Mattley Meadow Restoration (56125)

Stanislaus National Forest

Calaveras Ranger District

Hydrology Report

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Signed: ________________________________ Date: ___________

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Introduction

The Mattley Meadow Restoration Project is intended to restore ecosystem function in the currently degraded channel floodplain system in Mattley and Mattley Creek meadows. The project involves two distinct meadows: Mattley Meadow, a large meadow that spans both STF and private lands, and Mattley Creek Meadow, a smaller peripheral meadow on STF land. Natural and human caused disturbances over the past 100 years have caused the formation of three large gully channels in Mattley Meadow and one gully in Mattley Creek Meadow which have resulted in meadow degradation and impaired ecological function. Specific project objectives include restoring meadow hydrologic function, improving water quality by reducing channel erosion, improving the extent and vigor of meadow vegetation and aspen stands, and improving meadow habitat for aquatic and terrestrial wildlife.

The project proposes to restore approximately 45 acres of riparian and meadow habitat. In Mattley Meadow, two of the three gullies (middle and east gullies) would be filled with a series of five gully plugs created using onsite material (totaling 15,632 cubic yards) excavated from eight borrow ponds (totaling 3.2 acres). The west gully channel would not be treated or directly impacted as part of the project due to the presence of a population of Sierra Nevada yellow-legged frogs (SNYLF), an endangered species. In Mattley Creek Meadow, the gully would be filled with one plug using material (286 cubic yards) from one borrow pond (0.1 acre). A 0.1 mile segment of a motorized trail (17EV16) that crosses Mattley Creek Meadow would be rerouted outside of the meadow. The new rerouted trail segment would be approximately 0.2 – 0.4 miles in length. The existing trail segment within the meadow would be restored by scarifying the trail surface and placing woody debris and/or vegetation as needed to promote vegetation regrowth.

Affected Environment

Analysis Area

Watershed Description

Watersheds for the project are delineated using the hydrologic unit code (HUC) system, a nested hierarchical approach for classifying and naming watersheds based on size and location (USGS 2009). Watersheds at the 7^{th} and 8^{th} level are currently in draft form or delineated for this analysis and are not part of the National Hydrography Dataset (NHD). The project is located within the upper North Fork Mokelumne River watershed. Table 1 displays the hierarchy and size of each watershed as well as project area treatment acreage and land ownership within each watershed.

Table 1: Watershed hierarchy, treatment acreage, and land ownership for the Mattley project.

HUC Level	HUC Name	HUC Size (acres)	Percent in NFS Ownership	Project Treatment Acres in HUC	Percent of HUC to be Treated
5	Upper North Fork Mokelumne River	125,077	97	30	.02
6	Salt Springs Reservoir-North Fork Mokelumne River	27,985	98	30	.1
7	Mattley Creek-Salt Springs Reservoir (North Fork Mokelumne River)	16,800	97	30	.2
8	Mattley Creek	2,701	94	30	1

The project area is contained within the Mattley Creek subwatershed and is the focus of the Cumulative Watershed Effects (CWE) analysis (Figure 1).

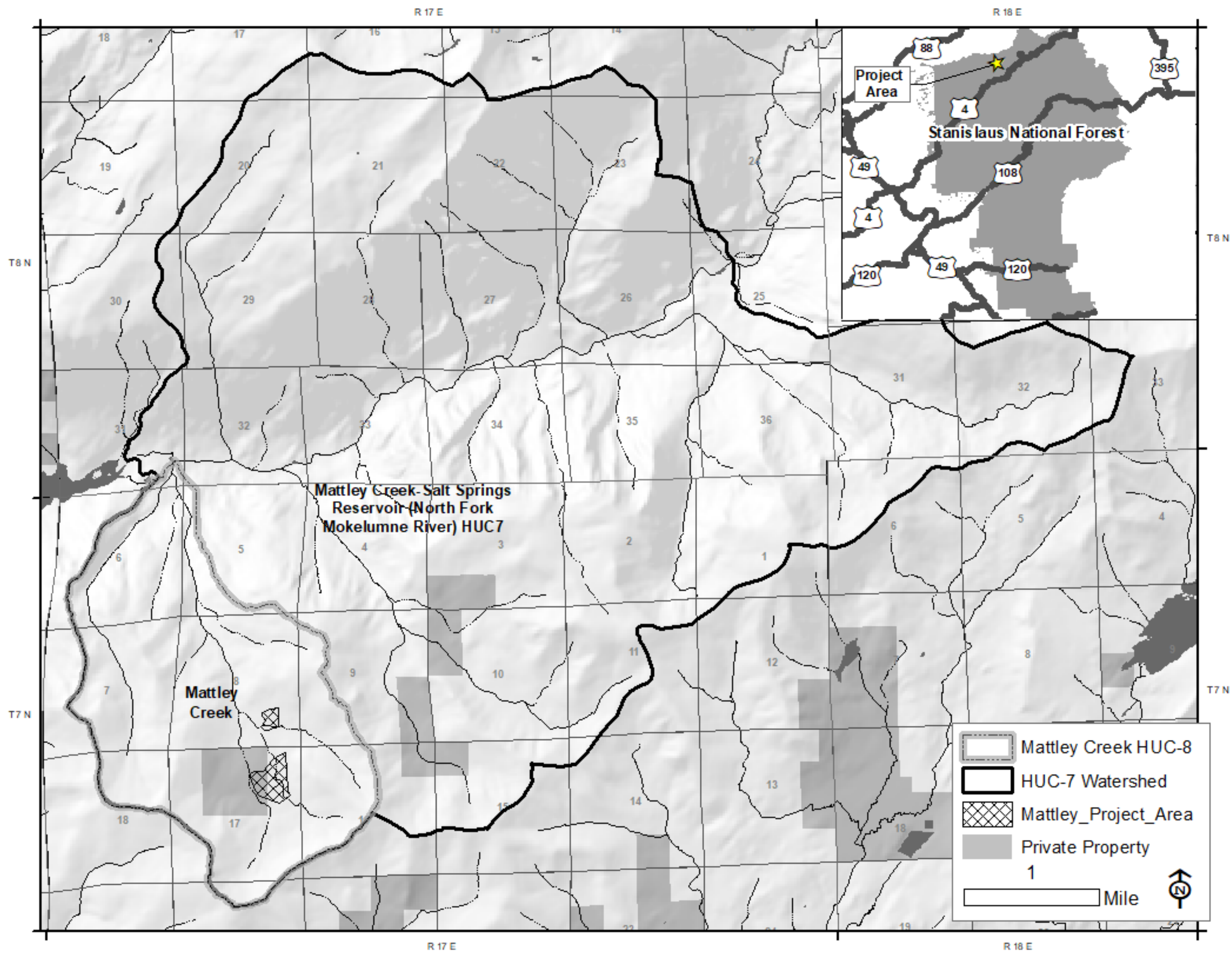

Figure 1: Map of HUC7 watersheds and project area.

CWE for this project were evaluated at the HUC8 scale given the small size of the project area and it being wholly contained within the Mattley Creek drainage. At larger watershed scales (HUC 6 or 7), potential effects may not be apparent or underestimated. The temporal scale of the CWE analysis is a 10 year period. Potential direct and indirect effects are evaluated at the scale of the project area and at short (i.e., 0 – 2 years) and long term (2 – 10+ years) temporal scales. Data sources used include USFS databases and monitoring reports, field survey data, scientific literature, geospatial data, and state timber harvest plan records.

Watershed Setting

Elevations in the Mattley Creek subwatershed range from 4,000 feet at Mattley Creek's confluence with North Fork Mokelumne River to nearly 8,000 feet at the ridge top. Vegetation is dominated by stands of mixed conifer and fir. While conifer forest is dominant, there are areas of exposed bedrock, hardwoods, and brush. Bedrock geology is a mix of volcanic mudflows of the Mehrten Formation and granitic rocks of the Sierra Nevada batholith. Mean annual precipitation is approximately 55 inches and falls primarily as snow. The lower third of the watershed is within the transient snow zone (4,500 – 6,500 feet elevation) which can experience high peak flows due to long-duration rain falling on shallow snow pack.

Watershed Management Goals and Objectives

The following goals and objectives are applicable to this project:

Goals

- Maintain or improve water quality and watershed condition to meet applicable state and federal regulations (USDA 2017).
- Maintain and restore the physical, chemical and biological integrity of the region's waters and provide habitat for riparian and aquatic-dependent species (USDA Forest Service 2004).

Objectives

- Comply with water quality objectives in the Water Quality Control Plan (Basin Plan) of the California Central Valley Regional Water Quality Control Board to protect beneficial uses of water (USDA 2017).
- Comply with Riparian Conservation Objectives (RCOs) outlined in the Sierra Nevada Forest Plan Amendment (USDA 2004).
- Prevent or minimize water quality impacts from forest management activities by implementing Best Management Practices (BMPs) (USDA 2017).

Beneficial Uses of Water

Designated beneficial uses for the Mokelumne River and its tributaries (sources to Pardee Reservoir) include: Municipal and domestic water use, hydroelectric power generation, contact and non-contact water recreation including canoeing and rafting, warm and cold freshwater habitat, warm water migration, warm and cold water spawning habitat, and wildlife habitat (CRWQCB 2015). There are no 303(d) listed impaired waterbodies within the project analysis area. The Forest is responsible for ensuring that water will be drinkable after normal treatment (USDA 2017).

Water quality parameters that could be affected by this project are sediment-related measures, including sediment, settleable material, total suspended solids, and turbidity. Ground disturbing activities can increase erosion and result in increases in sediment delivery to water bodies.

Existing Condition of Project Area Watershed

Overall conditions in the Salt Springs Reservoir-North Fork Mokelumne River HUC6 watershed were rated as *Functioning Properly* by the Watershed Condition Framework analysis (STF 2011). More than half of the HUC-7 watershed is within designated wilderness area. There are few roads in this watershed and the only major development/land use is the Bear Valley Ski Area at the upper headwaters. There have been no major vegetation management projects within the last 10 years and no history of major fires. Based on available data and recent observations, beneficial uses are being met at present within the analysis watershed.

<u>Project Area Meadow Conditions</u>

Mattley Meadow is a meadow complex in the headwaters of Mattley Creek, a tributary to the North Fork Mokelumne River. A separate, smaller nearby peripheral meadow, referred as the Mattley Creek meadow is also part of the project. Meadow conditions are currently degraded and there is a need to implement restoration activities to move them toward desired conditions (Figure 2). Mattley Meadow consists of several hydrogeomorphic meadow types including riparian (middle and high gradient), discharge slope, dry, and subsurface (Weixelman et al. 2011). Mattley Meadow receives surface water inputs from two distinct flow paths (west and east channels) that are not connected to each other. The contributing watershed area including the meadow is about 350 acres for the west channel and 190 acres for the east channel. The west channel and east channels are deeply incised with some areas still actively eroding. Gully dimensions range from 30 – 104 feet in width (averaging 14.5 feet) and 2.5 – 10 feet in depth (averaging 7 feet) for the west channel and 12 – 42 feet in width (averaging 29 feet) and 2.5 – 9 feet in depth (averaging 6 feet) for the east channel. The middle gully, lying between the east and west channels, is not connected to any surface water flow path and receives only groundwater drainage and snowmelt runoff from the immediate vicinity. Middle gully dimensions range from 22 – 85 feet in width (averaging 53 feet) and 3 – 10 feet in depth (averaging 7 feet).

The three gullies within Mattley Meadow have caused an alteration of hydrologic processes. The deeply incised channels prevent high flows from accessing the meadow surface and promote further erosion. The gullies act as drains that reduce groundwater storage and cause rapid drainage of groundwater after snow melt. Groundwater monitoring at a series of six wells has shown that groundwater depths in the drier upper meadow drop below 15 feet by early summer. Groundwater depths in the wetter lower part of the meadow steadily decline from around 4 – 5 feet at the end of snowmelt in wet years down to 10 – 12 feet by fall.

The hydrologic alteration caused by the gullies has influenced the meadow vegetation communities. Vegetation in the meadow varies and ranges from wet meadow species in the lower portions of the meadow to drier upland species in the upper end of the meadow and in dewatered areas adjacent to the gullies.

The 5 acre Mattley Creek meadow consists of subsurface and discharge slope hydrogeomorphic meadow types and has a contributing watershed area of around 20 acres (Weixelman et al. 2011). Gully dimensions average 14.5 feet in width and 4 feet in depth. A motorized trail (17EV16) bisects the Mattley Creek meadow and the gully within the proposed restoration area and is currently causing minor erosion.

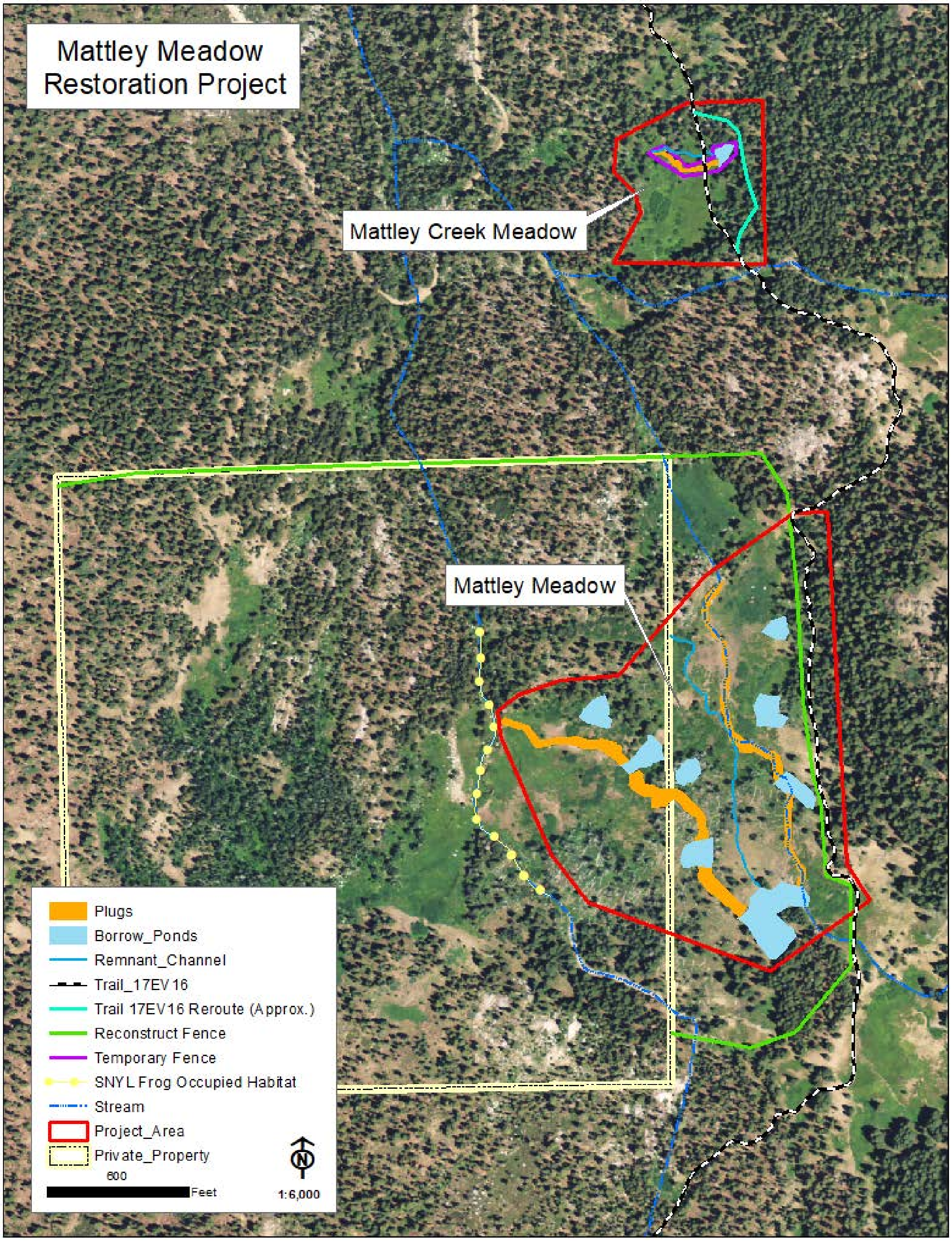

Figure 2. Mattley Meadow Restoration Project proposed action

Environmental Consequences

Direct and Indirect Effects

Alternative 1 – Proposed Action

Direct Effects

Erosion and Sedimentation
The use of mechanized equipment (e.g., excavators, loaders) to implement meadow restoration activities (borrow pond excavation, gully fill, large wood placement, OHV trail reroute and decommissioning, etc.) will result in ground disturbance that has the potential to increase erosion and sedimentation that could affect water quality. Design elements/BMPs (Appendix A) have been incorporated into the project design (e.g., working during dry season, erosion control, revegetation, etc.) that would reduce the potential for water quality to be affected. In addition, the project would comply with all other applicable state and federal permitting requirements (e.g., 404 U.S. Army Corps of Engineers Dredge and Fill permit; 401 State Water Quality Certification). Any increases in sedimentation and subsequent potential effects to beneficial uses are expected to be minor and short term and not adversely affect beneficial uses.

BMP effectiveness evaluations were conducted in 2015, 2016, and 2019 on four meadow restoration projects on the Stanislaus National Forest. At three sites, specified BMPs were found to be implemented and functioning effectively while at one site BMPs were not fully implemented and resulted in minor water quality exceedances of turbidity levels due to difficulties in dewatering the channel (USDA 2019). Monitoring data indicates BMPs implementation is at high levels and where implemented correctly are effective in protecting water quality.

Water Quality (Petroleum Products)
The use of mechanized equipment for restoration treatments present the potential for spills and leaks of petroleum products (e.g., fuel, oil, hydraulic fluid) from machinery into water courses. BMPs would be implemented during the project to minimize the risk of contamination to water.

Two BMP evaluations (i.e., servicing and refueling of equipment) were conducted in 2008 on the Stanislaus National Forest and were found to be implemented and effective (STF 2003 –2014). A regional summary of BMP monitoring data for the years 2003 to 2007 reported implementation and effectiveness rates of 100% and 96%, respectively, for servicing and refueling of equipment BMPs (USDA 2009). A regional summary for the years 2008 – 2010 reported implementation and effectiveness rates of 86% and 100% (USDA 2013). Monitoring data indicates that BMPs are effective in preventing fuel spills and, therefore, the risk of water quality degradation from spills of petroleum products during project activities is low.

Indirect Effects

Erosion and Sedimentation
Over the long term, channel erosion and sedimentation would decrease. Erosion in the east channel is currently occurring because peakflows are confined within the incised channel and cannot access the floodplain, causing the erosive force of the water to be concentrated within the channel and streambanks.

This channel erosion would be reduced by the channel fill restoration which would allow streamflow to once again access the floodplain and spread out, reducing its erosive energy and promoting sediment deposition in the meadow. Post-restoration decreases in erosion following pond/plug restoration were noted by Hoffman et al. (2013) and O'Hara et al. (2014). The minor erosion currently being caused by the OHV trail segment that is traversing the Mattley Creek meadow would decrease following the relocation of this trail segment outside of the meadow.

Hydrologic Changes

Meadow restoration activities, particularly the filling of incised channels and gullies within meadows and creating borrow ponds (also known as "pond and plug"), have the potential to change to surface water and groundwater dynamics. Meadow hydrology is a function of complex interactions between numerous factors such as climate, geology, soils, topography, vegetation and different meadows may respond to similar restoration activities in varying ways. A number of field and modeling studies were reviewed that document various potential hydrologic effects resulting from stream and meadow restoration (Table 2.)

Table 2. Potential hydrological effects of restoration and their causes (adapted from Hammersmark et al. 2008).

Hydrological Effects	Cause	Citation
Groundwater		
Raised groundwater levels	Raised channel bed no longer acted as a deep line sink	1, 2[a], 3, 4, 5,6,7,8
Increased subsurface storage	Raised channel bed no longer acted as a deep line sink	1, 2[a], 3, 4, 5,6,7,8
Channel/Floodplain Connectivity		
Increased frequency of floodplain inundation	Channel capacity reduced, reconnecting channel and floodplain at lower flow levels	2, 3, 4, 7
Decreased magnitude of flood peaks	Water transferred from channel to floodplain, and temporarily stored	2, 3, 4, 7
Increased surface storage	Increased channel-floodplain exchange and increased surface storage in ponds	2, 3, 4, 7
Streamflow		
Winter – early spring		
▪ Streamflow decreased	Increased overbank flooding; Increased riparian area storage; increased groundwater recharge	4, 7, 8
Spring – early summer		
▪ Streamflow increased	Slower draining riparian groundwater system; Higher groundwater levels	4, 8
Late summer – early fall		
▪ Streamflow increased	Increased groundwater storage	2[a], 3[b], 5, 7
▪ Streamflow decreased	Raised channel bed no longer drains groundwater after surface water inflow terminates	1[c], 2[c], 3, 4, 6
▪ Streamflow unchanged	Increased groundwater levels feeding streamflow offset by increased ET= no net streamflow effect	8
Total annual runoff - decreased	Increased subsurface storage and ET	3
Evapotranspiration		
Increased evapotranspiration	Elevated groundwater levels available to root zone and increased evaporation from ponds	3, 4, 6, 8
Little/no change	Meadow groundwater ET supplied primarily by bedrock aquifers; GW lost to ET much less than lost to streamflow	2
Plant vigor, shift community type	Shallow groundwater provides more plant available water and conditions conducive to wetland veg	6, 8

Erosion/sedimentation		
Reduction	Eroding channels/gullies filled; increased flooding attenuates peakflows and reduces erosive forces	4, 7

__1__- Essaid and Hill (2014); __2__- Hunsaker et al. (2015); __3__- Hammersmark et al. (2008); __4__- Hoffman et al. (2013); __5__- Hunt et al. (2018); __6__- Nash et al. (2018); __7__- Ohara et al. (2014); __8__- Tague et al. (2008)

__a__- for meadows with through-flowing streams where overbank flood recharge is an important source of groundwater; __b__- downstream of treated reach; __c__- for meadows supplied primarily by regional groundwater flow rather than overbank recharge

A gully or incised channel within a wet meadow creates a lowered base level which acts as a drain that causes the groundwater gradients to be directed towards it and flow into it. This draining of groundwater causes a lowered groundwater table within the meadow and a reduction in groundwater storage. Filling incised channels or gullies as a restoration activity “plugs” this “drain” and allows groundwater elevations to rise and be maintained at higher levels for longer periods of time, which increases groundwater recharge and the overall amount of groundwater storage within the meadow subsurface.

A higher groundwater table as a result of restoration increases plant available water which promotes increased growth and vigor and may cause a shift from mesic to more hydric vegetation communities. Evapotranspiration (ET) may increase as a result of the increased plant growth and shift to more water intensive hydric vegetation. ET may also increase as a result of evaporation of surface water from increased flooding and borrow source ponds. However, Hunsaker et al. (2015) reported that borrow ponds have evaporation rates comparable to wet meadow vegetation. In their study of summer groundwater balances of Sierra meadows, Hunsaker et al. (2015) found that meadow groundwater ET is supplied primarily by bedrock aquifers rather than local meadow groundwater storage. In addition, groundwater lost to ET was substantially less than discharge of groundwater to streams in all the study meadows; this implies that restoration may not necessarily significantly increase ET losses.

Channels that are deeply incised lose connectivity with their floodplains and may only overflow their banks during the largest flood events, which results in higher peakflows that have higher erosive energy. Filling incised channels allows the stream to flood the meadow more frequently and at lower peakflows. Increased flooding attenuates peakflows, increases recharge of meadow aquifers, reduces erosion, and promotes sediment deposition within the meadow. Overbank flooding can be an important groundwater recharge mechanism in meadows with through-flowing streams, especially those whose streamflow is not dominated by regional groundwater flow (Hunsaker et al. 2015). Borrow ponds filled with flood waters in these meadow types can help to recharge groundwater (Hunsaker et al. 2015).

Plug/pond restoration can affect streamflow in a number of ways and those effects can vary by season. Two field monitoring studies reported increases in streamflow during the snowmelt period in spring – early summer after meadow restoration projects were completed in the Lake Tahoe and Feather River basins (Tague et al. 2008; Hoffman et al. 2013). These studies also both reported that streamflow decreased during winter post-restoration, likely due to increased overbank flooding and storage and slower drainage of near channel areas. Hoffman et al. (2013) reported post-restoration reductions in late season baseflows at two sites, although this effect was not detected downstream. Tague et al. (2008) reported no overall change in post-restoration late season baseflows. In their modeling study, O’Hara et al. (2014) reported a post-restoration increase in dry season baseflows in relatively wet years, however, this effect may be limited in drier years due to a lack of adequate groundwater storage necessary to cover multiple years. In a different field monitoring study, Hunt et al. (2018) also reported a post-restoration increase of dry season baseflows. Hammersmark et al. (2008) reported a decrease in post-restoration late season baseflows within the restoration area but an increase in flows downstream from it. Nash et al. (2018) predicted a decrease in post-restoration late season baseflows in their modeling study. For meadows fed predominantly by groundwater sources (as opposed meadows recharged primarily by flooding of surface flows), two studies (Hunsaker et al. 2015; Essaid and Hill 2014) predict restoring incised channels would reduce summer streamflows since channel incision in unrestored meadows induces drainage of groundwater. However, for meadows with through flowing streams where overbank flooding is an important source of meadow groundwater recharge, restoring incised channels would be expected to increase groundwater storage and increase baseflows (Hunsaker et al. 2015). Some authors caution that meadow groundwater systems may take years to reach a new equilibrium after restoration and, therefore, short term monitoring results may not be representative of long term effects (Hoffman et al. 2013; O'Hara et al. 2014).

Summary of Potential Hydrologic Effects

Given the variety of responses documented in different studies, it is difficult to generalize or predict site specific effects for the Mattley project with high confidence without producing a high level hydrologic model of the project area, which is beyond the scope of this analysis. However, some effects can be predicted with some confidence based on consistencies of findings among different studies in the literature. Within the meadows, in the vicinity of the pond/plug treatments (east and middle gullies; Mattley Creek meadow), it is very likely that groundwater elevations and overall groundwater storage within the local meadow aquifer would increase in response to restoration. It is also likely that there would then be an increase in wet meadow vegetation extent and vigor in response to the increased availability of shallower groundwater. As a result of the gullies being filled, it is very likely that overbank flooding of the meadow surface would increase in frequency and extent, leading to increased groundwater recharge and a reduction in channel/gully erosion. Increased overbank flooding would attenuate peakflows downstream of the project area. The effects on streamflows within and immediately downstream of the restoration areas is uncertain; it is possible that post-restoration streamflows would increase during the snowmelt period of spring-early summer but it is uncertain whether this effect would persist into the late summer – fall or whether flows might even be decreased later in the season. The potential effects to streamflow within the west channel are of particular interest due to the presence of SNYLF. No restoration activities are planned within the west channel at this time. It is unlikely that streamflows would be reduced in the west channel as a result of the project. The vast majority of the west channel's contributing drainage area is upstream and uplsope of and, therefore, outside the influence of the project activities. It is possible that baseflows in the west channel within the meadow may increase. Higher post-restoration groundwater elevations in the vicinity of the middle gully could create a lateral groundwater gradient as groundwater at a higher elevation is directed toward the lower base level elevation of the incised west channel. Given the small size of the project area, any changes to streamflows resulting from the project would have a negligible influence on downstream beneficial uses.

Summary of Direct and Indirect Effects

The project is not expected to result in any adverse effects to beneficial uses of water. BMPs designed to protect beneficial uses have been incorporated into the project design and will be implemented during project construction. BMP monitoring has demonstrated that BMPs are effective in protecting water quality and are generally implemented at high levels. Overall, the project is expected to result in reduced channel erosion and a long term improvement in meadow hydrologic function and associated habitat.

Cumulative Effects

Introduction

Cumulative Watershed Effects (CWE) were assessed using the USFS methodology (USDA 1988) and the Stanislaus National Forest CWE spreadsheet that implements the Region 5 Equivalent Road Acres (ERA) model (USDA 2003). Cumulative impacts are defined as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time" (40 CFR 1508.7). CWE are defined as "[a]ll effects on beneficial uses of water that occur away from the location of actual land use which are transmitted through the fluvial system. Effects can be either beneficial or adverse and result from the synergistic or additive effects of multiple management activities within a watershed" (USDA 1988).

Physical alterations to watershed hydrology through land use disturbances are assumed to be the primary mechanisms for initiating CWE (USDA 1988). The CWE model uses conceptual site disturbance ERA coefficients to track land uses that could change watershed hydrology and initiate CWE. The ERA model is intended to predict the risk of cumulative effects, not actual effects. As such, it is intended to be an initial screen for focusing field evaluation priorities and can be used to compare effects between alternatives. ERA coefficients vary by activity type and are based on the intensity of ground disturbance an activity causes, ranging from 0 – 1, with a value of 1 representing the highest level of disturbance (i.e., a road). Most activity types are also assigned a recovery period to account for vegetative recovery over time. For example, ERA from selective logging with a 10-year recovery period will decrease by 10% every year after logging and will be 0 after 10 years. More permanent disturbances such as roads are not assigned a recovery period and are considered "Constant Features" in the CWE model. ERA from all disturbances in a watershed are summed to get total ERA for each of the years over the desired analysis time period.

Total ERA are expressed as a percentage of the watershed's area and are compared to a threshold of concern (TOC). TOC is an upper limit of land use disturbance that a watershed can absorb without resulting in adverse CWE. TOC is estimated based on a watershed's natural capacity "to absorb land use impacts without increasing CWE susceptibility to unacceptably high levels" (USDA 1988). TOC does not represent the exact point at which CWE will occur, but rather, it serves as a "yellow flag" indicator of increasing susceptibility for significant adverse cumulative effects to occur within a watershed (USDA 1988). Risk of adverse cumulative effects to downstream beneficial uses are increased as a watershed approaches or is impacted beyond the TOC. TOC was estimated for project analysis watersheds using the methodology outlined in USDA (1988) and ENF (1998).

Past, present and future foreseeable activities occurring within the analysis watersheds were identified and ERA calculated. Activities evaluated included land use (e.g., roads and other infrastructure, residential development, logging, construction) and disturbance events (e.g., wildland fires). Proposed project treatments were assigned appropriate ERA coefficients and recovery periods. CWE risk was evaluated over a 10-year analysis period.

Field evaluation is necessary to determine the threshold of concern (TOC) for each watershed and to validate the modeled ERA prediction with actual and expected future field conditions. Project-related water quality parameters and watershed condition are evaluated via in-stream and near-stream indicators of condition. This evaluation is essential to help interpret cumulative effects of past projects and potential cumulative effects given proposed activities and other reasonably foreseeable future activities. Field review was used to verify that the geographic and temporal extent of analysis was adequate for evaluation of cumulative watershed effects (Connaughton 2005).

CWE Analysis Results

Figure 3. ERA results for the Mattley Creek subwatershed

	Annual % ERA per Feature									
	2020	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**
Proposed Action (Alt. 1)	0.00	0.28	0.22	0.17	0.11	0.06	0.00	0.00	0.00	0.00
Other Current & Future Activities	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Previous Activities	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Constant Features	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75

	Annual % ERA per Alternative									
	2020	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**
Proposed Action (Alt. 1)	0.75	1.03	0.97	0.92	0.86	0.81	0.75	0.75	0.75	0.75
No Action (Alt. 2)	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75

Existing ERA for the analysis watershed is very low (total ERA of 0.75%), far below the estimated threshold of concern of 10 – 12%. The watershed has a low road density and little development given that a sizeable proportion of land is within a wilderness area; “Constant Features” comprise all of total existing ERA. No vegetation management activities have occurred within the past 10 years that would contribute to overall ERA. No recent fires or other disturbances have occurred. At present there are no known future foreseeable major land management or development projects planned. The proposed action would increase total ERA slightly when implemented (estimated in 2021) and then decline to zero over the estimated 5 year recovery period. The Mattley Meadow restoration project would have a negligible influence on CWE risk given its small size, implementation of BMPs, and its overall expected long term beneficial effects on reducing erosion and sedimentation. In summary, current CWE risk for the analysis watershed is very low and the proposed action would not appreciably increase the risk.

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Appendix A. Watershed Design Criteria

The following design criteria incorporate required Best Management Practices (BMPs) as outlined in USDA (2011) and USDA (2012). These requirements have been incorporated into the project design and implementation planning to ensure protection of water quality and beneficial uses. Design Criteria would also ensure project compliance with the Forest Plan (USDA 2017) and the Sierra Nevada Forest Plan Amendment Aquatic Management Strategy and Riparian Conservation Objectives (USDA 2004).

Erosion Control Plan *(BMP 2.13 Erosion Control Plans)*

- The erosion control plan will consist of the BMPs incorporated into the project design criteria as well as any additional measures required by regulating agencies as part of the project permitting process (e.g., 404/401 permits, Streambed Alteration Agreement, etc.)
- Implementation of BMPs will be documented in a BMP checklist that will be prepared prior to project implementation.

Meadow Restoration *(BMP 7.1 Watershed Restoration; BMP 1.19 Streamcourse and Aquatic Protection)*

- All required permits (e.g., 404/401 permits, Streambed Alteration Agreement, etc.) would be secured prior to project implementation.
- Work would be implemented during the low flow period (generally late summer through fall).
- Equipment access would be on existing and temporary routes. Temporary routes would be restored at the end of project implementation.
- To reduce erosion on disturbed areas the following techniques may be used: placement of large and small woody debris; soil scarification; scattering of fine organic debris (such as wood straw or chips, pine needles, etc.); other practices as needed or required by permits.
- To promote revegetation, topsoil would be removed and stockpiled during pond excavation and then used to top dress the completed plugs. Live plant material such as sod mats and willows excavated during construction may be transplanted to plugs or other areas. Locally collected seed, plant stakes, or live plants may be used where needed.
- Grazing would be excluded from restoration areas using temporary fencing until the site has sufficiently revegetated and stabilized, generally a minimum of 2 – 3 years.

Equipment Refueling and Servicing *(BMP 2.11 Equipment Refueling and Servicing; 7.4 Forest and Hazardous Substance Spill Prevention Control and Countermeasure Plan; 1.19 Streamcourse and Aquatic Protection)*

- Allow equipment refueling and servicing only at approved locations, which are well away from waterbodies.
- Report spills and initiate appropriate clean-up action in accordance with applicable State and Federal laws, rules and regulations.
- Clean equipment used for instream work prior to entering the water body: Remove external oil, grease, dirt and mud from the equipment and repair leaks prior to arriving at the project site. Inspect all equipment before unloading at site. Inspect equipment daily for leaks or accumulations of grease, and correct identified problems before entering streams or areas that drain directly to waterbodies. Remove all dirt and plant parts to ensure that noxious weeds and aquatic invasive species are not brought to the site.

Water Sources *(2.5 Water Source Development and Utilization)*

- Use of water sources would be in accordance with the conditions (e.g., minimum instream flows, etc.) specified in BMP 2.5 (Water Source Development and Utilization).

Monitoring *(BMP 7.6 Water Quality Monitoring)*

- Visual and photo point monitoring of the meadow restoration area would be conducted for several years after implementation to ensure restoration actions are functioning as intended and meeting project objectives. BMP effectiveness monitoring using the national protocol may also be conducted. Corrective actions consisting of any of the tools and techniques as described for the proposed action may be implemented where needed.
- Implement all monitoring and reporting required by terms of permits.