil quality monitoring indicates that standard timber harvest practices typically result in less than 10 percent of the areal extent of treated units having displaced soils and that displacement levels are typically similar to pre-activity levels (USDA 2008). Design features for PNF projects call for re-use of existing skid trails and landings, which also limits the level of detrimental soil displacement in forest stands. Equipment operating in outer RCAs (outside of the equipment exclusion zones) is not permitted to turn around while off a skid trail, which effectively limits soils displacement within RCAs. Any detrimental soil displacement on PNF mechanical thinning treatments is expected to occur in small, discontinuous areas and not of an areal extent that would significantly impair soil productivity within the forest stand.

Soil Moisture

Adverse effects to soil moisture typically do not occur on PNF mechanical thinning treatments. Soil moisture within special aquatic features such as wetlands, wet meadows, and fens is protected by equipment exclusion zones. In forested areas, removal of canopy cover may result in increased temperatures at the forest floor as well as reduced moisture content of forest floor materials (Erickson 1985); however, more precipitation would pass through the canopy layer and be available for groundwater recharge.

Chemical Application

Borax Fungicide

Borax fungicide is commonly applied to conifer stumps in PNF mechanically thinned units within one day of cutting, to prevent the introduction and spread of Heterobasidion root disease. The average application rate for borax is typically less than 1 pound per acre (approximately 0.5 pounds per acre) with a range of 0.1 lbs/acre to 1.1 lbs/acre. There is a considerable body of information describing the potential effects on soil and water resources associated with borax. Much of this information is contained in the risk assessment completed by Syracuse Environmental Research Associates, Inc. (SERA 2006), under contract to the Forest Service, and in the HFQLG Act Final Supplemental EIS (USDA 1999).

The agent of toxicologic concern in borax, i.e. boron, occurs naturally. The use of borax is not expected to substantially contribute to concentration of boron in water or soil beyond those that are associated with the normal occurrence of boron in the environment (SERA 2006). The SERA risk assessment states “in water, boron compounds transform rapidly into borates, no further transformation is possible, with borate speciation dependent upon pH. Those compounds may be transported by percolation, sediment, or runoff from soil to ambient water. Borate compounds are adsorbed to soils to varying degrees, depending on several factors, including soil type and water pH” (SERA 2006). A study by the Southeastern Forest Experiment Station in 1971 showed that borax “persisted uniformly at a toxic concentration 5.1 cm below the stump surface for at least 8 weeks. Twenty-six months after treatment, borax had leached to subtoxic levels throughout the upper 0.3 cm of stumps, but toxic amounts were measured at a depth of 1.2 cm” (Koenigs 1971). Borates are effective fungicides and some non-target soil microorganisms could be affected by exposure to boron in soil. “However, information to adequately assess risk in this class of organisms is not available” (SERA 2006). Due to the application method and rates, widespread exposure to soil microorganisms is not likely.

No effects on soil productivity are predicted from the proposed fungicide treatments. The potential for adverse effects of fungicide residues in soil and water would be minimized or eliminated by incorporating project design elements (where?) and applying appropriate BMPs for chemical application. Design elements include carefully planned fungicide use according to the label and other relevant requirements, spill contingency plans, proper disposal of containers and cleaning equipment, adequate buffer strips, spray drift control, and restricted use of fungicide near water bodies with sensitive amphibian species.

Water Quality Effects

Delivery of fine sediment to nearby stream channels and aquatic features from landings, skid trails, and temporary roads is the primary concern for water quality within mechanical thinning treatment units. BMPs for these features are prescribed for all PNF mechanical thinning treatments and are largely focused on measures that disperse drainage so that runoff is not concentrated to the point that surface soils are eroded and carried to streams. These BMPs include frequent waterbars on skid trails and temporary roads, and at the drainage outlet of landings, as well as adding slash mulch to those features where deemed necessary due to exceptionally erodible soils and/or steep slopes. Stream and aquatic feature water quality is also protected by equipment exclusion zones which are prescribed for all PNF mechanical treatments (see typical zone widths in Table 2). No equipment travel is allowed within these zones but equipment booms are allowed to reach into the zone to cut and remove vegetation. Excluding equipment from these streamside areas provides a buffer of undisturbed forest floor that acts as an effective trap for any sediment that may be generated from mechanical activities outside of the streamside zone (Sweeney 2014).

Extensive monitoring on PNF has demonstrated that these BMPs are effective at preventing erosion and sedimentation from mechanical thinning treatments (USDA 2012b). The 2012 BMP effectiveness report summarized results from over 320 BMP evaluations (skid trails, landings, streamside zone protections, prescribed burning, and road drainage) completed between 2007 and 2012. BMPs were rated as effective for 91 percent of these evaluations. For the BMPs rated as non-effective, none of the sites evaluated exhibited significant and long-term impacts to water quality and State of California designated beneficial uses of water. If road BMP evaluations are not considered, BMPs were rated as effective for 96 percent of the 222 evaluations, indicating that Plumas National Forest BMPs are highly effective at preventing water quality impacts for mechanical thinning and prescribed burning treatments. Road BMP deficiencies and typical treatments are addressed below. The monitoring shows that standard BMPs such as frequent waterbars along skid trails and temporary roads and at landings disperse runoff and prevent erosion rills that deliver sediment from waterbar outlets to adjacent stream channels. Streamside protection evaluations deomstrated that RCA equipment exclusion zones provide an effective buffer of undisturbed ground to prevent sediment from reaching streams and special aquatic features.

Recently, PNF has carried out a BMP effectiveness monitoring program to satisfy annual monitoring and reporting requirements of the 2017 CRWQCB General Order for waste discharges related to timberland management activities. This monitoring method strives to visit more project units and features (skid trails, landings, temporary roads, haul roads, etc.) by utilizing a more simple and concise documentation of BMP effectiveness than the USFS Region monitoring program described above and the more recent national USFS BMP evaluation program. For PNF's annual reports for 2017-2019, a total of 27 different mechanical thinning units were visited within 22 different timber sale of stewardship contract projects. The units surveyed were those units harvested the previous season that appeared to have the greatest waer quality risk to beneficial uses of water, primarily due to close proximity of mechanical treatment to larger streams. A total of 69 skid trail segments (totaling over 6 miles in length), 51 landings, and 16 temporary roads (totaling nearly 2 miles in length) were evaluated with the evaluated features being those located closest to streams. In addition, 7 skid trail stream crossings and 7 temporary road stream crossings were evaluated. These features were associated with 46 different streams, including 6 perennial streams, 10 intermittent streams, and 30 ephemeral streams.

For the 69 skid trail segments surveyed, only 2 of the trails exhibited evidence of sediment entering nearby stream channels. Other than those 2 exceptions, waterbars on skid trails were frequent and effective at dispersing runoff. Similarly, no sediment delivery was observed for the 51 landings reviewed. For the 16 temporary roads reviewed, no sediment delivery was observed and surfaces were found to be stable. The two problem skid trails were located on a wildfire salvage harvest project. One problem was not the result of poor BMP implementation but was caused by a lack of water bars on a temporary road utilized on an adjacent private land salvage harvest. The other problem skid trail had BMP water bars installed per specification but still erosion occurred due to high runoff from the burned area. One other BMP problem was observed at a skid trail stream crossing where temporary fill was left in the ephemeral channel above the natural channel grade. The remaining 13 temporary crossings all had stable rehabilitation of the crossings, with approaches waterbarred and stable and the channel stable and excavated to natural channel grade so that no significant scour was observed.

In summary, for the 150 BMP features evaluated for 2017-2019 mechanical thinning projects, only 3 (2.0%) indicated deficient water quality protection. Further, none of these 3 sedimentation issues were expected to have significant duration or magnitude. All were expected to have detrimental effects for only 1-2 runoff seasons and none were of a magnitude that would impact State designated beneficial uses of water.

These large sets of PNF monitoring data demonstrate that BMPs and PNF project design features for mechanical thinning activities effectively prevent water quality effects and assure that PNF mechanical thinning projects do not adversely affect State-defined beneficial uses of water. Exceptional areas of concern for mechanical thinning treatment areas on specific PNF projects are discussed in project level NEPA analyses.

Additionally, mechanical thinning treatments, as well as the mechanical fuels treatments and prescribed fire treatments described below, are designed to reduce the likelihood of high intensity wildfire in the treated forest stands. In the event of a severe wildfire in these stands, moderate and high soil burn severities would not only impact soil cover but would also likely generate substantially increased runoff and erosion that would measurably impact water quality in streams within and near the burned area (USDA 2005b).

Water sources (drafting sites for trucks that water roads during timber haul and road maintenance activites) can be a source of sedimentation to streams. A comprehensive BMP for water sources is presented in an R5 amendment to the Soil and Water Conservation Handbook (USDA 2011). Water truck drafting pads, located adjacent to the water source, as well as the road approach to the water source are treated with surface aggregate gravel or rolling dips to prevent sediment production and delivery to the nearby stream. Developed areas subject to high flood events are armored to prevent erosion. Where feasible, water sources are constructed or reconstructed to be hydrologically disconnected from streams, with small supply flows diverted to the water source during the time that it is used. Evaluation of all water sources to be used for PNF timber projects is included in the SEPES surveys described above so that any water sources that are currently causing, or have potential to cause, direct sedimentation to the stream are incorporated in the SEPES treatment plan.

Mechanical Fuels Treatments

Mechanical fuels treatments on PNF consist of removing small trees, shrubs, and dead and down material. These treatments could be utilized as both a stand-alone treatment and in combination with other treatments. Grapple piling is one such mechanical fuels treatment method that typically involves a tracked excavator to pile material. Grapple piling is effective where brush is dominant and overtops or competes with preferred tree species. To effectively treat areas with heavy brush or a high density of trees less than 10 inches DBH, hand thinning may be utilized with grapple piling.

Material resulting from fuels treatments may be removed, piled and burned, lopped and scattered, or masticated. Trailer mounted chippers are commonly used at landings to chip and remove the material. In areas where vegetation removal is not feasible due to accessibility or site sensitivity, a masticator or self-propelled chipper may be used to shred or grind vegetation and leave on site.

Best management practices and project design elements pertinent to mechanical fuels treatment described for the mechanical thinning section above are also implemented for mechanical fuels treatment. Mechanical fuels treatment operations are typically allowed in the same outer RCAs as mechanical thinning.

Soil Quality Effects

Detrimental effects of grapple or machine piling are considered less likely compared to mechanical thinning as described above. Mechanical piling equipment is mounted on tracks, resulting in less ground pressure to potentially compact soils that rubber-tired heavy equipment. Additionally, for mechanical piling activities, skid trails, temporary roads, and landings are typically not needed. Mastication treatments are expected to result in an increase in effective soil cover and fine organic matter as masticated debris is broadcasted away from the machine. Contract specifications for grapple pile activities include requirements to leave the required amounts of effective soil cover and surface fine organic matter. These requirements are typically readily achieved since the grapple hooks are ineffective at piling all fine fuels.

Water Quality Effects

BMPs and typical project design features such as equipment exclusion zones have adequately protected water quality and ensured that Riparian Conservation Objectives were met for past mechanical fuels treatment projects on PNF. Post-treatment areas of concentrated runoff that may cause soil erosion and carry material to adjacent streams are much less likely than for mechanical thinning treatments because mechanical fuels treatments typically do not require use of skid trails, temporary roads, or landings. Therefore, water quality impacts due to sedimentation for these treatments are much less likely than mechanical thinning treatments.

Aspen Stand Improvement and Meadow Restoration via Conifer Removal

PNF aspen stand improvement activities typically consist of removal of all competing conifer species via mechanical harvest and follow-up prescribed fire. The removal of conifers allows more sunlight to reach the forest floor, promotes aspen regeneration, promotes aspen growth and survival, and promotes expansion of aspen stands. All conifer trees, including trees greater than 30 inches DBH, could be removed from within aspen stands. Some conifers could be left standing as snags or could be felled and left as downed wood to create wildlife habitat. Conifers up to 150 feet around aspen stands may also be removed. The preferred treatment method is cutting and removal with mechanical heavy equipment. When mechanical removal is not practicable (e.g. due to soil moisture conditions, access or slope constraints, sensitive resources), conifers may be treated using hand thinning techniques. Like treatments in conifer forests, prescribed fire would be intended as a secondary treatment in aspen stands following conifer removal.

PNF meadow restoration treatments to remove competing conifers are very similar to aspen stand improvement activities. All conifer trees, including trees greater than 30 inches DBH, could be removed within meadows, preferably with mechanical heavy equipment. Where mechanical treatment is not feasible, trees could be hand-thinned and removed, lopped, and scattered, and/or piled in the meadow. Piled material resulting from treatments is subsequently burned when conditions allow. Prescribed fire within meadows is considered as a primary and/or secondary treatment to remove small diameter conifers, reduce conifer regeneration, promote herbaceous vegetation, and reduce fuels. Meadow boundary delineators may include vegetation and soil composition, topography, changes in landform, or changes in soil moisture.

Conifers could be thinned in the forest surrounding meadow edges to minimize seed sources and prevent future conifer encroachment. The extent and acreage of these thinning treatments around meadows is identified during implementation planning and could depend on factors such as the intensity of conifer encroachment in the meadow, surrounding stand density and species composition, and sensitivity of the surrounding forest. Surrounding forest trees are thinned, preferentially retaining fire-resistant, shade-intolerant species. If feasible, these trees are left in clumps prioritizing retention of trees that exhibit legacy tree characteristics (platy bark, flat top). Thinning preferentially removes trees less than 30 inches DBH, lodgepole pine, and white fir trees. Trees greater than 30 inches could be removed under limited circumstances when necessary to achieve meadow restoration objectives.

Soil Quality and Water Quality Effects

Effects of mechanical thinning within Aspen stands would have similar effects on soil measures and watershed condition as mentioned above under the Mechanical Thinning and Mechanical Fuels Treatment sections. A recent study of aspen stand improvement treatments on Lassen NF found limited to no effect on sedimentation levels for streams adjacent to treated areas, despite harvesting equipment operating as close as 4 meters from the stream channel (Jones 2013). With effective implementation of applicable BMPs, project design elements, and other condition-based management approach elements (e.g., monitoring plan), effects within aspen stands due to mechanical thinning and fuels treatment are not expected to be of a size or pattern that would result in effects to the soil measures and watershed condition.

Hand Thinning and Pile Burning

Hand thinning is commonly conducted on PNF where mechanical treatment is not feasible due to site sensitivity, slope steepness, or accessibility. Hand thinning can be conducted in upland forests, aspen stands, and meadows. Generally, hand thinning involves the use of chainsaws to cut trees up to 10 inches DBH but may cut larger trees to meet project objectives, particularly in aspen stands and meadows. Cut trees can be piled for burning later, bucked for firewood, chipped, and removed, or lopped and scattered.

Soil Quality Effects

Detrimental soil quality effects due to hand thinning and pile burning are less likely than any mechanical treatment. Groundcover and surface organic matter standards are generally always met with hand treatment because the forest floor is substantially less disturbed relative to mechanical thinning and because hand piling limits the amount of slash that can be cost-effectively removed from the treated units. Soil compaction and topsoil displacement caused by hand thinning treatments is practically nonexistent since no heavy equipment traffic is involved.

Pile burning will decrease soil cover to zero under the pile and there is a risk of nutrient pollution in ash moving off site to water bodies. A recent study conducted in the Tahoe Basin did show that although the water repellency of soils directly under burn piles is increased, the small areal extent of piles on the landscape ensured that nutrient did not move downhill more than a few meters (Hubbert 2015).

Water Quality Effects

Burn piles are not allowed immediately adjacent to streams (Table 2) to ensure that direct impacts to water quality are minimized. The small areal extent of piles on the landscape ensures that runoff in the treated areas is not substantially increased. Accessing the burn pile work areas in fall, winter, and spring (when fuel and weather conditions are favorable for burning) can result in vehicle traffic on wet native surface roads. On PNF, wet weather restrictions are placed in the contracts to protect the road system from rutting and forming areas where runoff can be concentrated, which risks sedimentation to streams.

Underburning (Prescribed Fire)

Prescribed fire aims to reduce surface accumulation of vegetative material and provide ecological benefits such as recycling nutrients, reducing inter-tree competition by maintaining spacing, creating snags beneficial to wildlife, and removing pine litter suppressing native grass and forb growth. Prescribed fire underburning can be used as a stand-alone treatment where it can be safely applied to achieve ecological and cultural benefits. Prescribed fire is also be used as a follow-up treatment to burn existing surface fuels, small diameter conifer trees, piles created by mechanical fuels and/or hand treatments, and slash created by thinning treatments. Prescribed fire and pile burning on PNF typically occur over multiple years, depending on fuel and weather conditions.

Prescribed fire is planned to burn in forest stands at low to moderate intensity. Burn plans are developed to identify consumption goals, acceptable levels of tree mortality, large tree and snag protection, and large debris retention. Areas to be underburned may receive hand thinning pretreatments to meet burn plan goals. Existing roads and natural barriers are utilized as fire lines to minimize new ground disturbance, although additional improvements or fire line construction around the planned burn area perimeter is often necessary.

Soil Quality Effects

Potential detrimental soil quality effects related to prescribe fire activities associated with underburning and fire line improvement or construction are much less likely than effects described above for mechanical treatments. Underburning can decrease soil cover since the duff layer and fine organic matter will be partially consumed by fire, but underburn treatments are designed and timed to burn at low severity so that effective soil cover and surface organic matter are not heavily impacted. Additionally, specifications are included in contracts or direction to crews to ensure that minimum soil cover and surface organic matter standards and desired conditions are met. Soil compaction and topsoil displacement is not expected in prescribed fire units since no heavy equipment traffic is involved.

Water Quality Effects

Underburning BMPs (USDA 2012a) and PNF project-specific design elements are included to ensure that any fire lines constructed by hand or mechanically will have adequate drainage structures installed to protect water quality. These features are rehabilitated, blocked, and disguised after use to prevent them from becoming non-system motorized trails after prescribed fire projects. BMP effectiveness monitoring on PNF has demonstrated that these BMPs are highly effective. Sixty-five PNF prescribed fire units were evaluated for BMP effectiveness from 2007 to 2012 (USDA 2012b). Only two of these evaluations indicated deficient BMP application, due to the treatment burning at a higher intensity than planned, resulting in reduction of ground cover below standard. However, for these sites, ground cover was re-established within a few and no lasting potential impact to water quality occurred.

Herbicide Treatments

Herbicide treatment is frequently proposed on PNF vegetation management projects to eradicate small areas of noxious or invasive weed species by applying the herbicide manually directly to the target species with a backpack sprayer.

Soil Quality Effects

Herbicide treatments may affect soil directly via short-term adverse impacts on certain soil microbes. Applied chemicals would likely experience leaching; hydrolysis; adsorption on to, and desorption from, soil particles; and biological degradation during the period of time that the particular herbicide remains present in the soil profile. Soil characteristics affect the herbicide residency time through drainage and cation exchange capacities.

The herbicide that is commonly used is Aminopyralid. It is likely to be non-persistent and relatively immobile in the field. Half-lives of 20 and 32 days were determined with minimal leaching below the 15 to 30 cm soil depth. Aminopyralid has been shown to be practically non-toxic to most organisms (SERA 2007).

The herbicide type and application rates proposed on PNF projects are typically low enough to facilitate decay by soil microbes, in some cases increasing microbial activity. Therefore, significant detrimental effects to soil productivity are not likely.

Water Quality Effects

As mentioned above, herbicide treatment is frequently proposed on PNF vegetation management projects to eradicate small areas of noxious or invasive weed species by applying the herbicide manually directly to the target species with a backpack sprayer. The herbicide that is commonly used is Aminopyralid. BMPs have been designed to protect water quality and are prescribed for PNF projects (USDA 2012a). The risk of detrimental effects to water quality are very low given the targeted treatment method, the fast decay times of Aminopyralid, and the ease of avoiding rainfall when treating during the California dry season.

Road Treatments

Road Reconstruction, Maintenance, and Obliteration

As mentioned above, other than high severity wildfire, unpaved roads are often considered the primary source of sediment to stream channels on National Forest lands. Delivery of fine sediment to stream channels is not uniform across NFS road networks. Rather, sedimentation issues are usually associated with a subset of problem road segments that are hydrologically connected to the stream network, such as eroding ditches or rills that flow where runoff is concentrated along the road surface or fill slope. If a stream crossing culvert becomes plugged during flood events, a large volume of sediment delivery could occur if the road template is washed away as the stream flows over the top of the culvert. Even larger volumes of erosion and sedimentation can occur if, when the crossing structure plugs, stream flow is diverted down the road away from the crossing site. Eroding, unstable crossing structures are also sources of fine sediment to streams.

Typical treatments for these problem road sites include reshaping the roadbed so that runoff is less concentrated; installing armored or unarmored rolling dips to better disperse storm runoff along the road surface or inside ditch to prevent rilling and disconnect concentrated road drainage from the stream network; rock armoring of dip outlets; and construction of new armored overflow dips at stream crossings to prevent water from diverting down the road in the event of a culvert plugging. Some sections of roads within RCAs may be surfaced with rock aggregate to decrease erosion. Armored low water crossings (LWXs) are often installed where ephemeral drainages currently flow over a native road surface or where an LWX would provide a more stable crossing structure than the existing culvert.

To support vegetation management projects, segments of PNF NFS roads are often reconstructed or maintained to facilitate access to the project area and to facilitate efficient haul of forest products, such as timber or biomass chips, from the project area. These road reconstruction and maintenance activities are not necessarily targeted to road segments with water quality issues. Road maintenance activities include grading or blading the road surface to smooth ruts and washboard areas, blading of ditches to clear vegetation and debris and assure that runoff will flow in the ditch without being diverted onto the roadway, and removing brush that is extending into the roadway. Road maintenance also involves clearing of complete or partial blockages of culvert inlets. Road reconstruction includes the road improvements described above and may also include widening of curves to facilitate truck traffic and repair of embankment material that may have eroded from the road template.

NFS roads with drainage problems that do not appear to be needed long term are often identified for decommissioning in project level NEPA. Decommissioning removes the road from the system of roads that appear in the MVUM as open for use. Decommissioning activities always include efforts to block the road at all of its intersections with open NFS roads and usually include obliteration treatments that are designed to, as closely as possible, restore the natural drainage patterns of the road area to fit the surrounding landscape. Additionally, non-system roads that are left over from past timber management projects or that were created by Forest users, are often identified for obliteration in PNF NEPA projects, particularly those that are causing erosion and sedimentation issues. However, many of these non-system routes are relatively stable and not causing water quality issues but are still proposed for obliteration since the route is not part of the transportation system, is not planned for future maintenance, is usually preventing natural vegetation productivity, and may be impacting other resources such as wildlife or native plant communities. For both NFS and non-system roads that are proposed for decommissioning and physical closure, PNF may choose to not implement road drainage treatments if the road area has not received traffic for many years and has become largely overgrown with vegetation, since this vegetation may be providing a large degree of soil stability that would be lost if disturbed by treatment activities.

As mentioned above, road obliteration treatments are designed to restore drainage patterns to as close to natural condition as possible. Full recontouring of the road prism, which would involve excavating the existing fill slope and reshaping the hillside to natural slopes, is usually not feasible since it would involve excavation of a large amount of existing trees and vegetation that act to stabilize soils. Partial recontouring is often a better alternative, whereby a portion of the fill slope is excavated and the road surface is sloped to return drainage patterns to natural hillslope directions. Waterbars are constructed to frequently divert runoff off of the road surface and prevent concentrated rills that could deliver sediment to streams. The road surface may be ripped or subsoiled to decompact soils and restore infiltration. For obliterated road segments, all existing stream crossing culverts are removed and the channel grade restored to natural slope. Rock or logs may be placed to stabilize the restored stream grades. Where necessary, restored channel banks are mulched with slash or imported weed-free straw to stabilize soils and prevent erosion to the stream. Rock or earth barriers are constructed to prevent future vehicle traffic from open NFS roads or, at flatter intersections with NFS roads, logs and slash may be used to effectively disguise potential vehicle access points to the obliterated road.

Soil Resource Effects of Road Improvements and Obliteration

As stated above in the "Existing Soil Condition" section, the R5 soil quality analysis measures are not used for those lands that are not dedicated to growing vegetation, such as roads, trails, and recreation and administrative sites. The BMPs used to protect water quality during road improvement and obliteration treatments are designed to prevent soil erosion. Also, as described below, SEPES treatments for roads are designed to correct soil erosion sites.

Water Quality Effects of Road Improvements and Obliteration

As stated above in the mechanical thinning effects discussion, the PNF's 2012 BMP effectiveness report summarized results from over 320 BMP evaluations completed between 2007 and 2012 and demonstrated that BMP deficiences on PNF were most commonly associated with NFS roads (USDA 2012b). Nearly 22 percent of the evaluations for road surface drainage and slope protection, stream crossings, and control of road grading material resulted in failed BMP effectiveness ratings (23 failed ratings for total of 106 evaluations). The BMP deficiencies observed were predominantly due to legacy effects associated with the original design or location of system haul roads. Legacy designs commonly used in-sloped road templates which concentrate road runoff in the inside ditch. Most PNF NFS roads were constructed prior to the Clean Water Act amendment of 1972 and often did not include sufficient frequency of drainage structures to disperse road runoff and prevent the ditches from delivering sediment to streams at road crossings.

As described above, the 2017 CRWQCB General Order requires identification of a list of Significant Existing or Potential Erosion Sites (SEPES) that are currently causing, or have potential to cause, direct sedimentation to area streams or water bodies. A treatment plan is developed for these SEPES lists as part of the project NEPA process. SEPES sites typically include road drainage issues that are hydrologically connected to the stream network such as rills on the road surface or fill slope or eroding ditches, stream crossing sites that have potential to divert the stream down the road if a culvert fails, and unstable crossing structures. SEPES sites may also include system and non-system roads that are to be obliterated.

Road improvement treatments, such as those prescribed for SEPES sites, consist of measures that better disperse road drainage and reduce erosion caused by concentrated road runoff. Short-term increases in sediment mobilization due to road reconstruction would be minimized by BMPs and would be offset by long-term improvements to water quality that result from less road generated fine sediment being delivered to streams at hydrologically connected road segments. Rock riprap armor at drainage structures, such as the outlets of rolling dips or stream crossing culverts, protect those structures from erosion and assure long term stability of those structures. Armored overflow dips at stream crossing culverts, also known as critical dips or diversion potential dips, provide assurance that, if the crossing culvert plugs with woody debris or bedload, flood flows will flow directly over the road into the channel. This may cause some loss of the road fill material above the culvert, but will prevent what may be a much larger amount of material eroding from the road surface and fill slope if the flood were to flow down the road and then leave the road at an inopportune location. Such an occurrence of stream flow diversion by the road would likely result in a long length of road being eroded and needing repair; creation of a new eroded gully from the road to the adjacent stream channel; and delivery of large volumes of sediment from the roadway to the stream.

Where gravel aggregate surfacing is installed of road segments within RCAs, the aggregate will stabilize the road surface and prevent fine sediments from washing from the road surface to the stream channel (Brown 2014). The installation of rock armored low water crossings on ephemeral stream crossings stabilize the road surface and provide a stream crossing structure that is less prone to plugging than a culvert.

Road maintenance activities to clear debris from culvert inlets protect water quality by assuring that the culverts function properly and prevent runoff from flowing uncontrolled along or across road surfaces. Watering of roads to compact the road surface during grading maintenance activities is an effective BMP for maintaining the stability of the road surface. However, road grading can result in some areas of loosened fine-grained road material that could be more susceptible to runoff transport to streams. This short-term effect is expected to be offset by the improvement of road drainage due to grading, which corrects ruts that concentrate runoff on the surface (Sugden (2007), Luce (2001). Sedimentation may be increased due to blading of road drainage ditches (Black 1999). Ditch blading is not a common maintenance treatment on PNF roads and is employed only on limited road stretches where necessary to keep the road drainage system functioning.

Road obliteration treatments would promote vegetative recovery, which can decrease soil compaction, increase infiltration into the roadbed, and increase soil stability and limit concentrated flow as well as surface erosion. Over time, obliterated roads produce less sediment and surface runoff to adjacent watercourses. Re-contouring of hillslopes significantly reduces soil compaction, surface runoff, and sediment production compared to sub-soiling or cover cropping alone (Kolka 2004). Soil disturbance during obliteration activities results in loosened material that could be delivered by runoff to nearby stream channels. However, BMPs have been designed and are prescribed for road obliteration treatments. Monitoring has demonstrated that these BMPs are highly effective. Fifty-three PNF road obliteration sites were evaluated for BMP effectiveness from 2007 to 2012 (USDA 2012b). Only one of these evaluations indicated deficient BMP application, at a site where a stream crossing culvert was left in place. While this area was stable at the time of the evaluation, future sedimentation issues could occur if the culvert becomes plugged.

Expected Effects to Soil and Water Resources (No Action)

Vegetation Management Treatments

Soil Quality Effects

Under the No-Action alternative, effective soil cover in the form of fine organic matter and large woody debris can be expected to increase as organic materials accumulate on the forest floor; consequently, erosion potential is currently very low and would continue to be so in the absence of a high severity fire.

The extent and degree of soil compaction is expected to decline slowly over time. This process may take several decades in forested environments (Grigal 2000). Root penetration, extension, and decay, along with the burrowing action of soil dwelling animals would contribute to an increase in soil porosity and decrease compaction.

Water Quality Effects

Under the No-Action alternative, ERA values would slowly decline to a baseline level over time. Surface, ladder, and crown fuels would not be treated on upslope areas or in RCAs.. Fuel treatment activities would not occur, leaving sub-watersheds at a greater risk of wildfire. A future severe wildfire could greatly increase ERA values within and across sub-watersheds.

Mechanical thinning treatments, mechanical fuels treatments and prescribed fire treatments are designed to reduce the likelihood of high intensity wildfire in the treated forest stands. In the event of a severe wildfire in these stands, moderate and high soil burn severities would not only impact soil cover but would also likely generate substantially increased runoff and erosion that would measurably impact water quality in streams within and near the burned area (USDA 2005b).

Road Reconstruction, Maintenance, and Obliteration

Road drainage improvements and decommissioning activities would not occur under no-action alternatives. Deferred maintenance issues of the road system, and the absence of treatment for SEPES road sites would continue to pose risks to water quality. Non-system roads and trails, as well as unneeded NFS roads, would not be obliterated or treated, likely leaving untreated erosion sites that impact water quality in nearby streams.

Monitoring

Project-specific monitoring plans for soil and water resources are typically prepared for PNF projects to verify the effects predicted in this paper and, if necessary, to adjust operations during implementation.

Forest Service Manual 2550 (USDA 2010a) directs that soil quality monitoring processes are to be used to determine if soil quality conditions and objectives have been achieved. The major objective of soil quality monitoring is to ensure that ecologically sustainable soil management practices are applied. Soil quality monitoring is to be used to validate and refine management decisions. Monitoring information collected allows land managers to determine if land management plan desired conditions are being achieved. The focus of project level monitoring is observation and documentation of the implementation of soil protection prescriptions.

Project-specific soil quality monitoring plans identify planned treatment areas that are of particular concern. For example, for monitoring of effective soil cover, mechanical treatment units located in areas with high or very high erosion hazard rating would be monitored to assure that accelerated soil erosion due to treatment has been prevented. Similarly, steeper treatment units may be identified as having a higher risk of soil displacement. District staff would visit those units during and after mechanical treatments and make ocular estimates of effective soil cover and surface fine organic matter retained, areas of soil displacement caused by project activities, and whether the project standard for retention of large down woody material was achieved. Where deficiencies are observed, consultations would occur with the timber sale administrator or contract administrator to refine the operator’s techniques (e.g. raising the brush rake or piling less material to assure that adequate cover is retained) or to inform future project operations. Beyond the areas of particular concern to soil quality, additional monitoring inspections would occur in a representative sample of other units.

For protection of water quality, CRWQCB General Order No. R5-2017-0061 requires implementation and effectiveness monitoring of the commercial timber projects described in this paper. Implementation monitoring investigates whether BMPs and other project design features (such as stream protection zones) were implemented correctly and in a timely fashion. For example, implementation monitoring investigates whether erosion control measures (e.g. water bars, subsoiling, special ground cover addition) were installed on all skid trails, landings, and temporary roads prior to completion of activities or winter shutdown. Implementation monitoring also documents that road maintenance necessary for control of sedimentation was provided on haul routes prior to completion of activities or winter shutdown.

On Plumas National Forest, implementation monitoring is documented for each treated unit by the timber sale administrator or stewardship contract administrator. A checklist is used, where the sale or contract administrator enters the date that compliance was observed in each treated unit for BMPs associated with layout and erosion control of landings, skid trails, and temporary roads. The administrator also documents the date that required maintenance BMPs for haul roads was accepted, stream channels at skid trail crossings were restored, and required post-harvest subsoiling of landings and skid trails was completed. During summer months, erosion control measures are required to be in place within 15 days of harvest for each completed unit. Temporary erosion control measures are required on incomplete harvest units prior to winter shutdown or any anticipated precipitation events throughout the season and the dates of inspection of temporary erosion control measures are documented.

Effectiveness monitoring for water quality protection on timber projects is a visual evaluation of management measures (BMPs and design features) and infrastructure within the treated project area following the winter and spring runoff period. Effectiveness monitoring is intended to determine the effectiveness of these management measures in protecting water quality and preventing significant sediment discharges to watercourses. Effectiveness is determined based on indirect measures of water quality protection, such as evidence of sediment delivery to channels, and direct observations of erosion, such as damage to streambanks or rilling along skid trails, landings, or road surfaces.

Per the monitoring requirements of CRWQCB General Order No. R5-2017-0061, effectiveness monitoring may be satisfied by completing “Veg A” BMP evaluation forms from the national BMP evaluation protocol developed for the 2012 National BMP Technical Guide. The Veg A evaluation is performed at one randomly selected unit within each of the timber projects that had operations the previous season.

Since 2016, a second method for effectiveness monitoring documentation has been used on Plumas National Forest. As with the national BMP evaluation program, this method also investigates whether erosion control measures on skid trails, landings, temp roads, and haul routes are effective at preventing sediment pollution to adjacent streams. This new documentation differs, however, in that the rigor of documentation is much less than the BMP evaluations. Instead, the Plumas NF effectiveness monitoring protocol strives to spend less time with documentation of a few sites and more time visiting additional sites and answering simple, basic questions of whether sedimentation was observed, the causes of that sedimentation, and the degree and duration of water quality impacts observed. Photos are taken for sites with observed activity-related erosion that impacted water quality.

Both effectiveness monitoring methods chose sites at random from a pool of priority treated units that had high potential for water quality impacts from the timber activities. These treated units are typically those units that are located immediately adjacent to perennial or intermittent streams or have these stream courses running through the unit.

Additionally, CRWQCB General Order No. R5-2017-0061 requires effectiveness monitoring of the Significant Existing or Potential Erosion Sites (SEPES) that were identified for each General Order project. To date, all SEPES locations identified for PNF projects have involved existing or potential sedimentation issues associated with NFS roads or motorized trails. Following treatment of these road or trail locations, BMP effectiveness is primarily evaluated by investigating the stream crossings addressed to evaluate whether instances of diversion potential, flood flow overtopping, and road hydroconnectivity have adequately addressed the potential for sediment delivery to nearby streams stream. Away from stream crossings, evaluation of treated SEPES sites investigates whether significant road surface rilling or cross-drain (dips and ditch relief culverts) erosion has resulted in sediment delivery. The “Road C” evaluation form from the national BMP evaluation protocol may also be used to document BMP effectiveness at treated SEPES sites.

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Typical Design Features for Vegetation Management Projects on Plumas NF

Appendix A to PNF Soil and Water Effects Briefing Paper
Version 1.0
February 26, 2021

The following project design features are protection measures that are typically used on Plumas National Forest (PNF) vegetation management projects to reduce or eliminate detrimental effects to soil and water quality. Integrated design features ensure the project is consistent with PNF standards and guidelines as well as other applicable laws, regulations, and policies. These design features are parameters that will be incorporated into treatments and contracts or agreements, or used to guide Forest Service personnel in conducting implementation. Design features are project specific and incorporated as part of the proposed action in addition to best management practices (BMPs). When a PNF project proposes design features that are less restrictive than those presented here, effects associated with those changes are discussed in the project level NEPA analysis.

<table>
<tr><th colspan="3">Soils and Water Quality</th></tr>
<tr><td>Soils & WQ 1</td><td>RCAs</td><td>Riparian Conservation Areas (RCAs) are composed of wetlands, meadows, lakes, springs, and seasonal and perennial streams and the land adjacent to those features. The table below shows the designated width of the RCAs as determined by measuring on each side of the RCA feature (e.g. edge of the active channel, wet perimeter of the soil, etc.) or riparian vegetation, whichever is greater. Mechanical equipment exclusion zones (EEZs) would be established within RCAs as indicated below.
<table>
<tr><th rowspan="2">Riparian Conservation Area (RCA)</th><th rowspan="2">RCA Designation Width</th><th colspan="2">Equipment Exclusion Zone (EEZ) Minimum Distance</th><th rowspan="2">Burn Pile & Active Ignition Minimum Distance</th></tr>
<tr><th>General Forest</th><th>Aspen & Meadow</th></tr>
<tr><td>Perennial Streams</td><td>300 feet</td><td>50 feet*</td><td>25 feet*</td><td>25 feet*</td></tr>
<tr><td>Intermittent Streams</td><td>150 feet</td><td>50 feet*</td><td>25 feet*</td><td>25 feet*</td></tr>
<tr><td>Ephemeral Streams including other Hydrologic or Topographic Depressions without a Defined Channel</td><td>150 feet</td><td>15 feet</td><td>15 feet</td><td>15 feet</td></tr>
<tr><td>Special Aquatic Features (Reservoirs, Wetlands, Fens, and Springs)</td><td>300 feet</td><td>50 feet*</td><td>25 feet*</td><td>25 feet*</td></tr>
</table>
*Note: EEZs of 82 feet are commonly used on PNF projects for perennial and intermittent streams and special aquatic features when prescribed by the project Wildlife Biologist, usually to protect amphibian habitat for special status species.</td></tr>
<tr><td>Soils & WQ 2</td><td>RCAs</td><td>Mechanical equipment will be permitted within designated Riparian Conservation Areas (RCAs), but would not be allowed to enter the mechanical equipment exclusion zones (EEZs) for the purpose of removing timber.</td></tr>
</table>

Soils & WQ 3	RCAs	Mechanical equipment will be allowed to reach into the RCA's EEZs with the extendable boom arm without disturbing the ground for the purpose of removing timber.
Soils & WQ 4	RCAs	Where mechanical equipment is used to fell timber within RCAs, one-end suspension would be used to remove felled timber where feasible. If one-end suspension is not feasible, endlining would be permitted. Excessive soil displacement (i.e., 'furrowing') caused by endlining would be mitigated or repaired by the operator.
Soils & WQ 5	RCAs	Hand felling and removal of material in a manner that will not cause soil disturbance within the mechanical equipment exclusion zones of the RCAs would be permitted.
Soils & WQ 6	All Activities	Riparian species (aspen, cottonwood, alder, willow, dogwood, etc.) would generally not be cut or removed unless needed for operations and/or safety.
Soils & WQ 7	All Activities	Trees that provide bank stability and/or contribute to channel integrity would not be felled unless they pose a safety risk, in which case they would be felled and left in place.
Soils & WQ 8	RCAs	To minimize soil displacement, no equipment would be permitted to turn around while off a skid trail in a RCA.
Soils & WQ 9	RCAs	Mechanical equipment would be allowed to enter EEZs for the purpose of crossings streams but would be limited and designated by a qualified specialist prior to implementation. Following use of these specified crossings, a qualified specialist would assess the site for potential repair and/or rehabilitation as needed for stream stabilization.
Soils & WQ 10	Skidding	Skid trails will be perpendicular to the stream course within 50 feet of the stream and spacing of skids will generally be no closer than 100 feet center to center, when trails are parallel.
Soils & WQ 11	Skidding	Skid trails within RCAs would require a minimum of 60 percent ground cover between 3-10 in depth following project implementation. Ground cover would consist of slash or organic material (logs, branches chips and duff). Slash would be scattered to resemble a natural appearance similar to the surrounding landscape. Rocks can be included as acceptable ground cover (included in the 60 percent cover).
Soils & WQ 12	All Activities Except Prescribed Burning	Ground cover would be maintained at, or above, an average of 60 percent within the treated units unless a qualified specialist reviews and approves otherwise.
Soils & WQ 13	Skidding	No cut and fill would be allowed for new skid trails within RCAs.
Soils & WQ 14	Skidding	Skidding of trees and other material outside of designated skid trails and temporary roads will not be allowed within RCAs unless a qualified specialist reviews and approves prior to implementation.
Soils & WQ 15	All Activities	Remove woody material generated by project activities, including hand piles, that would inhibit flow and/or potentially create erosional issues within the active channel of the RCA.

Soils & WQ 16	Piling/ Prescribed Burning	No piling of material or active ignition for burning would occur within 82 feet of perennial, intermittent and special aquatic features unless surveyed and approved upon by Wildlife Biologist to allow for a reduced buffer of 25'. Burn piles should be burned prior to commencement of underburning activities.
Soils & WQ 17	Prescribed Burning	Fire would be allowed to creep into non-ignition areas if fuels naturally carry them. Retain at least 90% of coarse woody debris and leave 50-75% of the ground unburned within the non-ignition areas of the RCAs. Burned areas within the non-ignition areas should appear intermittent and mosaic in pattern and not concentrated in underburning activities.
Soils & WQ 18	Meadow Treatments	Boles greater than 10 inches DBH will be felled and left within the meadow as large down woody debris, provided that appropriate ground fuel loadings are not exceeded.
Soils & WQ 19	Meadow Treatment	No landings and temporary roads would be allowed within meadows. If skid trails are needed in meadows, they would be limited and placed in areas agreed upon by a qualified specialist. After implementation, skid trails in meadows would be evaluated by a qualified specialist for detrimental compaction and soil disturbance. Locations that need repair would be remediated with an appropriate technique(s) such as subsoiling, scarification, spreading of native seed, and/or mulching with woody debris or certified weed-free straw.
Soils & WQ 20	Meadow Treatment/Piling	Burn piles would be allowed in meadows outside of RCA EEZs but would be no greater than 10 feet wide by 10 feet in height. Additionally, material in piles would be no greater than 10 inches in diameter and piles would cover no more than 30% per acre in the treated meadow. Material greater than 10 inches would be removed from meadow by hand or mechanized equipment outside of RCA EEZs or lopped and scattered and left within the meadow as large woody debris.
Soils & WQ 21	Landings	Landings will not be located within 82 feet of perennial and intermittent streams or special aquatic features (SAFs), unless approved by the District Hydrologist and District Wildlife Biologist. Landings may be allowed within 50 feet of an ephemeral stream or seasonal or dry RCAs if qualified specialist reviews and approves prior to implementation. If landings are approved within 50 feet of a non-perennial stream courses and SAFs, construction will not exceed 20 percent of stream reach and/or SAF including other disturbances.
Soils & WQ 22	Landings	Landings within RCAs would be decommissioned following project implementation and a qualified specialist would evaluate them for compaction or erosion potential. Additional treatment may be recommended such as subsoiling, scarification, spreading of native seed, and/or mulching with woody debris or certified weed-free straw.
Soils & WQ 23	Water Drafting	Abate dust from logging traffic with water selected from water drafting sites that have suitable stream flow and access. When water is scarce, the use alternative sources such as chlorite, sulfonate or other dust abatement materials are allowed outside of the RCA EEZs.
Soils & WQ 24	Water Drafting	New and existing (where modifications or improvements are necessary) water drafting sites would be identified and approved by qualified specialists prior to use.
Soils & WQ 25	Water Drafting	Maintain minimum pool levels during drafting using measurements such as staff gauges, stadia rods, tape measures, etc.

Soils & WQ 26	Water Drafting	Construct water-drafting sites so that oil, diesel fuel, or other spilled pollutants would not enter the stream. Back down ramps would be constructed and or maintained to ensure the streambank stability is maintained and sedimentation is minimized. Rocking, chipping, mulching, or other effective methods are highly recommended to achieve this objective.
Soils & WQ 27	Water Drafting	As necessary, earthen or log berm, straw waffle, certified hay or rice straw bale berms, or other containment structures would be constructed above the bankfull channel water line at the drafting site to protect the streambank.
Soils & WQ 28	Water Drafting	Forest personnel and contractors shall use the Forest Service approved suction strainer (FSM 5161) or other foot vales with screens having openings less than 2mm in size at the end of drafting hoses. The suction strainer shall be inserted close to the substrate in the deepest water available; the suction strainer shall be placed on a shovel, over plastic sheeting, or in a canvas bucket to avoid uptake of substrate or aquatic biota. “Mucked out” debris, bedload sediment, etc. shall be transported to an appropriate disposal site (to be designated) if no apparent site is feasible.
Soils & WQ 29	Borate Application	Plan and monitor Borate compound use in accordance to the label and other relevant requirements. Develop and implement spill contingency plan, properly disposal of containers and cleaning equipment, and restricted use when precipitation is predicted within 24 hours of application. Borate should also not be applied to stumps located within 82 feet of perennial and intermittent streams or special aquatic features and 15 feet from ephemeral stream or seasonal or dry RCAs. Any evidence of spillage and/or misapplication should be reported to the District Watershed or Wildlife staff immediately.
Soils & WQ 30	Mechanical Operations	Mechanical operations would be allowed to occur when the soils are dry to a depth of 8 inches, when the ground is frozen to a depth of 5 inches, uncompacted snow depth is at least 18 inches or compacted snow depth is 8 inches.
Soils & WQ 31	Landings, Temporary Roads, Skid Trails	Unless otherwise agreed upon by the District Watershed staff and sale administrator, landings, skid trail approaches to landings (to a distance of 200 feet), temporary roads and non-system access roads would be subsoiled and/or recontoured. Where available, slash would be spread out across the restored landing, skid trails temporary roads and non-system access roads. Additional seeding and/or mulching may be required based upon District watershed department staff recommendations. Stabilize and strategically place water bars on skid trails, temporary roads and non-system access roads where drainage control issues are evident or expected. After use, these features should be barricade at or near system and non-system road intersections to discourage vehicle traffic from accessing these features. Available natural materials such as rock boulders, logs, root wads and earth should be used where available to replicate a natural setting.
Soils & WQ 32	Machine Piling	Machine piling operations would remove only enough material to accomplish project objectives and would minimize the amount of soil being pushed into burn piles. Duff and litter layers would remain as intact as possible, and the turning of equipment would be minimized. Piles would be constructed as tall as possible, within limits of safety and feasibility. A mixture of fuel sizes in each pile is preferred, avoiding piles of predominately large wood when practicable.

Soils & WQ 33	Landings, Temporary Roads, Skid Trails	To the extent possible, existing landings, temporary roads, and skid trails would be used.
Soils & WQ 34	Landings, Temporary Roads, Skid Trails	Where temporary road or skid trail construction involves cut and fill, the feature would be subsoiled, then re-contoured to match the existing topography. Subsoiling to 18 inches minimum depth would occur on skid trails and 24 inches minimum depth on temporary roads and landings within the same year as harvest unless otherwise agreed to by the District watershed department staff and sale administrator. The subsoiler would be lifted where substantial root and bole damage to larger trees would occur from subsoiling. Skids with slope over 25% may not be approved for subsoiling but would be frequently water barred. Subsoiling would not occur on shallow soils where the displacement of rocks disrupts soil horizons or where there are concerns about the spread of root disease, or damage to tree roots. Subsoiling skid trails, temporary roads, and landings within harvest units on coarse textured soils (USDA texture classes: sands, loamy coarse sands; and coarse sandy loams with less than 5% clay content) that have developed from granitic parent material would generally not be recommended by the District watershed department staff.
Soils & WQ 35	Mechanical Operations	Allow low ground pressure (under 8.0 psi when "unloaded") excavators to work on short pitches (less than 100 feet) of slopes up to 45 percent outside of RCAs. All other mechanical equipment would be restricted to slopes that are equal to or less than 35 percent.
Soils & WQ 36	All Activities	Determine retention levels of large down woody material on an individual project basis. Within westside vegetation types, generally retain an average over the treatment unit of 10-15 tons of large wood per acre. Within eastside vegetation types, generally retain an average of at least three large down logs per acre.
Soils & WQ 37	All Activities	Install and maintain suitable stormwater and erosion control measures such as hay wattles and/or other material to stabilize disturbed areas and waterways before seasonal shutdown of project operations or when severe or successive storms are expected.
Soils & WQ 38	All Activities	Identify locations for equipment refueling and servicing and chemical storage sites and develop a Spill Prevention and Response Plan for these sites.

Analysis of Riparian Conservation Objectives

Appendix B to PNF Soil and Water Effects Briefing Paper

Version 1.0

April 22, 2021

Riparian Conservation Objectives (RCOs) are presented and described in Appendix A of the 2004 ROD for the Sierra Nevada Forest Plan Amendment (USDA 2004). Integral to achievement of these objectives are the 32 prescribed standards and guidelines for riparian conservation areas listed in section D of the ROD. These standards and guides provide requirements for stream crossing structures, coarse woody debris in treated areas, identification of restoration needs, and many other Forest management activities that are not usually applicable to PNF vegetation management or road / motorized trail treatments. An analysis of the RCOs relative to PNF vegetation management or road / motorized trail treatments is presented below.

RCO #1: Ensure that identified beneficial uses for the water body are adequately protected. Identify the specific beneficial uses for the project area, water quality goals from the Regional Basin Plan, and the manner in which the standards and guidelines will protect the beneficial uses.

Existing beneficial uses for PNF surface waters are identified in the Central Valley Water Quality Control Plan for the Sacramento and San Joaquin River Basins (CVRWQCB 1998). This plan identifies beneficial uses for specific water bodies and states that those beneficial uses generally apply to tributary systems of those water bodies. PNF streams generally flow into the forks of Feather River upstream of Lake Oroville or tributaries of North Fork Yuba River. Beneficial uses for these rivers include municipal and domestic water supply, hydropower generation, recreation, freshwater habitat, habitat suitable for fish reproduction and early development, and wildlife habitat. Among these beneficial uses, aquatic habitat is the most sensitive to delivery of fine sediment that could potentially result from land disturbing activities. Effective implementation of US Forest Service BMPs (USDA 2012) and design elements (Appendix A), which including streamside protection zones, would prevent sediment delivery and other contaminants from entering streams that would significantly affect water quality.

RCO #2: Maintain or restore: (1) the geomorphic and biological characteristics of special aquatic features, including lakes, meadows, bogs, fens, wetlands, vernal pools, springs; (2) streams, including in stream flows; and (3) hydrologic connectivity both within and between watersheds to provide for the habitat needs of aquatic-dependent species.

PNF vegetation management treatments are designed to improve the condition and sustainability of meadows and aspen stands within the project areas. Wetland and riparian areas are local and regional centers of biodiversity; providing important habitat for many species of plants and animals. Wet meadows provide processes that maintain water quality, flood attenuation, forage production, watershed functioning, and stream and lakeside stability (Cooper and Merritt 2012). Aspen is a valuable ecological component throughout the western United States; the diversity of understory plants that occur in the filtered light under aspen trees supply critical wildlife habitat, grazing resources, and protection for soil and water. Although aspen is a crucial component of many western landscapes, it may be even more valuable in the Sierra Nevada, where it is less common or extensive than elsewhere (Shepperd et al. 2006). Aspen stands and meadow systems in the project area are declining as juniper and other conifer trees encroach. Conifers limit the availability of nutrients, water, and sunlight and easily outcompete shade-intolerant aspen and meadow vegetation. The loss of meadow vegetation and its dense, shallow roots results in decreased streambank soil stability and a reduction of wildlife habitat quality.

PNF vegetation management and road / motorized trail treatments contain several elements directly aimed at improving aspen stands, meadows, and water quality. National Forest System road improvements at stream crossings and removal or crossings on obliterated non-system roads will improve water quality and stream flows. The removal of vegetation in the project areas may also increase local soil moisture and increase stream flows.

Project design features, including equipment exclusion zones and standard BMPs implemented during harvest activities would prevent sediment delivery to special aquatic features that would significantly affect water and habitat quality.

RCO #3: Ensure a renewable supply of large down logs that: (1) can reach the stream channel and (2) provide suitable habitat within and adjacent to the RCA.

In most forested landscapes large woody debris (LWD) is an essential element of proper functioning channel condition. LWD provides aquatic and terrestrial habitat diversity, structural conditions within channels (e.g., pool formation and fine sediment retention) and may increase channel shading thus reducing water temperatures.

For PNF treatments within aspen stands, it is anticipated that aspen sprouting will be vigorous 3 to 4 years following treatment. Future recruitment of LWD will be made available as existing mature trees, both “leave” conifer and mature aspen, are recruited by the channels, and replaced through anticipated regeneration. Excluding disturbance, aspen trees typically reach maturity at 30 years, and thus may potentially provide more frequent LWD to the channel than do “long-lived” conifers.

For PNF mechanical thinning treatments, equipment exclusion zones along streams and special aquatic features will limit the taking of the larger trees in those areas and will ensure a supply of down logs to the RCAs. Also, the 30-inch upper diameter limit throughout the project area, except for hazard trees, aspen stands, and meadows, will allow recruitment of larger trees on the landscape. Within aspen stands and meadows, conifers could be left standing as snags or could be felled and left as downed wood to contribute to the supply of large down logs.

RCO #4: Ensure that management activities, including fuels reduction actions, within RCAs and Critical Aquatic Refuges enhance or maintain physical and biological characteristics associated with aquatic- and riparian-dependent species.

Project specific design elements are included in project-level NEPA analyses for PNF projects that include Critical Aquatic Refuges, such as the 115,939-acre Critical Habitat Unit for California Red-Legged Frog that exists in in Butte and Plumas counties. The Plumas and Lassen national forests manage about 81 percent of this unit. The physical and biological characteristics associated with aquatic- and riparian-dependent species would be maintained for PNF vegetation management and road / motorized trail treatments through implementation of BMPs and typical design features.

RCO #5: Preserve, restore, or enhance special aquatic features, such as meadows, lakes, ponds, bogs, fens, and wetlands, to provide the ecological conditions and processes needed to recover or enhance the viability of species that rely on these areas.

As described under RCO #2, PNF vegetation management and road / motorized trail treatments are designed to improve the condition and sustainability of meadows and aspen stands within the project area. Special aquatic features are treated to improve ecological conditions within the project areas and processed to recover and enhance the viability of species that rely on these areas. Equipment exclusion zones for these features are designed to protect project soil measures and water quality.

RCO #6: Identify and implement restoration actions to maintain, restore or enhance water quality and maintain, restore, or enhance habitat for riparian and aquatic species.

In addition to aspen and meadow restoration treatments described above, system road improvements and non-system road obliterations will directly improve water quality and habitat for aquatic and riparian species. Additionally, the reduction of excessive forest fuels will decrease the risk of high severity wildfire which has been shown to put water quality and habitat at risk.