Dry Meadow Restoration Project

Hydrology Report and Erosion Control Plan

Sequoia National Forest-
Western Divide Ranger District

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Purpose and Need for Action

The purpose of the Dry Meadow Restoration Project is to restore the severely degraded channel(s) in the meadow. This restoration work is needed to move toward, or achieve, the desired condition of returning the stream channel to its proper hydrological function while decreasing erosion and sedimentation. The Dry Meadow Restoration Project is located in the Greenhorn Mountains of the Western Divide Ranger District, between Alta Sierra and Johnsondale in Tulare County, California, (T24S, R32E, MDB&M).

There is a need to restore Dry Meadow's hydrologic function and connectivity to its floodplain with benefits to timing of flow and water quality, onsite and downstream.

This project proposes five activities (described in more detail following this list) to restore and enhance Dry Meadow and move it toward the desired conditions. These proposed activities are:

- Install plug structures.
- Install rock and vegetation (also known as a valley grade control structure).
- Plant various riparian species in the meadow, including willows and sod.
- Use existing access roads during the implementation of the project.
- Install a temporary fence.

Project implementation will take place when flows are at their lowest and meadow conditions are at their driest, often in late summer to early fall. Equipment use will only be allowed in the meadow during this time period as the meadow is dry enough to support the weight. Water upstream of the project area may need to be diverted to other parts of the meadow during excavation to prevent unnecessary sediment delivery downstream.

To minimize equipment disturbance in the meadow, all equipment routes will remain near the gully and along the meadow margins. The shortest and most durable route from the meadow's margin to the installation points will be identified and used for equipment access throughout the implementation of the project.

All mechanical equipment used in the construction will be cleaned to remove all soil, seed, and plant materials, prior to entering the forest, to prevent the spread of noxious weeds. Refueling of mechanical equipment will take place at least 100 feet from the meadow’s edge. Vehicles used to transport personnel and materials, personnel clothing and footwear, or any other equipment or hand tools used will be cleaned to remove soil, seed, and plant materials before entering the Forest.

Plug Structures (also known as Pond and Plug)

This technique fills (plugs) portions of the existing gully system using material excavated from adjacent portions of the gully (borrow ponds). This eliminates the existing incised channel as a drain to the meadow, inducing groundwater and surface water elevations to rise up to the historic meadow elevation. As the groundwater rises, the borrow ponds fill and remain a ponded water feature in the landscape, similar in appearance to oxbow lakes or relict beaver ponds. Eighteen (18) plugs would be

installed with locations staked prior to implementation. Creation of the plug structure would include removing soil from the sides and bottom of the gully and the surrounding areas and using it to create the plugs. The soil removal would be done in a manner that sculpts the gully in preparation for filling with water as the groundwater levels rise with the restored hydrologic function of the meadow. The borrow ponds would be designed and constructed to have irregular shapes and varying depths that will provide numerous habitats for riparian-dependent species. This process would relocate approximately 26,500 cubic yards of existing soil through the use of mechanical equipment, such as a wheel loaders, track loaders and excavators.

Meadow sod and willows established in the gully bottom will be removed, stockpiled and transplanted to pond edges and plug surfaces. Topsoil from all excavation areas will be stockpiled adjacent to the plugs and used on top of the plugs once constructed.

Valley Grade Control Structure

A valley grade control structure is made of rock and soil and used to anchor the restored elevation of the meadow. For this project, the valley grade control structure will be located downstream of the plug structures, and above the existing culvert under the 24S80 road crossing. An estimated 750 cubic yards of 0.5- 2.0 foot diameter rock would be used to provide armoring at the lower end of the meadow, plugs, and grade control structure. Creation of the grade structure would include removing soil and vegetation from the gully surfaces, using it to mix with rock to create the structure.

Revegetation

Rooted willows (large enough to have established roots) would be planted along the stream banks and around borrow ponds. The willows and transplanted vegetation used with rock is intended to assist in stabilizing the existing bank and trap sediment. Stockpiled sod and willows will be placed on the plug structures. Large conifers outside the meadow will not be cut as part of this project unless they pose a safety hazard or limit equipment access during implementation of the project.

Access

Mechanical equipment would access the meadow using existing non-system road features or temporary access routes from Forest Service Road 24S80. These routes would be temporarily opened for the purpose of moving equipment and materials to the meadow to complete the restoration project.

Once the project is completed, all routes will be closed and the proper drainage and structures restored to minimize the potential for future erosion.

Project Performance Monitoring

Monitoring is a means to determine if conditions in Dry Meadow are meeting or moving toward the desired conditions. Extensive surveys have been conducted to document the existing conditions within the meadow and stream channel. Additional monitoring would take place within one year after the project is implemented and annually for five years to document the implementation and effectiveness of the project. This monitoring would include sedimentation, planted vegetation success or mortality, noxious weeds, the integrity of the installed structures, and the absence or presence of new headcuts.

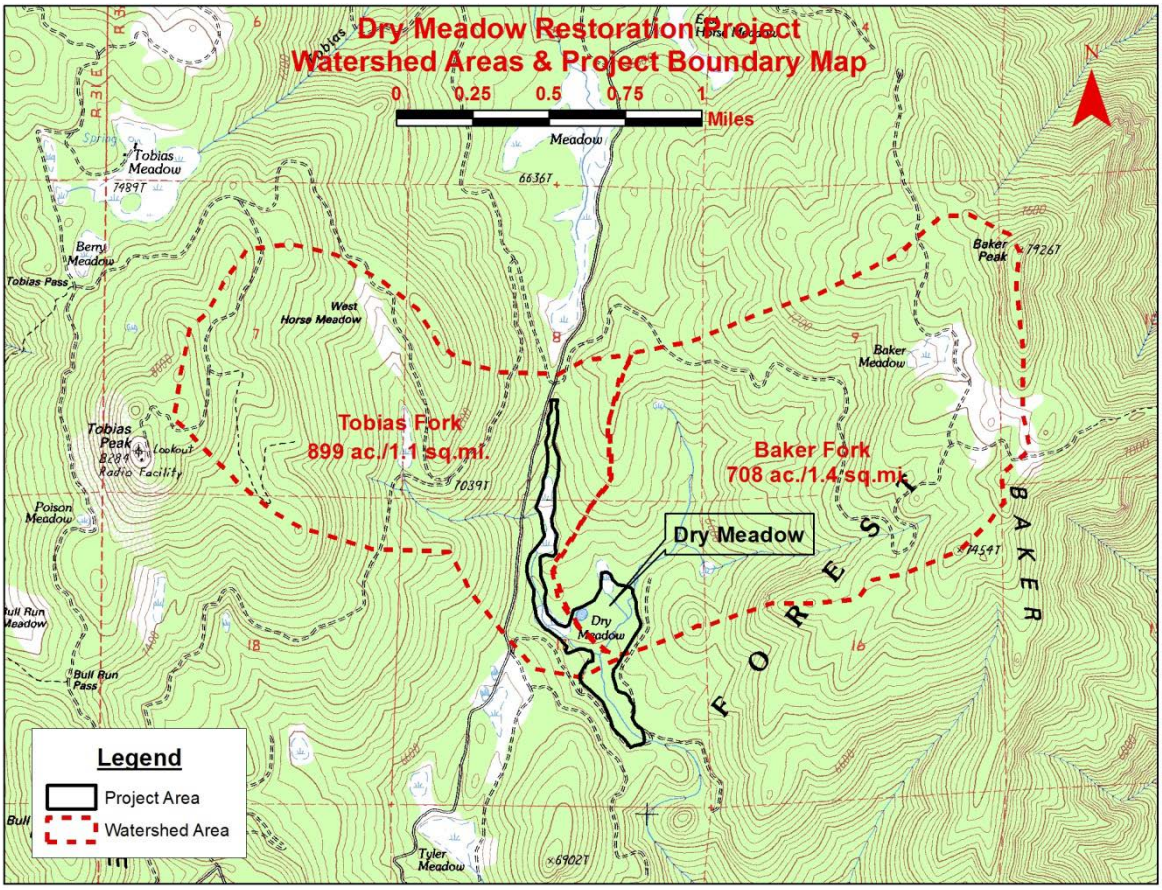
Other monitoring of expected ecosystem benefits is further described below in Project Effectiveness Monitoring and Appendices B &C.

Affected Environment

Historically, Dry Meadow was used for livestock grazing, and from the 1940's – 50's sporadically used as a sawmill site. The project area is within the Cedar Fire burn (2016). This was the second stand-replacing fire to affect the watershed since 1990.

The Dry Meadow Restoration Project is within the Bull Run Creek watershed (6th field HUC[1], #180300010604). Known beneficial uses include municipal, recreation, coldwater fisheries, wildlife, spawning, and freshwater. The only subwatershed of the Bull Run Creek watershed affected by this project is the Dry Meadow Creek subwatershed (7th field HUC, 9D-A) which encompasses 2,041 acres.

The Dry Meadow Creek subwatershed ranges from 8,284 feet to 6,400 feet in elevation. The restoration project is located in Dry Meadow at the confluence of the "Tobias" and "Baker" forks of Dry Meadow Creek (see Map 1). The two forks drain a watershed area of 1,607 acres. The project encompasses approximately 65 acres, or 0.3% of the Dry Meadow Creek subwatershed (Table 1).



Map 1 – Project map displaying the project and subwatershed boundaries.

[1] Hydrologic Unit Codes (HUCs) were designated by the United States Geological Service (USGS) in conjunction with other agency input.

Table 1. Affected HUC 7 Subwatershed in the Middle Kern River Basin, Tulare-Buena Vista Lake Hydrologic Province, with percentage of drainage affected based on acreage

Subwatershed Number	Subwatershed Name	Subwatershed Sensitivity[2]	Miles of Stream[3]	Subwatershed Acres[4]	Project Acres	Percent Affected
9DA	Dry Meadow Creek	Low	4.63	2041	65	0.3%

Dry Meadow Creek (9DA)

Dry Meadow Creek subwatershed flows south into Bull Run Creek. Dry Meadow is located near the center of the subwatershed. West Horse Meadow is located to the northwest of Dry Meadow near the western headwaters of the subwatershed. Baker Meadow is also located above Dry Meadow to the northeast near Baker Peak. Approximately 4.63 miles of stream exist within the subwatershed. Perennial flow consists of 3.88 miles while the intermittent flow consists of 0.75 miles.

Several roads exist within the subwatershed. These roads are 23S16, 24S02, 24S08, 24S24, 24S24A, 24S25, 24S34, 24S34A, 24S37, 24S45, 24S45A, 24S77, 24S80, 24S80B, 24S80C, 24S83, and 24S83A. Total mileage for these roads is approximately 13.1 miles. There are no trails within the subwatershed.

Dry Meadow Creek subwatershed contains the headwaters of Bull Run Creek. Dry Meadow is at the headwaters and is supplied by one perennial steam, from the northwest near West Horse Meadow; and, one seasonal stream from Baker Meadow to the east. An intermittent flow enters Dry Meadow from the North.

Dry Meadow received restoration attempts in the early 1990s. Headcuts had migrated up from the culvert, located at the base of the meadow, and impacted both channels near the meadow's center. Restoration efforts consisted of installing check dams and felling of trees to change the flow patterns and prevent further erosion. These efforts were generally not successful and remnants of these restoration attempts can be seen today.

Existing Condition

Design level stream surveys have been completed throughout Dry Meadow. The steeper headwaters of Dry Meadow Creek are naturally-stable, moderate gradient, boulder/bedrock channel types. Within Dry Meadow, Dry Meadow Creek shifts to a lower gradient, where the stream channel historically changed to a well vegetated, stable-sensitive, low gradient, gravel/sand dominated channel. Historic land use impacts adversely affected the channel stability, resulting in severe channel incision. The remaining portion of Dry Meadow Creek, below Dry Meadow, downstream of the 24S80 road crossing, becomes significantly steeper. The stream channel shifts to a very high gradient, entrenched, naturally stable, boulder dominated, A1a+ for the remainder of the subwatershed.

[2] Determined by the Sequoia National Forest's Cumulative Water Effects model using data collected from soil, topography, climate, geology, vegetation, and channel stability surveys.

[3] Miles are approximate.

[4] Acres are approximate.

Dry Meadow Creek, and its Tobias and Baker tributaries, have been eroding as a result of channel modification for the historic sawmill, road building and historic grazing. Active headcuts are present in both the Tobias and Baker tributary portions of Dry Meadow. Photos 1 & 2 below show the movement of the headcut since 2015 relative to the grass clump denoted by arrows. The Tobias tributary has eroded down an average of 6.8 feet, and 71 feet wide. The Baker tributary has eroded down an average of 5.9 feet, and 89 feet wide. Dry Meadow Creek downstream of the confluence of the Tobias and Baker tributaries has eroded down an average of 6.2 feet, and 62 feet wide. The total estimated sediment lost from within the gully is approximately 52,850 cubic yards[5]. The increased sediment and erosion continues to affect water quality (non-point source pollution) and downstream aquatic resources, including fish habitat.

As a result of this erosion, most of Dry Meadow no longer functions hydrologically, inhibiting floodwaters from accessing the floodplain. This dewatering has caused meadow vegetation composition to shift from traditional moist meadow species to dryer upland meadow vegetation types. Conifers and invasive species such as cheat grass grow or encroach into the meadow. Habitat for water-dependent or water-associated (aquatic) species is currently restricted at the site and threatens upstream resources.

Dry Meadow was extensively surveyed in 2015 by Plumas Corporation for the purposes of developing a restoration design. The design level surveys quantified existing conditions, and identified mechanisms of erosion, as well as features conducive to restoration. A typical cross-section is included as Figures 1a & 1b below.

Photo 1 – Active headcut on the Baker tributary within the gully in Dry Meadow (looking upstream) in 2015

Photo 2 – Active headcut on the Baker tributary within the gully in Dry Meadow (looking upstream) in 2017.

[5] Twenty (20) cubic yards is approximately the volume of a large, tractor-trailer dump truck. Sediment lost from the meadow system to date can be described as about 2,640 dump truck loads.

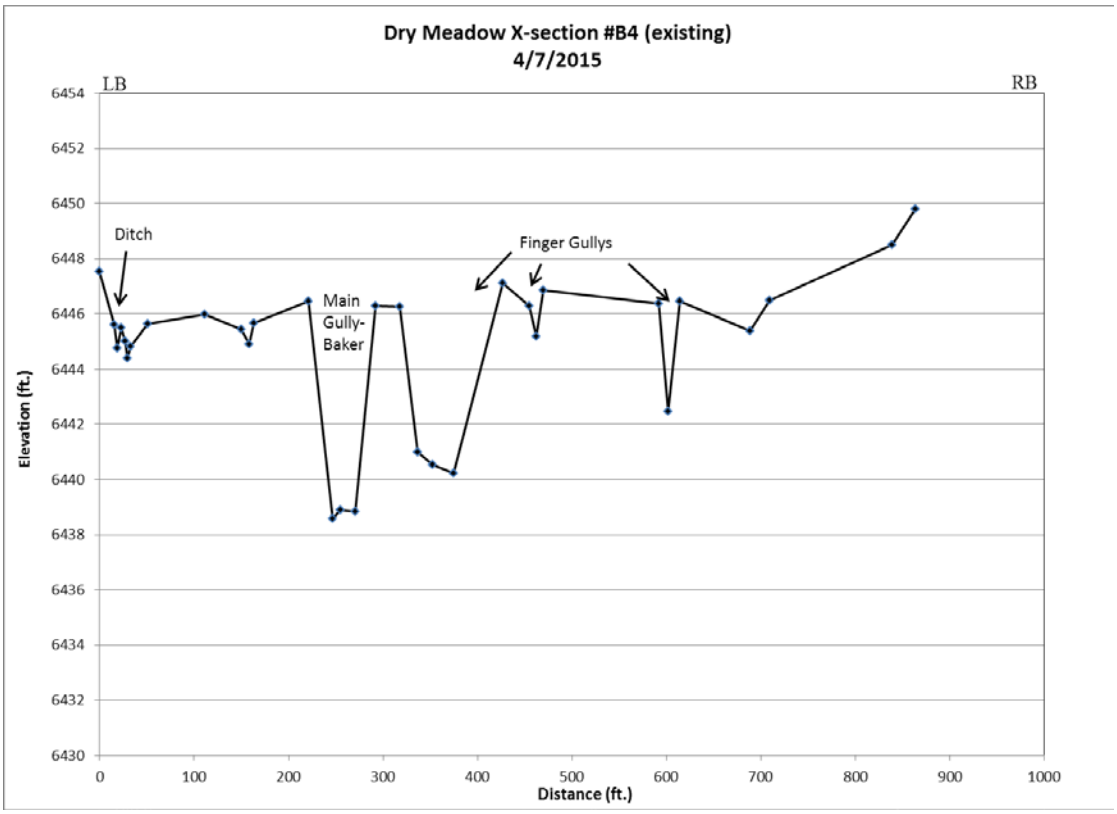


Figure 1a – Representative existing cross section of the Baker tributary downstream of the active headcut in Photo 1.

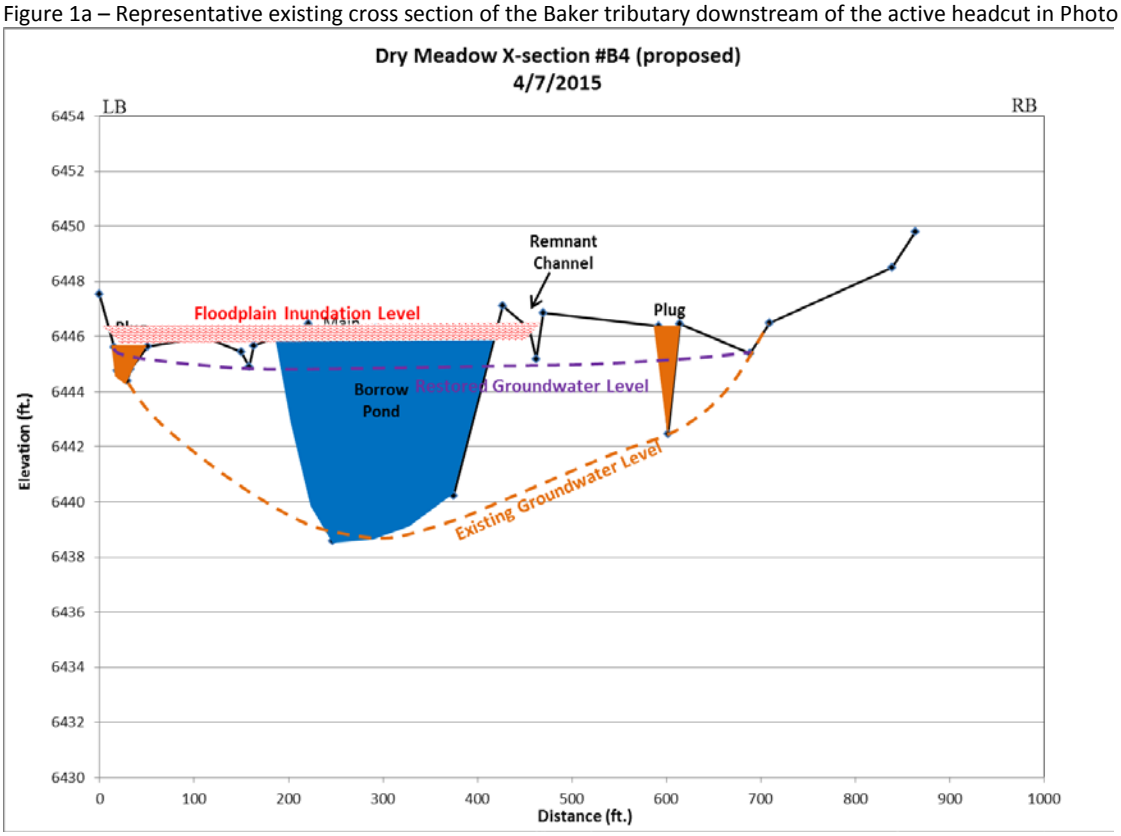


Figure 1b – Representative proposed cross section of the Baker tributary downstream of the active headcut in Photo 1.

Cumulative Watershed Effects for Existing Condition

Past and present activities within the Dry Meadow Creek subwatershed include grazing, wildfire, prescribed burning, timber harvest, road construction, reconstruction and maintenance, trail construction and maintenance, and recreational use. Prior to the 2016 Cedar Fire, The Sequoia National Forest Cumulative Watershed Effects (CWE) Model was used to determine existing condition of the entire Tobias Creek watershed, including the Dry Creek subwatershed. Table 2 displays the Dry Meadow Creek subwatershed, equivalent roaded acres (ERAs) available, ERAs used from past disturbances/projects, and what ERAs remained before the subwatershed threshold of concern (TOC)[6] would have been reached. The Cedar Fire likely pushed the equivalent roaded acres well above the threshold of concern. The Cumulative Watershed Effects Model has not been re-run to quantify how far above the TOC the subwatershed is as of 2018.

Table 2 – Dry Meadow Creek Subwatershed, Equivalent Roaded Acres, and Percent Used

Subwatershed	Subwatershed Name	ERA's Available	ERA's Used to Date	ERA's Remaining	Percent TOC
9DA	Dry Meadow Creek	61.14	40.27	20.87	65.86

Environmental Consequences

Dry Meadow Restoration Project contains several components; installation of plug structures, creation of ponds, a valley grade control structure, re-vegetation, temporary fence construction, and temporary reopening and closing of roads or access routes. Any of these could have potential direct and indirect effects on hydrologic resources. Concerns with these proposed actions include: increased erosion causing changes to water quality, hydrologic connectivity/elevation of the water table, increased sedimentation/ deposition, and bank stability. All of these concerns affect meadow and aquatic species habitats and water quality.

Effects by Alternative

Alternative 1 – No Action

Direct and Indirect Effects

Alternative 1 will allow the headcuts to erode further into Dry Meadow. This would continue to lower the water table, create excess erosion and sedimentation (negatively affecting water quality and seasonal timing of flows), increase stream channel instability, fill pools, and increase the loss of aquatic species habitat. These conditions have allowed the delivery of approximately 52,850 cubic yards of sediment over the last 120 years (approximately 440 cubic yards per year). Smaller headcuts developing along the sides of the gully would also continue to grow in size.

Cumulative Effects

Cumulative effects analysis using the Sequoia National Forest Cumulative Watershed Effects (CWE) model will have the same results discussed above under Existing Condition. No management action will

[6] The Threshold of Concern (TOC) is expressed as a percentage (% of ERA's used). The higher the percentage means the greater the possibility of a management action negatively impacting water quality within a subwatershed.

occur therefore Thresholds of Concern (TOC) for the watershed would remain the same, as well as the Equivalent Roaded Acres. As the watershed recovers from the 2016 Cedar Fire, the Equivalent Roaded Acres are expected to return to pre-fire conditions (in approximately 5 years). No Action would not alter this expected trajectory.

Alternative 2 - Proposed Action

Direct and Indirect Effects

Alternative 2 would allow for restoration efforts to occur within Dry Meadow. Restoration efforts include: the creation of ponds and plugs, a valley grade control structure, re-vegetation efforts, re-using an old access road, and installing a temporary fence. All restoration efforts, or project activities, would occur in late summer or early fall[7] when stream flow is lowest in order to minimize the potential for sediment transport into the creek. Project activities would result in short term ground disturbance that could allow for transportation of loosened soils if left exposed during a natural rain event. However, an erosion control plan for the project would be implemented as part of the Best Management Practices. The erosion control plan effectively limits and mitigates erosion and sedimentation from these short term ground-disturbing activities. Detailed information regarding the erosion control plan can be read in Appendix A of this document.

Plugs and Ponds and a Valley Grade Control Structure

Creation of plug and pond structures has the potential for both positive and negative impacts to occur within Dry Meadow. Reconstruction work includes elimination of several headcuts which are promoting the loss of meadow function and habitat. Plug and pond installation will restore the hydrologic base level of the meadow, which will allow for the water table to rise, increase water storage, reduce sediment transport back to natural background rates, and stop headcut migration further into the meadow. Loose and bare soil created by the construction of the plugs and ponds will have planted willows, native sod and/or seed planted to increase stability of the structures and filter suspended sediment under normal runoff flows. It is expected that within one to three years, the beneficial effects of channel/meadow connectivity should be visible in the form of standing water across the lower portion of the meadow for longer periods of time each summer, and regeneration of more riparian vegetation, especially in the areas adjacent to and near the gully. The borrow sites for the plug construction would remain on the landscape as ponded water. Water elevations in the ponds would seasonally rise and fall as a reflection of groundwater elevation.

The most downstream plug is a component of the valley grade control structure. This structure is built to create added stability to the plugs above. Dry Meadow Creek would flow over and down the structure. In order to prevent erosion along the structure, a riffle-pool channel system would be built. The riffle-pool system is designed to dissipate the stream flow's energy, prevent erosion and provide for aquatic organism passage. Rock would be brought in to build the riffle-pool system and accommodate the stream flow. Remaining bare soil created during construction would be re-vegetated with willows, native sod and/or seed to prevent erosion and further stabilize the structure. Figure 2 displays where the plug and pond structures would be installed as well as the valley grade control structure.

[7] Typically in August or September.

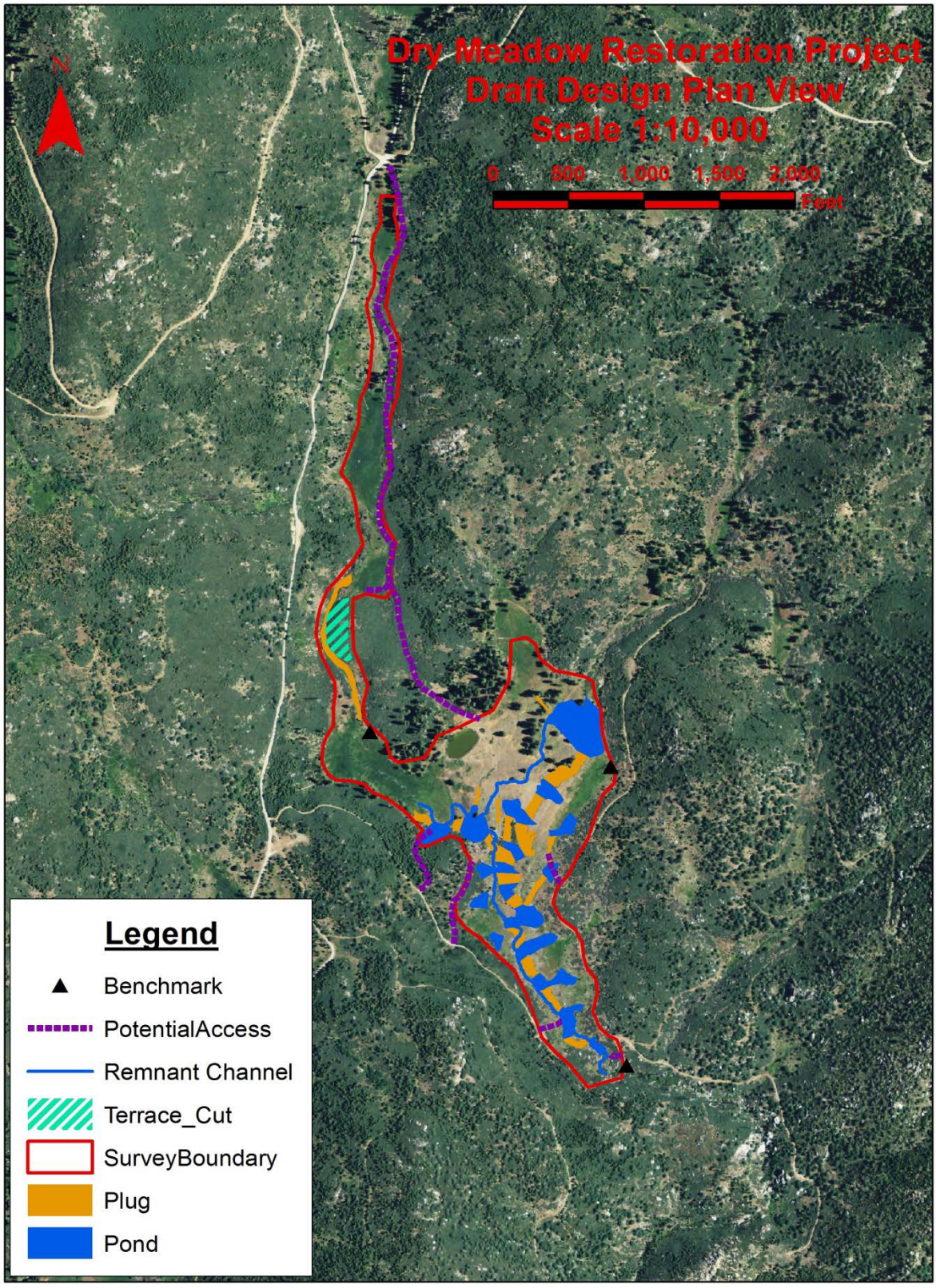


Figure 2 – Dry Meadow Restoration Plan layout for Pond, Plug, Access Routes and Valley Grade Control Structure

Project equipment utilized for creation of these structures may negatively affect the meadow. The equipment could contribute to soil compaction, loss of meadow vegetation, and creation of loose, bare top soil. When spring runoff flows over the project area, excessive erosion could occur as a result. However, minimizing these potential effects will be accomplished by implementation of the Erosion Control Plan (BMP 2.13) and other BMPs. Additional measures to minimize these effects from occurring include limiting travel corridors, use of tracked equipment when possible to displace the weight, and implementing the project under the driest soil conditions.

Water temperatures during and after implementation of the project are not expected to be negatively affected. Implementation would occur when the lowest amount of water flows through Dry Meadow. Restoration efforts will increase water depth in the vicinity of ponds, which is expected to provide cool-water refugia for aquatic species. The reconnection of the channel to the meadow floodplain is expected to improve meadow vegetative conditions, which would increase shade. The improved groundwater interaction with surface flow on the floodplain is also expected to improve overall water temperatures. Monitoring of similar projects has shown that this type of restoration is generally beneficial to water temperatures.

Road Access and Staging Area

Reopening and use of the access road during project implementation is anticipated to provide little to no increase in soil transport that would impact water quality or meadow habitat. Where needed, water bars and/or rolling dips would be installed to prevent erosion. Dust abatement practices would also be followed as necessary during implementation. The road would be closed and restored to pre-project condition once the project is complete.

Servicing and refueling of equipment would follow Best Management Practices to eliminate concerns for water contamination. Any servicing or refueling operations would be located a minimum of 100 feet away from the meadows edge. Site specific locations for equipment fueling will be identified during project layout. Refueling and servicing would occur only at these locations. A non-porous mat would be used at the serving/refueling area. Vehicles and heavy machinery needed for restoration purposes would be staged within the project area, but not within the meadow.

Temporary Fence

Once the project is completed, a temporary fence will be installed around the restoration site. This measure would exclude livestock from impacting the restoration site. The fence would remain in place for two to three years, or until stabilizing vegetation becomes established. Fence installation would present only small localized disturbance to the area where posts are installed. There is no erosion potential associated with installing a temporary fence. The fence would be aligned so that cattle trailing would not be encouraged in sensitive areas.

Project Effects Monitoring

The Dry Meadow Restoration Project will have a significant monitoring effort for both hydrological and biological effects. Hydrologic monitoring instrumentation was installed and began operating in the summer of 2017. The monitoring entails continuous recording of streamflow and water temperature,

below the project; monthly measurement of groundwater wells within the project footprint; and quarterly sampling of ground and surface waters for stable isotope ratios. Monitoring of this project is part of the Sierra Meadow Hydrology Monitoring (SMHM) project, and is being funded under a separate contract between Plumas Corporation and the California Wildlife Conservation Board's Streamflow Enhancement Program. The hydrologic data collected for Dry Meadow will also be included in a larger dataset from restored meadows throughout the Sierra Nevada. SMHM design and operation is more fully described in Appendix B.

The biological monitoring will be consistent and integrated with similar efforts on numerous restored meadows throughout the Sierra Nevada. A collaboratively developed monitoring plan called Wetland and Riparian Area Monitoring Plan (WRAMP) would be applied via implementation funding. The WRAMP structure is detailed in Appendix C. The specific metrics to be monitored in the Dry Meadow Restoration Project have not yet been determined.

Cumulative Effects

Cumulative effects analysis for this action includes restoration activities such as mechanical equipment disturbance and streambed alteration. As previously discussed, these disturbances have the potential to contribute increases in sediment transport, soil compaction, and to negatively affect water quality. However, these disturbances would be short term and greatly minimized by using Best Management Practices. The long term cumulative effects are expected to be beneficial, and include reducing sedimentation back to natural levels, restoring Dry Meadow's hydrologic function and connectivity to its floodplain, and improving riparian and aquatic habitats.

The Cumulative Watershed Effects (CWE) Threshold of Concern (TOC) and Equivalent Roaded Acre values would not change from that stated in Alternative 1, as the project entails no additional roads, and would restore temporary access routes to pre-project conditions. Channel/floodplain re-connection and invigorated riparian vegetation is expected to improve infiltration into the floodplain aquifer. The expected overall impact to the subwatershed would be a subtle shift back to a more stable and natural hydrologic function. As a result there will be no measureable negative cumulative effects from implementing Alternative 2 of the Dry Meadow Restoration Project.

Summary and Conclusion of Alternatives

In summary, Alternative 1 provides the least amount of hydrologic benefits. Allowing the headcut to continue eroding will negatively affect water quality and increase the loss of aquatic species habitat. Implementing Alternative 2 could have short term disturbances to water quality and aquatic habitat. However, mitigations measures would minimize the short term disturbances created during project implementation. Upon completing the project, the long term benefits to water quality and aquatic habitat outweigh the short term disturbances.

Law, Regulation, and Policy applicable to Hydrology

Laws, regulation and policy applicable to managing soil and water quality include the Clean Water Act and Sierra Nevada Forest Plan Amendment (SNFPA) 2004. Applicable management requirements and constraints provided by the SNFPA are:

☒ Aquatic Management Strategy (AMS) goals and objectives
☒ Riparian Conservation Areas
☒ Riparian Conservation Objectives (RCO) Analysis standards and guidelines
☐ Critical Aquatic Refuges (CAR)
☐ Long-term strategy for anadromous fish-producing watersheds

Critical Aquatic Refuges does not apply as the project is not associated with a CAR. Long-term strategy for anadromous fish-producing watersheds applies only to the Lassen National Forest and is therefore not applicable to this project area.

Riparian Conservation Objectives Analysis

The Riparian Conservation Objectives (RCOs) listed in the Sierra National Forest Plan Amendment 2004 was reviewed for applicability to the project. All RCOs apply to the Tobias Ecosystem Restoration Project. Each RCO listed has a brief overall objective to achieve when completing the RCO analysis.

☒ 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.

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

☒ 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.

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

☒ 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.

☒ 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.

Each RCO listed above contains several guidelines. These guidelines may or may not apply to the project being proposed. Those that apply to the project insure management activities are meeting the overall Riparian Conservation Objective and, ultimately, the Aquatic Management Strategy. The Dry Meadow Restoration Project meets all the Riparian Conservations Objectives applicable to the project and further detailed analysis can be read in Appendix B of this report.

Best Management Practices

The beneficial uses of water in the project watershed include cold water habitat and wildlife habitat. Proper BMP implementation and effectiveness monitoring would serve to protect identified beneficial uses. Forest management and associated road building in the steep rugged terrain of forested mountains has long been recognized as sources of non-point water quality pollution. Non-point pollution is not, by definition, controllable through conventional treatment means. Non-point pollution is controlled by containing the pollutant at its source, thereby precluding delivery to surface water. Sections 208 and 319 of the Federal Clean Water Act, as amended, acknowledge land treatment measures as being an effective means of controlling non-point sources of water pollution and emphasize their development.

Working cooperatively with the California State Water Resources Control Board, the Forest Service developed and documented non-point pollution control measures applicable to National Forest System lands. These measures were termed "Best Management Practices" (BMPs). BMP control measures are designed to accommodate site specific conditions. They are tailor-made to account for the complexity and physical and biological variability of the natural environment. The implementation of BMP is the performance standard against which the success of the Forest Service's non-point pollution water quality management efforts is judged.

The Clean Water Act provided the initial test of effectiveness of the Forest Service non-point pollution control measures where it required the evaluation of the practices by the regulatory agencies (State Board and EPA) and the certification and approval of the practices as the "BEST" measures for control. Another test of BMP effectiveness is the capability to custom fit them to a site-specific condition where non-point pollution potential exists. The Forest Service BMPs are flexible in that they are tailor-made to account for diverse combinations of physical and biological environmental circumstances. A final test of the effectiveness of the Forest Service BMP is their demonstrated ability to protect the beneficial uses of the surface waters in the State.

Best Management Practices, as described in this document have been effective in protecting beneficial uses within the affected watersheds. These practices have been applied in other projects within the Sequoia National Forest. Where proper implementation has occurred there have not been any substantive adverse impacts to cold water fisheries habitat conditions or primary contact recreation (etc.) use of the surface waters. The practices specified herein are expected to be equally effective in maintaining the identified beneficial uses.

The following management requirements are designed to address the watershed management concerns. Most are BMPs from the Forest Service publication "Water Quality Management Handbook[8]" (USDA Forest Service, 2011). All applicable water quality BMPs shall be implemented. The implementation phase of the BMPs occur during and after a project is completed, but before the winter season. BMP monitoring of the project is done one year later after the project has experienced one rainy season.

To meet this standard and guideline, the following BMPs would be implemented and tailored to meet site specific needs. The following BMPs are associated with Dry Meadow Restoration Project.

BMP 2.13 Erosion Control Plan:

Implementation of this BMP is required since the restoration site is greater than 50 square feet located in a riparian area and wheeled or tracked equipment will be utilized for construction. This plan is further discussed in detail under Appendix A of this report.

BMP 2.4 Road Maintenance and Operations:

This BMP ensures water-quality protection by providing adequate and appropriate maintenance and by controlling road use and operations. BMP 2.4 would be implemented through the development of an erosion control plan (BMP 2.13), maintenance plan, and planning for emergency interim erosion controls along the road. The access road would be maintained to dissipate intercepted water in a uniform manner by installing rolling dips if needed. Only authorized personnel will be allowed use of this road during implementation. Once the project is complete, this road will be closed and restored to reduce the potential for future erosion and concentrated runoff.

BMP 2.5 Water Source Development and Utilization:

The objective of this BMP applies to dust abatement and other management activities requiring the use of water while protecting and maintaining water quality. Dust abatement may be necessary on the access route to Dry Meadow. Additionally, water will be needed to assist in construction of structures. Approved drafting sites designated by the district hydrologist would be utilized.

BMP 2.11 Equipment Refueling and Servicing:

This BMP prevents pollutants such as fuels, lubricants, bitumens and other harmful materials from being discharged into or near rivers, streams and impoundments, or into natural or man-made channels. Servicing and refueling activities will be located a minimum of 100 feet away from the meadow edge. Site specific locations for equipment fueling will be identified prior to or during project implementation. A non-porous mat or equivalent would be used for the refueling at the staging area.

[8] *R5 FSH 2509.22 – Soil and Water Conservation Handbook, Chapter 10 – Water Quality Management Handbook.* Effective as of 12-5-2011.

BMP 7.1 Watershed Restoration:

The objective of this BMP is to repair degraded watershed conditions and improve water quality and soil stability. Restoration measures described herein reflect state-of-the-art techniques and have been chosen to custom fit the unique hydrologic, physical, biological and climatic characteristics of Dry Meadow. The proposed design for restoration of Dry Meadow restores the meadow condition and hydrologic function to the watershed as described in this document.

BMP 7.4 Forest and Hazardous Substance Spill Prevention Control and Countermeasure (SPCC) Plan:

The objective of this BMP is to prevent contamination of waters from accidental spills. BMP 7.4 will be implemented when a total oil product at a site exceeds 1,320 gallons or any single container exceeds 660 gallons. The forest has a SPCC spill plan designed to guide the emergency response to spills during construction. Please refer to the SPCC for further information regarding pollutants and their associated spill plan design for this project.

BMP 7.6 Water Quality Monitoring:

The objective of this BMP is to collect representative water data to determine base line conditions for comparison to established water quality standards, which are related to beneficial uses for that particular watershed. This BMP is implemented through establishment of a Sierra Meadow Hydrology Monitoring (SMHM) station prior to project implementation to establish a pre-project condition. The station is currently collecting pre-project baseline data.

BMP 7.8 Cumulative Off-site Watershed Effect:

This BMP serves to protect the identified beneficial uses of water from the combined effects of multiple management activities. Beneficial uses and effects have been document in the Hydrology report. Impacts of past and present activities including impacts of the proposed future management activities were considered in the evaluation of the analysis area. Results of the analysis are summarized in this document.

References

Management Agency Agreement between the State Water Resources Control Board, State of California and the Forest Service, United States Department of Agriculture, March 1981.

USDA Forest Service. 2011. Water Quality Management Handbook. Pacific Southwest Region, Vallejo, California.

Appendix A

Erosion Control Plan

The Erosion Control Plan provides detailed considerations and mitigations applicable to the completion of the project to reduce erosion. The plan is broken up into three sections which are pre-project, project implementation, and post project. These sections will contain information regarding, but not limited to, mitigations measures, anticipated ground-disturbing activities, maps, and waste management strategies. For example, information for a section related to closing the access road would be discussed within the post project section and not the pre-project section.

Pre-Project Implementation

Prior to implementing the Dry Meadow Restoration Project, several attributes of the Erosion Control Plan must be in place. These include mitigations measures developed through project analysis, requirements to meet Best Management Practices (BMP), project plans and specifications, and required State and Federal permits.

Ground-disturbing activities are expected to occur as a result of the Dry Meadow Restoration Project. There are a total of five anticipated activities. The first is opening an old access road on the west side of the project which would require removal of debris and brush along the road bed. The second is closing the old access road after project completion. The third is to construct a series of pond and plug structures. Fourth is to construct one valley grade control structure. Fifth is to plant willows and onsite sod and or native seed if available within the meadow.

Implementation would occur during the driest time of the year for the meadow, typically August thru October. The driest time of the year was chosen to avoid and or minimize effects on meadow and soil resources and reduce the potential for increased erosion. Work would not occur during wet weather.

Dust abatement may be required along the old access road and staging area. Gravel would be added to the access road to minimize dust. If necessary, a designated drafting site would be used if additional dust abatement is required. Any water source utilized would follow BMP 2.5.

Best Management Practices have been determined for the Dry Meadow Restoration Project and are discussed in detail in the Hydrology report. A summary of what is applicable to the project is as follows: BMP 2.13 – Erosion Control Plan, BMP 2.4 – Road Maintenance and Operations, BMP 2.5 – Water Source Development and Utilization, BMP 2.11 – Equipment Refueling and Servicing, BMP 7.1 – Watershed Restoration, BMP 7.4 – Forest and Hazardous Substance Spill Prevention Control and Countermeasure (SPCC) Plan, BMP 7.6 – Water Quality Monitoring, and BMP 7.8 – Cumulative Off-site Watershed Effect. Some of these BMPs are required during the planning stages or pre-project stage:

- As required by BMP 2.13 – Erosion Control Plan, a plan to control erosion is required prior to project implementation. This document addresses this BMP requirement.
- As required by BMP 7.6 – Water Quality Monitoring, baseline conditions are being established in 2017 within and outside of Dry Meadow. Baseline conditions are being collected per Sierra Meadow Hydrology Monitoring protocols.

There are two permits required from other agencies prior to implementation. One is a Clean Water Act (CWA) Section 404 dredge and fill permit from the Army Corps of Engineers. The other is a CWA Section 401 Water Quality Certification from the California Central Valley Water Quality Control Board. Both of these must be obtained in order to proceed with the project.

Flagging will be used to identify the project perimeter, avoidance areas, location of the access road and staging area, fuel storage and equipment servicing locations, and access into the meadow prior to or during implementation. Pink flagging will designate the project boundary. Orange will be used to show the path of the access road to the staging area. Red and blue combo are areas to avoid either for archeological or resource reasons. Yellow and black combo will be used for fuels and equipment. White and pink combination will be used for staging restoration materials (i.e. rocks for the structures). Contact personnel on the Dry Meadow Restoration Project are listed below. Their full name, position, and contact phone numbers are included.

Name	Position	Phone Number
Don Kozlowski	District Hydrologist	559-539-2607 x2282
Nina Hemphill	Forest Aquatic Biologist	559-784-1500 x1161
TBD	Contracting Officer Representative	TBD
Timothy Patrick?	Civil Engineer	559-784-1500 x1321
Eric LaPrice	District Ranger	559-539-2607

Project Implementation

The Project Implementation portion of the Erosion Control Plan discusses the when, where, why, and how the project activities will be implemented while minimizing or preventing erosion. Project activities during implementation are opening the old access road, creating ponds and plugs, creating a valley grade control structure, and planting willows and onsite sod and or native seed if available within the meadow.

Opening the access road would be the first ground disturbing activity. The road would only be accessible to authorized personnel. Brush and debris will be removed along the road. BMP 2.4 will be followed to minimize the potential for erosion. A gravel apron would be used to reduce sediment transfer onto the Western Divide Highway. At the end of the access road is a large flat area which would be used as a staging area.

Staged equipment would be kept at least 100 feet or more from the meadows edge. BMP 2.11 would go into effect for any servicing and refueling needs in the staging area. The staging area would require non-porous mat residing around the portion used for refueling. BMP 7.4 would be implemented if fuel stored onsite and above ground exceeds 1320 gallons or a single container exceeds 660 gallons, which produces a Hazardous Substance Spill Prevention Control and Countermeasure Plan.

The use of heavy machinery will be limited to the access road, staging area, and restoration site within the meadow. The machinery used for the restoration would follow the Dry Meadow Restoration Plan layout. Tracked equipment will be used whenever possible.

The Dry Meadow Restoration Plan layout, as displayed on page 11 of the hydrology report, shows the location of the restoration work. Implementation may vary slightly, but the concept of the Pond and Plug method would be followed. Soil used to create the plugs and valley grade control structure would come from the meadow during construction of the ponds. Rock will also be used to armor and form channels on the plugs and valley grade control structures.

Onsite sod and or native seed if available will be used to cover the bare soil of the plugs and valley grade control structure. Native willows would be used along the banks for stability and improvement for future wildlife habitat.

Once the project is completed, Best Management Practices protocol requires all header and implementation portions of the BMP evaluation forms be completed. The Contracting Officer assigned to the project will be responsible for completing all required BMP forms. Submission of these forms will go to the Western Divide Ranger District Hydrologist. If the hydrologist is not available for any reason, the forms will go to the District Ranger.

Post Project Implementation

Post project procedures include removal of heavy equipment, removal of any items stored in the staging area, waste management and disposal, and post project water management. The staging area may contain waste generated during project implementation. The contractor will be responsible for removing any and all waste from the site in accordance to all applicable laws. The goal of waste management and disposal is to return the project area, as much as possible, to pre-project conditions. Once those items are removed, the old access road used will need post project water management.

Post Project Water Management is described within BMP 2.13 as a way of implementing water control structures and management practices to minimize pollutants, in this case erosion, after project activities have been completed at the site (pre-project and project implementation). The old access road would be ripped, slash put on the road, and have water bars installed. These actions would minimize the chances for excess erosion and reduce soil compaction created during project implementation. Water bars would be installed in accordance with Forest Service Handbook 2409.15 R5 supplement 2409.15_2012-01 Chapter 60. Water bar spacing is expected to use the High Erosion Rating of High for the old access road. The entrance to the old access road will be closed. A natural barrier may be utilized, either down logs or large boulders, berms, or any combination of these to prevent use.

Post project monitoring will occur as required by BMP protocol. BMPs used during pre and project implementation would be evaluated the following year. A Forest Service hydrologist is required during post project BMP monitoring.

Appendix B

Monitoring Station Design:

The intent of each monitoring station is to use several indicators to determine changes in the timing of stream flow and volume resulting from meadow projects and management changes in the monitored basins. The effort expects to build on, and collaborate with, other ongoing intensive research and monitoring to estimate the degree in which restoration is improving water availability via changes in floodplain aquifer recharge and release. A positive trend in two or more of the metrics listed above is expected to indicate the influence of meadow restoration on stream flow. The following list details how each parameter would be measured and analyzed:

1. Stream flow would be recorded hourly with a pressure transducer. The station would be equipped with a staff gage, and monthly calibration flow measurements would be conducted. For redundancy and visual monitoring, an automated game camera would also be installed to record still pictures of the staff gage and environs at set intervals. Data would be summarized annually and analyzed for monthly and/or seasonal stream flow and total volume, in the context of precipitation from nearby existing remote automated weather stations (RAWS). Sagraves Environmental, a Plumas Corporation subcontractor, will provide preparation of annual summary data worksheets for flow and water temperature and final data processing on the existing Feather River monitoring stations. This includes data compilation and continuity check, field data evaluation, stage shift development, and new rating development as required.
2. Paired water and air temperature monitoring would be recorded hourly with Hobotemp data loggers. Water temperature can help indicate changes in the contribution of groundwater to surface flow. Data analysis in the Feather River has shown that diurnal fluctuations and maximum temperatures are the parameters most affected by restoration. Water temperatures in the context of air temperatures would be summarized annually and analyzed for at least these parameters. Further analysis of the large dataset may allow other temperature trends to become apparent.
3. Groundwater wells would be read by hand on a monthly basis. The wells would be ½" galvanized perforated pipe, similar to those used throughout the Feather River watershed and other Sierra-wide monitoring projects. Groundwater elevation using these wells is also under investigation as one of the potential surrogate variables to indicate greenhouse gas sequestration in an on-going study with the Sierra Meadow Restoration and Research Partnership (SMRRP). Well data would be analyzed for monthly and/or seasonal elevation change, and can include a much larger dataset of similar wells recently installed throughout the Sierras. Well data could provide valuable pre-project information for project monitoring that may expand to include greenhouse gas sequestration, or surveys that quantify soil porosity (hence, floodplain aquifer volume). This can provide information regarding the potential meadow soil water volume available for recharge to stream channels. Wells would also be a component of any proposed carbon monitoring. Wells also provide groundwater access for sampling of groundwater isotopes and electrical conductivity.
4. Oxygen isotope samples and electrical conductivity (EC) field measurements would be collected from inflows, springs, groundwater wells (described above), and downstream channel flows. Samples would be collected quarterly, and would be analyzed at California State University, Sacramento to help determine the seasonal variability, and sources of groundwater to surface water.

5. Evaluate sediment supply and instream habitat change related to restoration. This would be accomplished by conducting channel cross-sections surveys and habitat assessments using the California Rapid Assessment Method (CRAM).

Appendix C

Proposed Sierra Meadows Wetland and Riparian Area Monitoring Plan

Introduction

The proposed Sierra Meadow Wetland and Riparian Area Monitoring Plan (SM-WRAMP) has been developed by the Sierra Meadows Partnership WRAMP Advisory Committee (WAC) with the intent of creating a framework to assess pre- and post-restoration conditions specific to mountain meadows within the greater Sierra Nevada. The two primary objectives associated with development of the SM-WRAMP are to:

1. *Serve as a robust, replicable and cost-efficient monitoring and assessment plan to understand current conditions of meadow systems, employed pre- and post-restoration, to quantify and evaluate changes associated with physical and biological attributes.* Establishing a Sierra Meadows specific WRAMP provides the basis for determining the efficacy of meadow restoration at the project site-level and for improving our scientific understanding of cause and effect relationships among key meadow attributes and restoration actions. This system of consistent monitoring protocols also would generate data on meadow restoration and conservation that could be more directly compared with other management and regulatory programs at regional and statewide scales.

2. *Serve as a short, medium and long-term approach to monitoring the implementation of the Sierra Meadows Strategy.* The Sierra Meadow Strategy was completed in the fall of 2016. The intention of the Strategy is to guide all aspects of restoring and maintaining the health of meadows, including assessments, prioritization, project design, permitting, implementation and post-implementation monitoring. The overarching goal of the strategy is to increase the pace, scale and *efficacy* of meadow restoration, targeting 30,000 acres of restored and/or protected meadows by the year 2030. In addition to the SM-WRAMP providing site-level information, data derived from its implementation will serve as a framework for evaluating overall success of the Strategy through short, medium and long-terms outcomes. More specifically, data derived from the application of the SM-WRAMP will provide the foundation necessary to determine advances in terms of: (a) the abundance, in number and acreage, of meadows restored, (b) diversity and distribution of meadows restored, (c) overall condition of meadows reported, and (d) information on important meadow attributes, such as water storage, soil carbon storage, biological abundance and diversity such as the distribution, abundance and diversity of plants, fish, birds, amphibians, and mammals.

The Sierra Meadow Partnership

The Sierra Meadow Partnership (SMP) evolved out of a group of interested parties working to develop and implement the National Fish & Wildlife Foundation's Sierra Nevada Meadow Restoration Business Plan (NFWF 2010). Three Sierra meadow workshops held in Calistoga, California fostered further collaboration and the idea of creating a better-defined partnership among members of the group and in

developing a Sierra Meadow Strategy as part of the group's common vision. The intent of the Sierra Meadow Partnership, is to recognize and foster expanded collaboration among partners engaged in meadow conservation to increase the pace, scale, and efficacy of meadow restoration and protection in the Sierra region. The Partnership, which is open and encourages additional participants, currently includes representatives from over fifteen public, private, non-profit, and educational institutions. Many participating members have one to several decades of experience working in meadow restoration and monitoring. Areas of expertise among these members include meadow restoration design and implementation, regulatory compliance and reporting, meadow soils, biogeochemistry and hydrology, geomorphology, meadow vegetation and range management, meadow dependent fisheries, aquatic ecology, birds, and amphibians, remote sensing and spatial analysis. Moreover, most of these partners have worked together in multiple projects and, through the Calistoga Workshops, have established a working rapport of mutual respect and clear, open communication.

Through collaboration and coordination among participants in the SMP, we will provide a much larger, more coherent, and more consistent data set than would multiple entities working independently. Moreover, through the large SMP, data collection methods and protocols will incorporate existing institutional knowledge which will foster broader acceptance and adoption. Familiarity, training, and adoption of data collection and reporting protocols will be made broadly available through in person trainings, databases such as EcoAtlas and the U.C. Davis Meadows Clearinghouse, but dissemination also will be reinforced through word of mouth across the large network of SMP participants.

Feasibility

Members of the SMP have experience working successfully together. A current example of such coordination is the Sierra Meadow Restoration and Research Partnership (SMRRP), which is orchestrated by CalTrout and includes Plumas Corp, Stillwater Sciences, UNR, UC Merced, South Yuba River Citizen League, Truckee River Watershed Council, and Sierra Foothills Conservancy. The intent of the Sierra Meadow Restoration and Research Partnership is to collect, analyze and report on measured changes in meadow soil carbon sequestration that occur after meadow restoration, with the ultimate intent of drafting a meadow carbon protocol for creation of carbon credits through meadow restoration. The SMRRP was created to build a coordinated, consistent set of data collected using the same research framework, field and laboratory methods, across six different restoration projects in the Sierra. By banding together, all six projects are creating a much stronger and more broadly applicable data set on which to build a carbon-sequestration protocol than could be created by the six independently. Thus far, the group has completed research field methods development, field methods training, and collection of pre-restoration data from the 15 meadows stretching from the Feather River basin south to the Kern River Basin. Post-restoration data collection, site-specific and landscape scale data analysis and model development, protocol development, reporting and publishing will continue through 2021. As another example of successful collaboration, the broader SMP group developed and wrote the Sierra Meadows Strategy in late 2016 (Drew et al. 2016). This guiding framework for restoring and conserving 30,000 acres of meadows in the Sierra Nevada by 2030 includes a call for consistent measures and reporting of meadow condition to support science based prioritization, restoration, adaptive management, and

tracking movement towards desired conditions and Strategy goals at site and regional scales (Tables 1-3 in Drew et al. 2016).

Methodological approach

A Sierra Meadows WRAMP advisory committee (SM-WAC) has been formed and will guide the implementation of the SM-WRAMP. The SM-WAC consists of engaged expert scientists with substantial experience in meadow ecology, and active members of the Sierra Meadows Partnership (See SM-WAC Structure and Responsibilities section below). The proposed SM-WRAMP has been developed based on the identification of information considered essential to effectively assess and monitor meadows pre and post-restoration in a robust, replicable and cost-efficient manner. It has also been developed with the intent of meeting requirements of Prop. 1 funding programs as well as future funding programs requiring assessments and monitoring activities.

SM-WRAMP -Tiered Data Approach

The SM-WAC determined that having a tiered approach was important for guiding data collection: all projects and project types (Tier 1), necessary to meet specific project objectives such as species level information (Tier 2), relevant for scientific research that would likely be pursued and applied at "sentinel" or long-term research meadows (Tier 3). Level 1 & 2 of the SM-WRAMP contain only Tier 1 data. Level 3 includes three distinct tiers; Tier 1 requirements that focus on data collection for physical processes performance measures and metrics as well as Tier 2 & Tier 3 requirements for physical and biological performance measures & metrics (Table 1).

Table 1. SM-WRAMP Levels and Tiers

WRAMP Level	Tier 1	Tier 2	Tier 3
1			
2			
3			

Prior to spring 2018, the SM-WAC will refine attributes to be measured, as each is linked to specific desired conditions for tracking restoration or conservation outcomes. Through this project, the exact field protocols and metrics for measuring, analyzing and reporting on these attributes will be finalized. We further assume, that between the first and second year, additional refinements in these data collection and management methods will occur. The attributes and metrics listed in tables 2-5 below are based upon current best estimates of attributes and associated field data collection methods.

Once applied to the collective meadows funded through Prop. 1 (2017), the SM-WAC will be responsible for reviewing and analyzing the data collected with a goal of (1) determining trends in meadow conditions across varied geographical settings and (2) adaptively revising the SM-WRAMP to provide for a more cost/resources efficient monitoring and assessment framework that creates the necessary information to accurately identify and track changes to meadow conditions.

The SM-WRAMP will be applied as a tool to assess pre-restoration conditions of hydrologic, physical and biological attributes of target meadows. Additionally, the intent is to apply the SM-WRAMP post-

restoration at *three* and *five-year* intervals to enable quantification of changes of meadow conditions as a function of restoration activities.

Data management, analysis and adaptive approach to proposed SM-WRAMP

Additional to the SM-WRAMP development, the SM-WAC will be responsible for coordinating collection, management and analysis of data derived from the implementation of the SM-WRAMP. This will include ensuring QA/QC of SM-WRAMP specific data, as well as ensuring data appropriate for other statewide database submittals (California Data Exchange Network (CEDEN), electronic California Rapid Assessment Method (eCRAM) etc.) are accomplished, per Prop. 1 requirement. In addition, working with the San Francisco Estuary Institute, the SM-WAC will develop a databased specific to Sierra meadows and the SM-WRAMP that will ultimately be housed in EcoAtlas. The WAC will also investigate the opportunity to integrate and or link current data from the UC Davis Meadows clearinghouse with EcoAtlas data, to ensure longevity, accessibility and a user friendly platform. The SM-WAC will also be responsible for evaluating the efficacy of the proposed SM-WRAMP and potentially revising it based on analysis of its implementation, and its ability to be scaled back for time and cost-efficiency - while ensuring data collected provides robust and necessary information to evaluate efficacy of restoration activities over time at site-specific and programmatic scales. For all database submittals, the SM-WAC will work with database leads at San Francisco Estuary Institute (SFEI) to ensure that all meadow data are tagged with a unique Meadow ID, to enable queries across multiple databases that include or are outside of the Meadow data clearing house (e.g., CEDEN, eCRAM, etc.).

Proposed information for inclusion in the Sierra Meadows Wetland and Riparian Area Monitoring Plan (SM-WRAMP)

Level 1: Maps and Spatial Information

Level 1 data are required for all participating meadows. This Level 1 information is primarily directed towards tracking the number and distribution of planning vs. implementation meadow restoration projects in the Program Area. In addition to some *CARI* information, other basic information on land ownership and project partners is also reported at this level (Table 2). Level 1 data can be used to facilitate analysis of distribution and diversity of meadow restoration and conservation projects, and to explore relationships between meadow restoration projects and landscape scale characteristics, such as land use and climate change patterns, as well as fundamental differences in geology, growing season length, fire frequency, etc. For level 1, we have included landscape context variables that could be used to stratify meadows within the program area, such as underlying parent material (granitic, volcanic, etc.), elevation, county, start and end date, and restoration type (proposed drop-down list).

Table 2. Proposed Level 1 data for SM-WRAMP

From California Aquatic Resources Inventory (CARI)-online dataset	***Tier***
Globalid: a placeholder attribute for EcoAtlas.org	1
CARI_id: Unique id for CARI feature	1
clickcode: an alphanumeric code for the wetland classification. Clickcode values are undergoing revision and will be updated in a future release of CARI.	1
clicklabel: a detailed description of a feature's wetland type.	1

Additional information	*Tier*
Project name	1
UCD Unique Meadow ID	1
Project partners	1
Meadow site characteristics: Meadow HGM type(s), project objectives, restoration methods (select from list), target restoration species, target restoration functions	1
Meadow landscape context: underlying parent material, elevation, site location (lat/long)	1
County	1
HUC 12	1
National Forest Land (Y/N)	1
If Yes, Specific Ranger District	1
If No, Specify Land Ownership	1
Meadow name, total acreage, expected impact area acreage	1
Project activity type (assessment, planning, restoration-implementation etc.)	1
Project schedule: Start and end dates	1

Level 2: General wetland condition information

Level 2 data are required for all participating meadows. Project specific information is reported here on meadow vegetation type, extent of section 404 wetland delineated area, and target restoration objectives and methods (Table 2).

Table 3. Proposed Level 2 data for SM-WRAMP

Methodology	Tier
CRAM	1
Wetland delineation	1*

*Wetland delineation is required prior to restoration implementation, regardless of project type. However, it is not considered required for every project. For example, if a proposed project is to conduct only assessments and prioritization of meadow needs, it may not be included.

Level 3: Specific condition information

Within the Level 3 data, we propose having three Tiers of information. Level 3, Tier 1 would be required of all participating meadow restoration projects. Level 3, Tier 2 data would be optional and directed toward reporting outcomes specifically targeted by the management objective and restoration design (e.g., increased wildlife diversity). Level 3, Tier 3 data would support greater understanding of underlying processes that support healthy and resilient meadows in the face of climate change and in response to restoration actions and would be implemented in a subset of meadows selected to

represent the diversity of meadows in the program area. These Level 3, Tier 3 data would be designed to address hypotheses and require the greatest level of scientific rigor.

Level 3, Tier 1

The intent of these Level 3, Tier 1 data are to provide more detailed landscape and site-specific information on meadow conditions that are expected to show changes in response to most restoration activities. Thus, information from Tier 1 could be used to track condition or target population changes in individual meadows as well as changes in overall site conditions for meadows at a programmatic scale. All of these data types are screened to provide 'cheap, easy, and effective' information.

Table 4. Proposed Level 3, Tier 1 variables for SM-WRAMP

Meadow Attribute Category (performance measures)	**Quantifiable Attribute (*Performance outcomes*)**	**Initial Methodology**	**Rationale**
UCD Unique Meadow ID	N/A	N/A	Maintain linkage across all databases
Landscape scale attributes	Mean annual precipitation and temperature	Weather station data (specifics tbd on selecting station)	Interpret observed inter-annual variation within a meadow and for variation among meadows
	Change in water stress	Normalized Difference Water Index http://climateengine.org/app/	Indicator of level of stress over time due to local, regional or global factors
	Change in vegetation vigor	Normalized Difference Vegetation Index (NDVI) http://climateengine.org/app/	Indicator of vegetation vigor. This is a good simple monitoring tool for restoration effectiveness which can visually display if after restoration vegetation vigor increases despite drought conditions.
	Watershed hydrologic record	USGS gage in watershed or nearby and similar watershed	Interpret observed inter-annual variation within a meadow and for variation among meadows
Area of impact	Acres by vegetation community type	Acres by community type as mapped under CRAM	Changes in vegetation community type are expected to be a fundamental response to most restoration actions. This is a role-up of existing and reported data under Level 2
Ground/surface water interactions	Depth to shallow groundwater table	Shallow groundwater well transects established and monitored at least monthly during the growing season	Fundamental expected restoration effect that supports multiple other changes in site conditions for terrestrial habitat
	Dominant plant species along transect	Dominant (>10%) plant species composition at each groundwater well	Links fundamental changes in physical template to fundamental change in habitat type
	Floodplain connectivity	Relevant indicators from USFS Stream Condition Inventory and/or other scientifically accepted protocols	Fundamental expected restoration effect that supports multiple other changes in site conditions, including aquatic habitat
Water quality	Water temperature	Deploy and manage data from temperature loggers within meadow (e.g., HOBO's)	Reflects multiple interactions: ground/surface water contributions, channel shade, duration of snow melt
	Specific conductance	Growing season measures using YSI meter or field titration kit	Reflects dissolved solids such as salts, minerals, and can be used indicator of pollution and/or source water
Soil Conditions	Surface soil carbon content	Measure to 30 cm depth	Core samples for bulk density in 15 cm depth intervals, C and N content

Level 3, Tier 2

Level 3, Tier 2 attributes are not required for all meadows but are standardized so that meadow restoration proponents choosing to track specific meadow condition responses to restoration actions can report changes using the same method protocols. This will support tracking and adaptive management on a meadow-specific basis, as well as meta-analysis of meadow response and restoration 'success' at broader spatial scales, or within stratified sets of meadows (e.g., classified by parent material, elevation, ownership, or restoration methods) (Table 5).

Table 5. Proposed Level 3, Tier 2 variables for SM-WRAMP

Meadow Attribute Category (performance measures)	**Quantifiable Attribute (*performance outcomes*)**	**Initial Methodology**	**Rationale**
UCD Unique Meadow ID	N/A	N/A	Maintain linkage across all databases
Area of impact	Acres by depth to shallow groundwater	Use transect groundwater and surface topography data to develop spatial data of depth to groundwater; create depth bins and report acreage per bin	Change in depth to groundwater is a common expected response to most restoration actions. Reporting change by area will support tracking efficacy of restoration action(s). Depth bins will be included in protocol
Hydrology	Stream channel discharge above and below meadow	Establish and collect data from multiple field gages, perform hydrologic modeling	Track change in amount and duration of summer baseflow, a potential benefit of meadow restoration
Groundwater storage	Alluvium storage capacity	Measure alluvium surface area, depth, porosity, and 'shape factor' per Cornwell and Brown 2008	Track change in total volume of groundwater storage in meadow
	Depth to water table	Establish and monitor groundwater wells	
Water quality	Benthic invertebrates	Direct surveys: community structure: diversity, richness, tolerance	Reflects spatial and temporal integration of water quality conditions (DO, temperature, etc.); also characterizes base of aquatic food web
	Bank stability pre and post restoration	Multiple Indicator Monitoring of Stream Channels and Streamside Vegetation	Reflects aquatic and streamside habitat condition
	Turbidity	Turbidity meter during range of conditions, with focus on peak storm events; timing, spatial density and frequency of measurement tbd	Turbidity reflects water transparency, due to suspended solids and dissolved organic matter; it affects aquatic habitat quality

	Suspended sediment concentration	<2mm filtered, dried and weighted water samples; timing, spatial density and frequency of measurement tbd	Increased filtration is an expected benefit of many meadow restoration efforts. Suspended solid concentration reflects part of sediment transport load as well as water quality condition
	Dissolved oxygen	DO meter, timing, spatial density and frequency of measurement tbd	Direct measurement of important water quality attribute that directly affects aquatic plants and animals
Vegetation resources	Rare plant survey	CNPS protocol	Likely already required for NEPA or CEQA compliance and monitored to reflect progress towards restoration goal(s).
	Plant species richness and diversity	Methods tbd, assessment of needed plot size; directing survey timing to sync with range of bloom times	Plant species diversity may increase, or decrease, with restoration. Benefits to tracking distribution across meadow types and restoration actions.
	Plant rooted frequency, root depth, groundcover	R5 Rangeland monitoring protocol	Valuable because data would align with existing long-term monitoring database
	Conifer encroachment and edge habitat condition	USFS R5 protocols for conifer encroachment; edge habitat condition methods tbd	Conifer encroachment is an issue in many meadows so this would provide direct measure of intended benefit
Soil Conditions	Soil texture distribution	Sand/silt/clay analysis, SOM content (sampling distribution and density tbd)	Provides information fundamental to interpreting C sequestration, surface erosion, plant community composition, water holding capacity
	Soil carbon content	Measure to 50 m depth	Core samples for bulk density in 50 cm depth intervals, C and N content
Aquatic and terrestrial species richness and habitat diversity	Measures of abundance, species richness, diversity, community structure/age class, recruitment, presence/absence,) expansion of spawning area through change in substrate type and temperature, habitat connectivity	Fish surveys Bird surveys Amphibian surveys Mammal surveys Habitat surveys	Direct measure of expected benefit of restoration to determine changes in aquatic and terrestrial species richness and habitat diversity

Level 3, Tier 3

Level 3, Tier 3 data will be tailored to address hypotheses directed at a range of scales. These will be developed by the WAC over the first two years of the project. Initial data types proposed for consideration include GHG flux data collected from eddy flux towers to complement chamber data currently being collected under the SMRRP project, soil C samples collected to 1 m depth, analysis of satellite or other remotely collected reflectance data to characterize plant community types and moisture content, stable isotope and tracer studies to characterize meadow source data and preferential groundwater flow paths, eDNA sampling and analysis of soils and waters to describe current and past habitat use by species of interest.

SM-WAC Structure and Responsibilities

An identified priority from the 2017 Sierra Meadows partnership workshop, attended by 60+ meadow restoration practitioners, was the need to establish a SM-WRAMP Advisory Committee (SM-WAC) which is responsible for standardizing data collection and assessment methodologies for meadow-related projects. Since then the SM-WRAMP has been formed and is comprised of experts from diverse fields involving meadow research, planning and restoration. The SM-WAC will serve to guide the further development, implementation and revision of the proposed SM-WRAMP as part of CalTrout's proposal and in coordination with other proposals submitted as part of a broader Sierra Meadows Partnership collective effort. CalTrout will provide overarching coordination that will serve to ensure the WAC is operating smoothly, convene calls/meetings of the WAC and oversee revisions to the SM-WRAMP document. Topical leads (fish & wildlife, soils, hydrology, vegetation and data coordination) will guide data coordination, analysis and management with input from the general WAC membership. All WAC participants will collaborate to advance science, implementation of the SM-WRAMP and future revisions as necessary.

The SM-WAC was assembled for the following purposes:

1. To guide the overall development, implementation and revision (as needed) to the SM-WRAMP.
2. To develop topically focused groups within the WAC based on WAC members fields of expertise. These groups currently include, fish and wildlife, soils, hydrology and vegetation. Additionally, a representative from the San Francisco Estuary Institute will serve as a data-coordination topical lead to help insure alignment and integration of SM-WRAMP data into EcoAtlas. Each of the topical groups will have a designated lead responsible for ensuring all data collected based on the application of the SM-WRAMP is complete, of sufficient quality and that is uploaded and managed in the SM-WRAMP database. The designee also will lead the coordination of uploading appropriate data to relevant statewide datasets.
3. Designated leads, working with coordinator will spearhead potential revisions to the SM-WRAMP once applied, based on review of data.

Table 6. The Sierra Meadows WRAMP advisory committee (SM-WAC) currently include the listed members who will lead development and integration of subject area monitoring goals and methods.

Name	Institution	Role and/or Area of Expertise
***Mark Drew**	**CalTrout**	**SM-WAC Coordination Lead**
***TBD**		**Soils-Topical Lead**
***Ryan Burnett**	**Point Blue**	**Fish/Wildlife-Topical Co-Lead**
***Carrie Monahan**	**Sierra Fund**	**Hydrology- Topical Lead**
***Sabra Purdy**	**Trout Unlimited**	**Fish/Wildlife- Topical Co-Lead**
***Amy Merrill**	**Stillwater**	**Vegetation and Soils- Topical Lead**
***TBD**	**San Francisco Estuary Institute**	**EcoAtlas/Data Coordination**
Sheli Wingo	USFWS	Vegetation
*Nina Hemphill	USFS	Aquatic ecology
Beth Christman	Truckee River Watershed Council	Restoration and Permitting
Rene Henery	Trout Unlimited	Fisheries
Jim Wilcox	Plumas Corps	Restoration/Hydro/Geomorphology
Leslie Mink	Plumas Corps	Restoration/planning/vegetation
Gia Martin	Plumas Corps	Planning/Restoration
*Shana Goss	USFS	Ecosystem monitoring/restoration
Luke Hunt	American Rivers	Restoration/planning/hydrology

*Receiving Funding for WRAMP involvement from this proposal.

Other Duties for WAC members include:

- Participating in launch and hence fourth annual meetings
- Participate in quarterly calls-All WAC members
- Review and analysis of data-All WAC members
- Data coordination and database development-Topical leads with input from all members
- Revise, as needed, SM-WRAMP-Overarching coordinator with Topical leads per section and input from all members

Citations

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Appendix D – Riparian Conservation Objectives Analysis

Riparian Conservation Objects Analysis – SNFPA 2004 R.O.D.			
Standards and Guidelines Associated with RCO #1:	**Does It Apply?**		**Why or Why Not?**
	YES	NO	
For waters designated as "Water Quality Limited" (Clean Water Act Section 303(d)), implement appropriate State mandates for the water body, such as Total Maximum Daily Load (TMDL) protocols.		X	There are no areas designated as Water Quality Limited within the project area.
Ensure that management activities do not adversely affect water temperatures necessary for local aquatic and riparian-dependent species assemblages.	X		RCA's and SMZ's will be applied to the project to minimize potential for adversely affecting water temperatures. See hydrology report for more information regarding design features.
Limit pesticide applications to cases where project level analysis indicates that pesticide applications are consistent with riparian conservation objectives. Prohibit application of pesticides to livestock in RCAs and CARs.		X	Not applicable to project.
Within 500 feet of known occupied sites for the California red-legged frog, Cascades frog, Yosemite toad, foothill yellow-legged frog, mountain yellow-legged frog, and northern leopard frog, design pesticide applications to avoid adverse effects to individuals and their habitats.		X	Not applicable to project.
Prohibit storage of fuels and other toxic materials within RCAs and CARs except at designated administrative sites. Prohibit refueling within RCAs and CARs unless there are no other alternatives. Ensure that spill plans are reviewed and up-to-date.	X		No fuel will be stored within the RCA's. Refueling equipment will be completed outside of RCA's as mentioned in BMP 7.4. Spill plans will be reviewed and up-to-date prior to project implementation.
Standards and Guidelines Associated with RCO #2:	**Does It Apply?**		**Why or Why Not?**

	YES	NO	
Maintain and restore the hydrologic connectivity of streams, meadows, wetlands, and other special aquatic features by identifying roads and trails that intercept, divert, or disrupt natural surface and subsurface water flow paths. Implement corrective actions where necessary to restore connectivity.		X	Not applicable to project.
Ensure that culverts or other stream crossings do not create barriers to upstream or downstream passage for aquatic-dependent species. Locate water drafting sites to avoid adverse effects to in stream flows and depletion of pool habitat. Where possible, maintain and restore the timing, variability, and duration of floodplain inundation and water table elevation in meadows, wetlands, and other special aquatic features.		X	Not applicable to project.
Prior to activities that could affect streams, determine if relevant geomorphic characteristics, including bank angle, channel bank stability, bank full width-to-depth ratio, embeddedness, channel-floodplain connectivity, residual pool depth, or channel substrate, are within the range of natural variability for the reference stream type as described in the Pacific Southwest Region Stream Condition Inventory protocol. If properties are outside the range of natural variability, implement restoration actions that will result in an upward trend.		X	The project is a restoration action that would result in an improving trend of stream condition.
Prevent disturbance to meadow-associated streambanks and natural lake and pond shorelines caused by resource activities (for example, livestock, off-highway vehicles, and dispersed recreation) from exceeding 20 percent of stream reach or 20 percent of natural lake and pond shorelines. Disturbance includes bank sloughing, chiseling, trampling, and other means of exposing bare soil or cutting plant		X	Not applicable to project. Project seeks to treat stream channels.

roots. This standard does not apply to developed recreation sites and designated off-highway vehicle routes.			
In stream reaches occupied by, or identified as "essential habitat" in the conservation assessment for, the Lahonton and Paiute cutthroat trout and the Little Kern golden trout, limit streambank disturbance from livestock to 10 percent of the occupied or "essential habitat" stream reach. (Conservation assessments are described in the record of decision.) Cooperate with State and Federal agencies to develop streambank disturbance standards for threatened, endangered, and sensitive species. Use the regional streambank assessment protocol. Implement corrective action where disturbance limits have been exceeded.		X	Not applicable to project area.
At either the landscape or project-scale, determine if the age class, structural diversity, composition, and cover of riparian vegetation are within the range of natural variability for the vegetative community. If conditions are outside the range of natural variability, consider implementing mitigation and/or restoration actions that will result in an upward trend. Actions could include restoration of aspen or other riparian vegetation where conifer encroachment is identified as a problem.	X		Meadow community is converting to drier upland species due to dewatering caused by gully erosion. Proposed restoration aims at reversing this trend
Cooperate with Federal, Tribal, State and local governments to secure in stream flows needed to maintain, recover, and restore riparian resources, channel conditions, and aquatic habitat. Maintain in stream flows to protect aquatic systems to which species are uniquely adapted. Minimize the effects of		X	Not applicable to project area.

stream diversions or other flow modifications from hydroelectric projects on threatened, endangered, and sensitive species and essential habitat as identified in conservation assessments. (Conservation assessments are described in the record of decision.)			
For exempt hydroelectric facilities on national forest lands, ensure that special use permit language provides adequate in stream flow requirements to maintain, restore, or recover favorable ecological conditions for local riparian- and aquatic-dependent species.		X	Not applicable to project area.
Standards and Guidelines Associated with RCO #3:	**Does It Apply?**		**Why or Why Not?**
	YES	NO	
Determine if the level of coarse large woody debris (CWD) is within the range of natural conditions in terms of frequency and distribution and is sufficient to sustain stream channel physical complexity and stability. If CWD levels are deficient, ensure proposed management activities, when appropriate, contribute to the recruitment of CWD. Burning prescriptions should be designed to retain CWD; however short-term reductions below either the soil quality standards or standards in species management plans may result from prescribed burning within strategically placed treatment areas or the urban wildland intermix zone.		X	Not applicable to project area, which is in a meadow, where CWD would not naturally occur.
Standards and Guidelines Associated with RCO #4:	**Does It Apply?**		**Why or Why Not?**
	YES	NO	
Within CARs, in occupied habitat or "essential habitat" as identified in conservation assessments for threatened, endangered, or sensitive species, evaluate the appropriate role, timing, and extent of prescribed fire. Avoid direct lighting within riparian vegetation; prescribed fires may back into riparian vegetation areas. Develop mitigation measures to avoid impacts to these species whenever ground disturbing		X	Project is not within a CAR.

equipment is used.			
Use screening devices for water drafting pumps. (Fire suppression activities are exempt during initial attack.) Use pumps with low entry velocity to minimize removal of aquatic species, including juvenile fish, amphibian egg masses and tadpoles, from aquatic habitats.	X		Screening devices will be used when drafting water during project implementation. This applies to drafting sites that directly take water from stream channels.
Design prescribed fire treatments to minimize disturbance of ground cover and riparian vegetation in RCAs. In burn plans for project areas that include, or are adjacent to RCAs, identify mitigation measures to minimize the spread of fire into riparian vegetation. In determining which mitigation measures to adopt, weigh the potential harm of mitigation measures, for example fire lines, against the risks and benefits of prescribed fire entering riparian vegetation. Strategies should recognize the role of fire in ecosystem function and identify those instances where fire suppression or fuel management actions could be damaging to habitat or long-term function of the riparian community.		X	Not applicable to this project, which does not include prescribed fire.
Post-wildfire management activities in RCAs and CARs should emphasize enhancing native vegetation cover, stabilizing channels by non-structural means, minimizing adverse effects from the existing road network, and carrying out activities identified in landscape analyses. Post-wildfire operations shall minimize the exposure of bare soil.	X		The project would enhance vegetation and stabilize channels, after a wildfire, however, the work is not post-wildfire management in and of itself.
Allow hazard tree removal within RCAs or CARs. Allow mechanical ground disturbing fuels treatments, salvage harvest, or commercial fuelwood cutting within RCAs or CARs when the activity is		X	Not applicable to this project.

consistent with RCOs. Utilize low ground pressure equipment, helicopters, over the snow logging, or other non-ground disturbing actions to operate off of existing roads when needed to achieve RCOs. Ensure that existing roads, landings, and skid trails meet Best Management Practices. Minimize the construction of new skid trails or roads for access into RCAs for fuel treatments, salvage harvest, commercial fuelwood cutting, or hazard tree removal.			
As appropriate, assess and document aquatic conditions following the Regional Stream Condition Inventory protocol prior to implementing ground disturbing activities within suitable habitat for California red-legged frog, Cascades frog, Yosemite toad, foothill and mountain yellow-legged frogs, and northern leopard frog.	X		Project is within suitable habitat. Surveys will be conducted prior to implementation.
During fire suppression activities, consider impacts to aquatic- and riparian-dependent resources. Where possible, locate incident bases, camps, helibases, staging areas, helispots, and other centers for incident activities outside of RCAs or CARs. During presuppression planning, determine guidelines for suppression activities, including avoidance of potential adverse effects to aquatic- and riparian-dependent species as a goal.		X	Not applicable to project.
Identify roads, trails, OHV trails and staging areas, developed recreation sites, dispersed campgrounds, special use permits, grazing permits, and day use sites during landscape analysis. Identify conditions that degrade water quality or habitat for aquatic and riparian-dependent species. At the project level, evaluate and consider actions to ensure consistency with standards and guidelines or desired conditions.	X		Project activities are consistent with standards and guidelines, and intended to achieve desired conditions.

Standards and Guidelines Associated with RCO #5:	**Does It Apply?**		**Why or Why Not?**
	YES	NO	
Assess the hydrologic function of meadow habitats and other special aquatic features during range management analysis. Ensure that characteristics of special features are, at a minimum, at Proper Functioning Condition, as defined in the appropriate Technical Reports: (1) "Process for Assessing PFC" TR 1737-9 (1993), "PFC for Lotic Areas" USDI TR 1737-15 (1998) or (2) "PFC for Lentic Riparian-Wetland Areas" USDI TR 1737-11 (1994).		X	Not a range management project. START HERE
Prohibit or mitigate ground-disturbing activities that adversely affect hydrologic processes that maintain water flow, water quality, or water temperature critical to sustaining bog and fen ecosystems and plant species that depend on these ecosystems. During project analysis, survey, map, and develop measures to protect bogs and fens from such activities as trampling by livestock, pack stock, humans, and wheeled vehicles. Criteria for defining bogs and fens include, but are not limited to, presence of: (1) sphagnum moss (Spagnum spp.), (2) mosses belonging to the genus Meessia, and (3) sundew (Drosera spp.) Complete initial plant inventories of bogs and fens within active grazing allotments prior to re-issuing permits.		X	Project seeks to benefit hydrologic processes to improve these resources. A wetland delineation was completed. The project would not re-issue a grazing permit.
Locate new facilities for gathering livestock and pack stock outside of meadows and riparian conservation areas. During landscape analysis, evaluate and consider relocating existing livestock facilities outside of meadows and riparian areas (RCA42). Prior to re-issuing grazing permits, assess the compatibility of livestock management facilities located in riparian conservation areas with riparian conservation objectives.		X	Not applicable to the project. No new facilities are proposed as part of the project.

Under season-long grazing: § For meadows in early seral status: limit livestock utilization of grass and grass-like plants to 30 percent (or minimum 6-inch stubble height) § For meadows in late seral status: limit livestock utilization of grass and grass-like plants to a maximum of 40 percent (or minimum 4-inch stubble height). Determine ecological status on all key areas monitored for grazing utilization prior to establishing utilization levels. Use Regional ecological scorecards and range plant list in regional range handbooks to determine ecological status. Analyze meadow ecological status every 3 to 5 years. If meadow ecological status is determined to be moving in a downward trend, modify or suspend grazing. Include ecological status data in a spatially explicit Geographical Information System database. Under intensive grazing systems (such as rest-rotation and deferred rotation) where meadows are receiving a period of rest, utilization levels can be higher than the levels described above if the meadow is maintained in late seral status and meadow-associated species are not being impacted. Degraded meadows (such as those in early seral status with greater than 10 percent of the meadow area in bare soil and active erosion) require total rest from grazing until they have recovered and have moved to mid- or late seral status.		X	Not part of the proposed project. The project area would be rested from grazing until vegetation has recovered.
Limit browsing to no more than 20 percent of the annual leader growth of mature riparian shrubs and no more than 20 percent of individual seedlings. Remove livestock from any area of an allotment when browsing indicates a change in livestock preference from grazing herbaceous vegetation to browsing woody riparian vegetation.		X	Not applicable to the proposed project.
Standards and Guidelines Associated with RCO #6:	**Does It Apply?**		**Why or Why Not?**
	YES	NO	

Recommend and establish priorities for restoration practices in: (1) areas with compaction in excess of soil quality standards, (2) areas with lowered water tables, or (3) areas that are either actively down cutting or that have historic gullies. Identify other management practices, for example, road building, recreational use, grazing, and timber harvests, that may be contributing to the observed degradation.	X		Project would implementation recommended restoration of this meadow with incised channels, by raising the water table.

Reviewed by the following specialists:

_____	_____	_____
Name	Position	Date
_____	_____	_____
Name	Position	Date
_____	_____	_____
Name	Position	Date