

Placer County Water Agency Middle Fork American River Project (FERC Project No. 2079)

GEOMORPHOLOGY/RIPARIAN MONITORING PLAN



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List of Acronyms

CDFG	California Department of Fish and Game
Commission	Federal Energy Regulatory Commission
DBH	diameter at breast height
FERC	Federal Energy Regulatory Commission
GIS	Geographic Information Systems
GPS	Global Positioning System
GRMP	Geomorphology and Riparian Monitoring Plan
MFP	Middle Fork American River Project
PCWA	Placer County Water Agency
Project	Middle Fork American River Project
State Water Board	State Water Resources Control Board
TSP	Technical Study Plan
TSR	Technical Study Report
USDA-FS	United States Department of Agriculture-Forest Service

1.0 INTRODUCTION

This Geomorphology/Riparian Monitoring Plan (GRMP) was developed for the Placer County Water Agency's (PCWA) Middle Fork American River Project (MFP or Project) located on the west slope of the Sierra Nevada range primarily in Placer County, California. Monitoring of sediment and channel conditions and riparian vegetation conditions has been integrated into one plan to facilitate coordination of data collection, analyses, and reporting for these two inter-related resources.

The goal of the GRMP is to obtain, for comparative purposes, information on channel and riparian conditions in selected bypass and peaking reaches associated with the MFP under the flow and sediment regimes specified in the new license.

2.0 GRMP ORGANIZATION

The GRMP is organized into the following sections:

Section 3.0 GRMP Objectives: This section defines the purpose of the GRMP.

Section 4.0 Monitoring Approach: This section describes the locations, schedule, and sampling and analytical methods for monitoring of channel and sediment conditions and riparian vegetation in bypass and peaking reaches over the term of the new license.

Section 5.0 Reporting and Consultation: This section describes agency consultation and reporting that would be conducted over the term of the new license.

Section 6.0 Literature Cited: This section provides a list of documents or other resources that are referenced in the GRMP.

3.0 GRMP OBJECTIVES

The objectives of the GRMP in the bypass and peaking reaches are as follows:

- General Purpose Monitoring
 - Monitor channel and sediment conditions, including general channel shape, bank erosion and stability, and fine sediment in pools; and
 - Monitor riparian vegetation communities, including species composition, age class structure, relative cover, vegetation community structure, position along the stream channel, and health.
- Special Purpose Monitoring
 - Monitor channel shape and particle size composition in reaches where both sediment augmentation / sediment pass-through and scheduled pulse flows occur.

4.0 MONITORING APPROACH

This section describes the monitoring locations and schedule, methods, and analyses for general purpose and special purpose monitoring.

4.1 MONITORING LOCATIONS AND SCHEDULE

General purpose monitoring of channel and sediment conditions and riparian vegetation will be conducted at ten monitoring locations on the bypass and peaking reaches (GRMP Table 1; GRMP Map 1). The length of each of the general purpose monitoring locations (monitoring reach) will be a minimum of 20 channel widths. The monitoring reach will be selected during the first monitoring period and the end points documented for monitoring during subsequent years. The types of monitoring to be conducted at each location are identified in GRMP Table 1. Geomorphology and riparian studies were previously conducted at all of these locations during studies conducted in support of the relicensing of the MFP (AQ 9 – Geomorphology Technical Study Report [AQ 9 – TSR] and AQ 10 – Riparian Resources TSR [AQ 10 – TSR]) (PCWA 2011a and 2011b; Supporting Document [SD] B).

Special purpose monitoring of channel cross-sections and substrate facies mapping will be conducted at five locations within the reaches where sediment augmentation/ pass-through will be implemented downstream of diversion facilities (GRMP Table 1; GRMP Map 1). The three special purpose monitoring locations downstream of the small diversions (Duncan Creek, North Long Canyon Creek, and South Long Canyon Creek) are in the vicinity of the general purpose monitoring locations, but the special purpose monitoring may occur, for example, closer to the diversion structures (see the method of special purpose monitoring site selection below). The monitoring is designed to document any changes in channel shape or channel substrate conditions that may occur from the sediment that will be placed or passed downstream of these facilities. The length and location of the special purpose monitoring locations will be determined in the field in consultation with the USDA-FS, State Water Board, and CDFG. The length will not exceed 20 channel widths unless mutually agreed to by PCWA. The intent is to select an appropriate response reach (not a transport reach) downstream from the diversion facilities and augmentation sites, if possible.

General purpose monitoring will be conducted once every 5 years beginning in year 2 of license issuance (i.e., years 2, 7, 13, 18, etc.). If, however, the License is issued early in the calendar year (Jan – May), the first year of monitoring will occur in Year 1 to develop a baseline. Subsequent sampling, however, will remain on the year 7, 13, 18, etc. schedule synchronous with several other monitoring plans. Monitoring will also occur in the years following the first three large winter/spring flow events. Large flows are defined as flows greater than 6,000 cfs measured in the Rubicon River at the Rubicon River above Ellicott Bridge Gage and greater than 2,000 cfs in the Middle Fork American River measured at the Middle Fork American River at French Meadows Gage (USGS Gage No. 11427500). All monitoring will occur in the summer/fall.

Special purpose monitoring will occur at the same time as the first three general purpose monitoring events. After the results from the first three monitoring events are

available, PCWA will meet with the USDA-FS, State Water Board, and CDFG to re-evaluate future special purpose monitoring needs.

4.2 MONITORING METHODS

4.2.1 General Purpose Monitoring

A combination of methods will be used to monitor trends in channel and sediment conditions and riparian vegetation, including ground-level photo documentation, riparian/channel cross-sections, V* sampling, channel stability, and riparian vegetation mapping. The integration of the geomorphology and riparian vegetation data collection is shown in GRMP Table 1. Each of these methodologies and the relation to monitoring channel and sediment conditions and riparian vegetation is described below.

4.2.1.1 Photo-documentation

Photography at the monitoring locations over the term of the license will be used to visually document any trends in conditions of the channel and riparian communities (Elzinga et al. 1998; Bureau of Land Management 1999; Burton et. al. 2007). Specifically, the photographs will be used to document changes in bank erosion; general channel shape; relative herbaceous and woody vegetation cover along the stream banks; structure of the vegetation community (e.g., multi-layered canopy, single stratum shrub, tree-shrub, shrub-herbaceous, etc.); and position of the vegetation along the channel.

Permanent photo point locations will be selected at each monitoring location (GRMP Table 1) in consultation with the United States Department of Agriculture-Forest Service (USDA-FS), State Water Resources Control Board (State Water Board), and California Department of Fish and Game (CDFG). Photo point locations used in support of the relicensing studies will be reviewed and considered when selecting permanent photo point locations (PCWA 2007a). Each photo point will be marked with capped rebar or other permanent marker at the photographer's location and the location will be recorded with a Trimble® GeoXT Global Positioning System (GPS) unit, or similar (sub-meter accuracy).

Photographs from previous years will be taken into the field each year to assist in relocating the photo point locations and with orienting the camera. The photographs will be taken at approximately the same time of year (season) and time of day during the monitoring surveys. The photo point procedures, including protocols for documenting the photo point locations and repeat photography, are outlined in Attachment A.

4.2.1.2 Riparian and Channel Cross-sections

Riparian/channel cross-section surveys will be used to monitor both the shape of the channel and the position of riparian vegetation adjacent to the channel. The endpoints of the cross-sections will be marked with headpins, such as capped rebar or other semi-permanent marker, and documented with a Trimble® GeoXT GPS unit, or similar (sub-meter accuracy).

Three riparian/channel cross-sections will be surveyed at each geomorphology and riparian monitoring location (GRMP Table 1). The riparian/channel cross-sections will correspond to those surveyed during the relicensing studies, if the headpins can be relocated (PCWA 2007a; PCWA 2011b). If headpins for any cross-section cannot be located, photographs taken during the relicensing studies of the cross-section will be reviewed to locate its approximate location. Each cross-section survey will include the channel and will extend across the riparian zone to the hillslope including any bars, if present. Elevations will be surveyed in sufficient detail to detect changes in channel shape and topography, which may occur within the channel, on the channel bars, and within the riparian corridor. In addition, the surveyors will document the location of the water surface elevation and the location(s) of the established woody vegetation closest to the channel along each surveyed cross-section.

4.2.1.3 Residual Fine Sediment in Pools

Residual fine sediment in pools will be monitored using V^* estimates (Hilton and Lisle 1993), which is consistent with the survey method used for studies completed during the relicensing of the MFP (AQ 9 – Technical Study Plan [TSP]; PCWA 2007b; and AQ 9 - TSR; PCWA 2011a). V^* is a ratio of the volume of residual fine sediment deposited in a pool divided by the total residual pool volume. “Residual” refers to the pool dimensions at the point of zero flow.

The V^* estimates will be conducted in ten pools within each of the monitoring reaches in the bypass reaches and in five¹ pools at the monitoring reaches in the peaking reach (GRMP Table 1). The pool locations will be the same as those surveyed for the relicensing studies, if they can be relocated (PCWA 2007a; PCWA 2011a). Field notes, maps, and photographs from the relicensing studies will be used to assist in re-locating the pools, as necessary. The locations will be documented with a Trimble® GeoXT GPS unit, or similar (sub-meter accuracy), and mapped for use in locating pools during subsequent sampling efforts.

The V^* surveys will be supported by a combination of photographic documentation of pool bottom sediments and sketch maps, and measurements of surface area and depth of fine sediment patches observed. Photographs and sketch maps will be scanned and compared following each monitoring survey.

4.2.1.4 Rosgen Level III Stream Condition and Channel Stability Characterization

Stream channel stability in North Fork Long Canyon Creek and South Fork Long Canyon Creek will be determined using the Rosgen modified Pfankuch procedure. This protocol, which has been used by the Forest Service for over 35 years, will be

¹ Due to their very large size and depth (often over 0.5-mile long and exceed 10-feet deep); pools in the Middle Fork American River below Ralston Afterbay will require significantly greater effort to monitor. Therefore, a total of five pools, instead of ten, will be visually surveyed at each of the monitoring locations, which is consistent with the number sampled for the studies completed during the relicensing of the MFP (AQ 9 – TSP and TSR; PCWA 2007b and 2011a).

undertaken to evaluate the upper and lower banks and streambed for evidence of excessive erosion and/or deposition. Mass wasting potential, detachability of bank and bed materials, channel capacity, and evidence of excessive erosion and/or deposition, will be considered.

4.2.1.5 Riparian Vegetation Mapping

Riparian vegetation will be mapped in the field along the length of each monitoring reach (GRMP Table 1). The mapping will extend across the riparian zone to the hillslope and on any bars, if present. The upstream and downstream points of the reaches will be documented with a Trimble® GeoXT GPS unit, or similar (sub-meter accuracy). An attempt will be made to survey the same reaches during subsequent surveys.

Co-dominant species will be mapped as polygons on either aerial photographs (if available) or topographic maps, with a minimum mapping size of 2,500 square feet. The boundaries of the polygons will be delineated using a Trimble® GeoXT GPS unit, or similar (sub-meter accuracy), if necessary. Percent cover of the dominant and sub-dominant species will be recorded for each polygon. This information will be used to classify the vegetation into plant associations, as defined in Potter (2005)². Age class information by woody species³ will be recorded for polygons with woody species present. Additional information will also be recorded at each polygon, including substrate size, bedrock, and large woody debris. In addition, observations of riparian health, recent scouring by high flows, or other factors that may affect the condition of the riparian vegetation will be recorded at each polygon, as appropriate.

The vegetation polygons will be digitized in Geographic Information Systems (GIS) or similar application, and maps of the vegetation composition, age classes, and substrate will be produced. An accompanying database (attribute table) will be developed that will include information on the dominant and sub-dominant species and age classes present, as well as any other observations made in the field for each polygon.

The riparian vegetation mapping will be combined with the cross-section survey data (Section 4.2.2. above) to illustrate and document trends in the distribution of riparian vegetation in relation to the stream channel and topography over the term of the license.

Species lists will also be compiled for each monitoring location, and will include common and scientific names of each taxon, whether each species is native or non-native, and any noxious weed or special-status category.

² Or subsequent classification, as agreed to by the USDA-FS, State Water Board, and CDFG.

³ Age class structure will be based on categories of shrub stem densities per individual and tree diameters, as follows: Seedlings and sprouts (S); Young (Y): shrubs with less than 10 stems per individual or trees with diameters (diameter at breast height [DBH]) less than 3 inches; Medium-aged (M): shrubs with between 10 and 60 stems per individual or trees with DBHs between 3 and 9 inches; and Old/Mature (O): shrubs with more than 60 stems per individual or trees with DBHs greater than 9 inches.

4.2.2 Special Purpose Monitoring

Channel shape and surface substrate composition will be monitored at the five special purpose monitoring sites as described below.

4.2.2.1 Channel Cross-sections

Channel cross-section surveys and substrate facies mapping will occur within each of the sediment augmentation/pass-through locations (GRMP Table 1). Seven channel cross-sections will be surveyed at the sediment augmentation/pass-through locations downstream of the small stream diversions (Duncan Creek, North Fork Long Canyon Creek, and South Fork Long Canyon Creek) (GRMP Table 1). These are in addition to the three riparian/channel cross-sections that are being surveyed in each of the reaches as part of the general purpose monitoring (GRMP Table 1). If the three general purpose monitoring cross-section locations are not suitable for sediment augmentation/pass-through monitoring, an additional three sediment augmentation/pass-through cross-sections may be added in consultation with the USDA-FS, State Water Board, and CDFG during the site selection process. A total of 10 channel cross-sections will be surveyed at each of the sediment augmentation/pass-through locations downstream of Middle Fork Interbay and downstream of Ralston Afterbay (GRMP Table 1). Five of the cross-section will be those that will be surveyed as described in the Sediment Management Plan and the other five cross-sections will be selected as part of this monitoring plan.

The channel cross-sections will be co-located within the length of channel where substrate facies mapping occurs. The channel cross-sections will be located, to the extent possible, in portions of the channel that are sensitive to channel changes due to substrate augmentation (e.g., pool tails, wide riffles). The cross-sections will include the channel and extend to or beyond bankfull, including any mid-channel bars, if present. Elevations will be surveyed in sufficient detail to detect changes in channel shape and topography, which may occur.

4.2.2.2 Channel Substrate Facies Mapping

Channel substrate facies will be mapped for the length of the monitoring reach (selected in consultation with the agencies [Section 4.1]) and will be used to describe reach-wide variations in surface substrate size. The term facies refers to “sedimentary deposits distinct in grain size and/or sedimentary structure representing distinct local depositional environments (Pettijohn 1975).” Mapping will follow the system developed by Buffington and Montgomery (1999) to classify textural patches using ternary diagrams. The three dominant size categories present (e.g. silt, sand, cobble, boulder) will be identified (excluding any component less than 5%) and the deposit classified based on a visual estimate of the relative abundance of the identified sediment types.

Particle size distributions of several facies will then be determined through use of pebble counts (Wolman 1954). At least three pebble counts will be conducted in each of the facies types for each monitoring reach, such that a weighted average grain size distribution can be calculated. Each pebble count will include approximately 100 grains.

Particles will be selected using the “first blind touch” method and will be measured on the intermediate axis (b-axis) and recorded into size categories at one-half phi increments. All silt and sand-sized particles will be recorded as “less than 2mm”.

4.2.3 Hydrology

The hydrology and other environmental factors (e.g., fire) that may affect the trends in channel and riparian vegetation conditions (upward or downward) since the previous sampling period will be summarized. The frequency and magnitude of high flow events and non-spill years between monitoring periods will be summarized.

4.3 ANALYSIS METHODS

The following describes the analyses methods to be used.

4.3.1 General Purpose Monitoring

4.3.1.1 Photo-documentation

The photographs will be compared to each preceding monitoring period. Results will be included in the Geomorphology/Riparian Monitoring Report.

4.3.1.2 Riparian and Channel Cross-sections

The shape of each cross-section will be compared to the preceding monitoring periods and surveys completed in support of the relicensing studies (if available) (PCWA 2007a) to document potential change in channel shape and/or floodplain topography. In addition, the position of the vegetation adjacent to the channel along the surveyed riparian/channel cross-sections will also be compared to the preceding monitoring periods.

4.3.1.3 Residual Fine Sediment in Pools

V^* will be calculated for each pool using the method described in Hilton and Lisle (1993). The residual pool measurements, average volume of fine sediment stored within each pool, and the calculated V^* index will be summarized in tabular format. The weighted average, V^*w of the calculated individual V^* s, will be determined using all of the sampled pools at a monitoring location and compared to previous measurements.

4.3.1.4 Riparian Vegetation Mapping

The riparian community composition and age class maps will be compared to each preceding monitoring period, and to comparable data collected during the relicensing studies, as appropriate (PCWA 2007a; PCWA 2011b). The comparison will include a discussion of the recent hydrology, as it relates to any changes in riparian cover, composition, and age classes present at each monitoring location. Observations of riparian health, scouring by high flows, or other factors that may have affected the conditions of the riparian vegetation will also be summarized. Species lists and any

occurrences of special status plants or noxious weed species within each site will be documented in tabular format.

4.3.1.5 Rosgen Level III Stream Condition and Channel Stability Characterization

Rosgen Level III stream condition and channel stability data in North Fork Long Canyon Creek and South Fork Long Canyon Creek will be summarized for each monitoring location in tabular format. Conditions will be compared to the results of the preceding monitoring periods. The comparison will also include a discussion of recent hydrology, as it relates to any changes in channel conditions and channel stability in each monitoring reach.

4.3.2 Special Purpose Monitoring

4.3.2.1 Channel Cross-sections

Channel cross-sections will be compared as discussed in Section 4.3.1.2.

4.3.2.2 Channel Substrate Facies Mapping

Channel substrate facies mapping will be compared to the substrate facies maps from the preceding monitoring periods. The comparison will also include a discussion of recent hydrology, as it relates to any changes in channel substrate in each monitoring reach.

4.3.3 Hydrology

Daily flows and peak flows, measured at the gage located nearest each monitoring location, will be summarized since the preceding monitoring period in graphical format.

4.4 ELECTRONIC DATABASE

All photo point data will be stored electronically with supporting photograph information. Channel cross-section and sediment V^* data will be entered and stored in an electronic database (Excel spreadsheet or similar program). Riparian mapping data will be stored electronically (GIS or similar format), with supporting metadata and attribute information. Attribute data will also be stored in Excel or other compatible program. The databases will be provided to resources agencies upon request.

5.0 REPORTING AND CONSULTATION

A Geomorphology/Riparian Monitoring Report summarizing the general and special purpose monitoring, including photo points, channel cross-sections, V^* , channel stability, riparian vegetation, facies mapping, and hydrology data will be prepared by PCWA and distributed to the USDA-FS, State Water Board, and CDFG for review and comment within 120 days following the completion of each monitoring period. A 60-day review period will be provided to the agencies. Based on the results of the monitoring and/or comments received during the review process, PCWA and the agencies may call

a meeting to discuss the results or modify the monitoring program. Within 60 days of receipt of comments, or 60 days following any meeting, comments will be addressed and the final report will be filed by PCWA with the agencies (USDA-FS, State Water Board, and CDFG) and the Federal Energy Regulatory Commission (FERC or Commission).

6.0 LITERATURE CITED

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- Hilton, S, and T.E. Lisle. 1993. Measuring the fraction of pool volume filled with fine sediment. Res. Note PSW-RN-414. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture.
- Pettijohn, F.J. 1975 *Sedimentary Rocks*, Third Edition, New York: Harper and Row, 628 p.
- Placer County Water Agency (PCWA). 2007a. Middle Fork American River Project (FERC Project No. 2079). 2006 Physical Habitat Characterization Study Report – Supporting Document G.
- _____. 2007b. Middle Fork American River Project (FERC Project No. 2079), Pre-Application Document (PAD), Submitted to FERC on December 13, 2007.
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- Potter, D.A. 2005. Riparian Plant Community Classification. West Slope, Central, and Southern Sierra Nevada, California. United States Forest Service Pacific Southwest Region. R5-TP-022. December.

Wolman, M.G. 1954. A method of sampling coarse river-bed material. Transactions of American Geophysical Union 35: 951-956

TABLES

GRMP Table 1. Geomorphology and Riparian Vegetation Monitoring Locations.

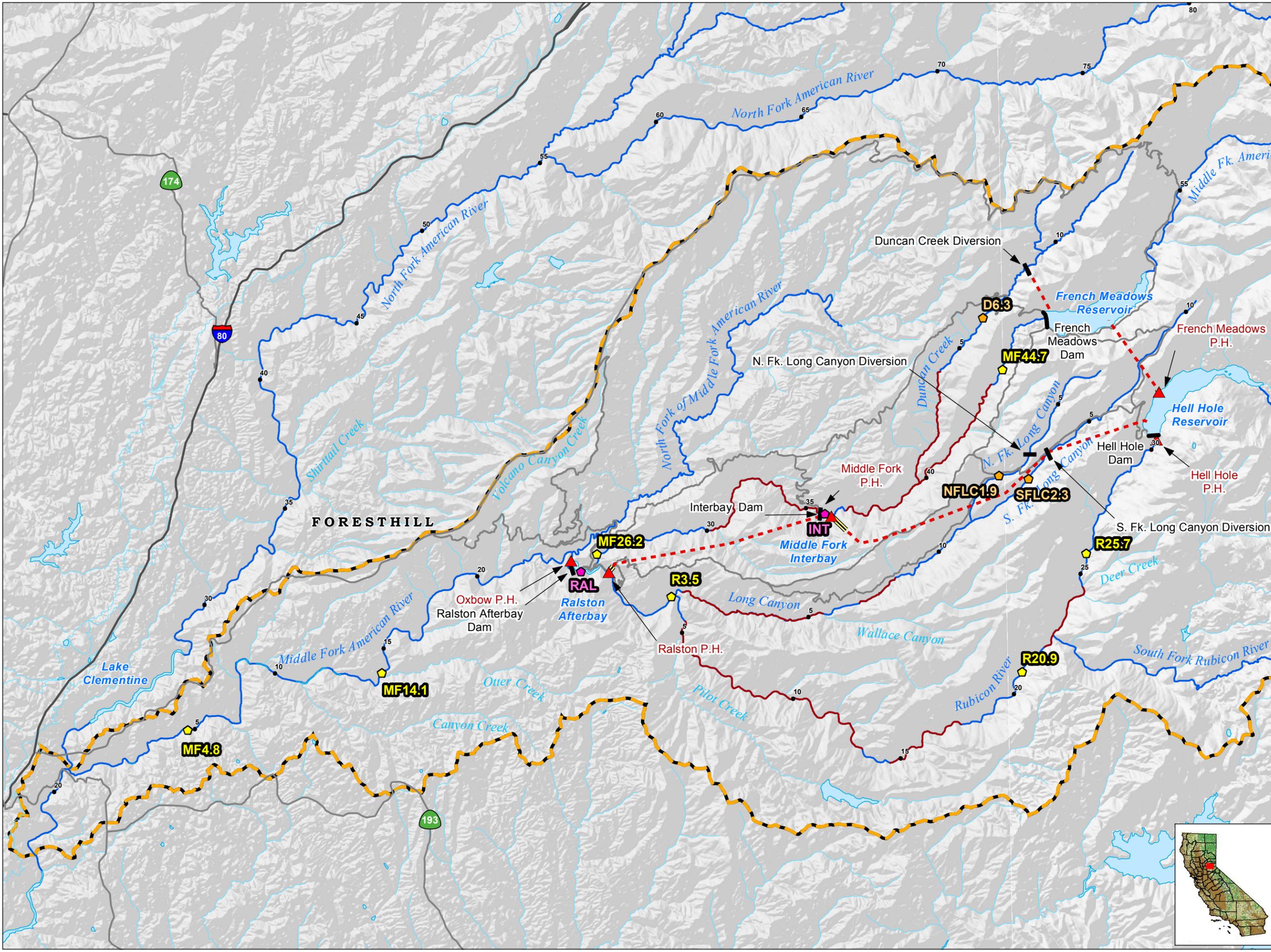
Monitoring Location Description	Monitoring Location ¹	Reach Type		Monitoring Method						
				General Purpose Monitoring					Special Purpose Monitoring	
		Peaking Reach	Bypass Reach	Photo-documentation	Riparian/Channel Cross-sections	V [*] Sampling Pools	Vegetation Mapping	Channel Stability	Channel Cross-sections	Substrate Facies Mapping
Middle Fork American River Downstream of French Meadows Dam										
French Meadows Dam to confluence with Duncan Creek	MF44.7		•	•	3	10	•			
Middle Fork American River Middle Fork Interbay to Ralston Afterbay										
Downstream of Middle Fork Interbay	INT (MF35.3)		•	•				5 ³	•	
Upstream of Ralston Afterbay	MF26.2		•	•	3	10	•			
Middle Fork American River Downstream of Ralston Afterbay										
Downstream of Ralston Afterbay	RAL (MF23.5)	•		•				5 ³	•	
Volcano Canyon Creek confluence to Canyon Creek confluence	MF14.1 ²	•		•	3	5	•			
Canyon Creek confluence to North Fork American River confluence	MF4.8 ²	•		•	3	5	•			
Rubicon River										
Hell Hole Dam to Deer Creek confluence	R25.7		•	•	3	10	•			
Deer Creek confluence to Long Canyon Creek confluence	R20.9		•	•	3	10	•			
Long Canyon Creek confluence to Ralston Afterbay	R3.5		•	•	3	10	•			
South Fork Long Canyon Creek										
Diversion to confluence with Long Canyon Creek	SFLC2.3		•	•	3	10	•	•	7	•
North Fork Long Canyon Creek										
Diversion to confluence with Long Canyon Creek	NFLC1.9		•	•	3	10	•	•	7	•
Duncan Creek										
Diversion to confluence with Middle Fork American River	D6.3		•	•	3	10	•		7	•

¹ All the monitoring sites were surveyed for the relicensing studies (AQ 9 - TSR PCWA 2011a; and AQ 10 - TSR PCWA 2011b).

² Riparian vegetation composition and substrate particle size mapping was conducted at this monitoring location during the relicensing studies (AQ 10 – TSR; PCWA 2010b and AQ 1 – Instream Flow TSR [AQ 1 – TSR]; PCWA 2011c).

³ These cross-sections are in addition to the 5 pool cross-sections that are being selected in the Sediment Management Plan and will be monitored as part of this plan.

MAPS



- Project Facilities**
- Powerhouse
 - Dam
 - Tunnel
 - Penstock
- Transportation**
- Major Highway
 - Minor Highway
- Hydrography**
- Watercourse with river miles (5 mi. increments)
 - Water Body
 - Middle Fork American River Watershed*
 - Inaccessible Stream Segment
- *Modified from Calwater Ver. 2.2 to represent drainage above high-water mark of Folsom Lake

- Monitoring Site Locations**
- General Purpose Monitoring (Photo-documentation, Channel Cross-sections, V* Sampling, and Vegetation Mapping)
 - General Purpose and Special Purpose Monitoring
 - Special Purpose Monitoring Only



PCWA
Placer County Water Agency
Middle Fork American River Project

GRMP Map 1
Geomorphology and Riparian Vegetation Monitoring Locations

0 1 2 3
Miles

Projection: CA State Plane, Zone 2
Datum: NAD 83

Date: 11/16/12

ATTACHMENT A
Photo Point Procedures

PHOTO POINT PROCEDURES

Images taken at the photo points will be landscape photographs that will be taken each monitoring period from the same locations. The views in the photographs will be the same so that differences between monitoring periods can be compared.

Photo point locations will be established to document channel and riparian vegetation conditions within each monitoring location. The location(s) will be established at a location from which multiple view photographs could be taken, if possible. If necessary to document the riparian vegetation, more than one photo point location will be established. Within each view, an identifiable object, such as a large rock, will be included, if possible, to assist with scale and orientation during the monitoring periods. The photo point markers will be located in places that will likely not be eroded easily by high floods or disturbed by other activities, such as vandalism. Markers will be as inconspicuous as possible to minimize the potential for vandalism.

Photo point locations will be established from which channel conditions, including bank erosion, stream bank and bar vegetation, and vegetation within floodplains are clearly visible. If a location is established within the stream channel, a GPS point and distance(s) from the stream banks or other permanent marker will be used to document its position.

This attachment describes the procedure for documenting the photo point locations and for retaking the photographs each monitoring period. A field datasheet is provided. One datasheet will be filled out for each photo point location. For those locations where more than one view is taken from the same photo point location, all the views can be recorded on the same datasheet.

DOCUMENTING PHOTO POINT LOCATIONS

Photo point locations will be selected in consultation with the USDA-FS, State Water Board, and CDFG. A site marker, such as a stake, will be placed at the location. During the first monitoring period, the photo point locations will be established, using the following procedure:

- The photographer will stand immediately over the site marker, if possible. If this is not possible, the location of the photographer relative to the marker will be recorded on the datasheet (distance and angle from the marker).
- The time of the photograph, camera type, focus distance, height of the camera above the ground, compass bearing and vertical angle of the view will be recorded on the datasheet.
- At least one reference point will be established for each photo point location. The reference point will be within 200 feet of the photo point location. A reference point could be a large tree outside of the flood zone or a large rock. The distance, compass bearing, and vertical angle will be measured and

recorded from the reference point to the photo point location. A marker will be placed on the reference point. The reference point will be described on the datasheet and a site sketch will be drawn showing major landmarks and the locations of the photo points and reference points. The information from the initial sketch with the reference point locations identified will be transferred to GIS for display over a high resolution aerial image and stored electronically.

- Additional photographs will be taken of the reference point and the photo point locations. The locations of each will be marked and labeled on the photographs for future use in the field. All information on the location of the photo points and reference points will be stored electronically.
- The locations of the photo and reference points will be recorded with GPS. These locations will be overlain on aerial photographs of each monitoring location to document the approximate locations of the points. The maps will be completed at a scale with sufficient detail to identify obvious landmarks and trees. These maps will be electronically stored for future use.
- Each photo point will be given an identification number, which will be used through the duration of the monitoring.

REPEAT PHOTOGRAPHY

The procedures for the photo points that will be followed during the subsequent monitoring periods are described below.

- For each photo point monitoring period, the field crew will take copies of the original photo point documentation on the locations of the photo and reference point markers, copies of the photographs, and maps. The type(s) of cameras used to take the photo points will be noted on the datasheet.
- The photographer will stand at the same place and height as that which the first photographs were taken. The camera will be aligned with the view at the same compass bearing as recorded during the initial photographs. The view will be compared with the previous photographs to ensure that it is as close as possible to the original.
- The time of the photograph, camera type, focus distance, height of the camera above the ground, compass bearing and vertical angle of the view will be recorded for this monitoring period.
- If the photo point marker cannot be located, an attempt will be made to locate a new photo point as close as possible to the original location using the reference point documentation, maps, and previous photographs. The USDA-FS, State Water Board, and CDFG will be notified and consulted if a new location is established.

- The new photographs will be catalogued with the previous photographs and stored electronically. The photographs will be compared with the previous photographs in the Geomorphology and Riparian Monitoring Report.

LITERATURE CITED

Powell, D.C. 2006. Recording the changes: field guide to establishing and maintaining permanent camera point systems. United States Department of Agriculture – Forest Service. Pacific Northwest Region. FS-14-SO-09-06. August. 21 pp.

PHOTO POINT DATASHEET

Site Name: _____ **Photo Point Identification Number:** _____

Date: _____ **Time:** _____ **Weather Conditions:** _____

GPS Coordinates: _____ **Photographer:** _____

Camera Type: _____

Subject of Photograph and Purpose of Photographs:

Photo 1	Photo 2	Photo 3
Camera Height (ft):	Camera Height (ft):	Camera Height (ft):
Camera Angle:	Camera Angle:	Camera Angle:
Azimuth:	Azimuth:	Azimuth:
Focus Distance:	Focus Distance:	Focus Distance:
Photo No.:	Photo No.:	Photo No.:
Camera No.:	Camera No.:	Camera No.:
Photo 4	Photo 5	Photo 6
Camera Height (ft):	Camera Height (ft):	Camera Height (ft):
Camera Angle:	Camera Angle:	Camera Angle:
Azimuth: °	Azimuth:	Azimuth:
Focus Distance:	Focus Distance:	Focus Distance:
Photo No.:	Photo No.:	Photo No.:
Camera No.:	Camera No.:	Camera No.:

Reference Point 1	Sketch of Photo and Reference Point Locations:
Description:	
Marking:	
Azimuth: Angle:	
Distance to photo point marker (ft):	
Reference Point 2	
Description:	
Marking:	
Azimuth: Angle:	
Distance to photo point marker (ft):	
Reference Point 3	
Description:	
Marking:	
Azimuth: Angle:	
Distance to photo point marker (ft):	

EQUIPMENT CHECKLIST

1. Datasheets
2. Photo point location markers
3. Sledge hammer
4. Markers for reference points
5. Tape measure (at least 100 feet)
6. Compass
7. Clinometer
8. Field Map
9. GPS unit