EL DORADO HYDROELECTRIC PROJECT NO. 184

Geomorphology Monitoring Plan Continuing Evaluation of Representative Channel Areas

VERSION 3.0

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PREPARED BY

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This monitoring plan (Plan or Monitoring Plan) has been developed to satisfy the geomorphology monitoring requirements as required by the Federal Energy Regulatory Commission license for the El Dorado Hydroelectric Project No. 184 (Project 184).

1. License Requirements

The Project 184 Monitoring Program[1] defines the specific geomorphology monitoring requirements:

Method: establishment and monitoring of permanent cross-section transects, longitudinal profiles, and channel properties in representative channel areas. Measurement of cross-section profile and substrate composition at each transect. The following sites are to be evaluated

- Lower Echo Creek
- SFAR below the diversion dam
- Silver Fork American River at Forgotten Flat
- Caples Creek all three reaches + spillway channel
- Oyster Creek below Highway 88

Frequency: Years 5, 10, 15, 20, 25, 30.

Rationale: Monitoring of permanent cross-sections, in combination with channel properties, provides the basis for evaluating changes in channel condition. Sampling as part of the relicensing process has provided baseline data prior to streamflow modification and/or measureable response to streamflow modification. Monitoring at the end of each 5-year period provides an index of changes in channel condition relative to changes in streamflow regime.

This Plan is to be developed in coordination with the FS, SWRCB, and Project 184 Ecological Resources Committee (ERC).

2. Background

There have been various geomorphic assessments conducted since the late 1990s through 2002 as part of the Project 184 relicensing process (ENTRIX, 2002). More recent geomorphology studies have been conducted at Oyster Creek, Caples spillway channel, and Caples Creek as part of the post-license compliance requirements. These compliance studies specifically address channel stability on Oyster Creek and on the Caples spillway channel. On Caples Creek, compliance studies are addressing the magnitude of pulse flows needed for channel maintenance.

[1] Section 7 of the El Dorado Relicensing Settlement Agreement, U.S. Forest Service 4(e) Condition No. 37, and California State Water Resources Control Board Section 401 Clean Water Act water Quality Certification Condition No. 13

3. Study Plan Objective

The objective of this monitoring effort is to monitor permanent cross-sections and channel properties at selected stream reaches for comparison to the ecological resource objectives in order to help determine if ecological resource objectives are achievable and being met as specified in the Project 184 Adaptive Management Program[2].

The ecological resource objectives identified in Appendix B, Section 1, of the El Dorado Relicensing Settlement Agreement provides the following fluvial geomorphology objective:

1. Fluvial Geomorphology Objective

Maintain or restore channel integrity. Maintain, improve, or restore fluvial processes to provide for balanced sediment transport, channel bed material mobilization and distribution, and channel structural stability that contribute to diverse aquatic habitat and healthy riparian habitat.

4. Monitoring Locations

The Project 184 FERC monitoring program license conditions specify eight locations for conducting geomorphic monitoring including three distinct sub-reaches in Caples Creek in addition to the spillway channel:

- Lower Echo Creek
- SFAR below the diversion dam
- Silver Fork American River at Forgotten Flat
- Caples Creek
  - Caples Meadow
  - Girl Scout Access
  - Jake Schneider Meadow
  - Caples Spillway Channel
- Oyster Creek below Highway 88

The eight general monitoring locations are depicted in Figure 1. Seven of the eight required monitoring locations have had prior geomorphic assessments performed for either the relicensing or the post-license compliance and in some cases for both. Lower Echo Creek is the only location which has not had a previous geomorphic assessment during relicensing studies. The Plan presented here preferentially establishes the monitoring sites in those stream reaches that have been geomorphically evaluated during past or ongoing studies.

[2] Section 8 of the El Dorado Relicensing Settlement Agreement and U.S. Forest Service 4(e) Condition No. 38

NUMBER OF CROSS-SECTIONS AND LOCATIONS

Three monitoring cross-sections will be established at each of the eight study sites, providing a total of twenty-four monitoring cross-sections, as follows:

- Caples Meadow channel sub-reach
- Jake Schneider channel sub-reach
- Girl Scouts Access channel sub-reach
- Caples spill channel
- Oyster Creek below Highway 88
- South Fork American River at Sand Flat
- Silver Fork American River at Forgotten Flat
- Lower Echo Creek

Table 1. Monitoring Locations for this Plan

CROSS-SECTION REACH LOCATION	DATES OF PAST SURVEYS	NO OF CROSS-SECTIONS FOR THIS PLAN	DESCRIPTION
Caples Meadow	1999, 2007, 2010	3	Downstream from Kirkwood Creek
Girl Scout Access	2000, 2007	3	Downstream of Caples Meadow
Jake Schneider	1999, 2007, 2010	3	6 miles downstream of Caples Meadow
Caples Spill Channel	1999, 2000, 2007, 2009	3	downstream of Caples Auxiliary Spill Dam
Oyster Creek below Hwy 88	1999, 2000, 2008	3	Reach begins immediately below culvert thru Hwy 88
South Fk American River at Sand Flat	2000	3	From just below diversion dam downstream to Carpenter Ck[3]
Silver Fk American River at Forgotten Flat	1999, 2000	3	Silver Fk Rd to Fritz Bridge to trailhead at Caples Ck bridge crossing. Trail 17E63 crosses Silver Fk in middle of reach
Lower Echo Creek	None	3	From Lower Echo Lake outlet to confluence with Upper Truckee River. Monitoring cross-sections to be established

Since multiple cross-sections have been previously established in all of the study reaches, except Lower Echo Creek, the monitoring team will attempt to re-locate and select from cross-sections used in the past. By selecting from an existing set of cross-sections, a longer historical record will be available from which to identify potential future changes. Table 1 provides a list of the dates of past cross-section surveys. Geomorphic studies, including cross-section surveys, longitudinal profiles, and particle size analyses have been conducted for most of these locations.

Lower Echo Creek extends from the release point at the dam on Lower Echo Lake to the confluence with the Upper Truckee River, a distance of approximately 1.5 miles. Since there are no known past cross-sections established on Lower Echo Creek, EID will establish three new cross-sections in this

[3] For Sand Flat reach, cross-section 1 is above campground, downstream of big boulder on right bank; cross-section 2 is at campground above steep riffle; cross-section 3 is the gage at Carpenter Creek confluence.

reach for monitoring. The monitoring team will select three cross-section sites in representative channel sections.

It may be challenging to relocate exactly the same cross-sections that have been previously established, in some cases prior to 2002. This will be particularly true for the Forgotten Flat and Sand Flat monitoring sites because there were no recent or ongoing surveys at these locations, and there are no detailed maps of the past cross-section locations. The monitoring team will use past relicensing study reports (ENTRIX, 2002), and recent study reports (Blue Line Consulting, 2009 and 2010, and ENTRIX, 2009), in conjunction with conducting a ground survey at each of the monitoring locations to identify the presence of flagging, cross-section headpins, benchmarks or other landmarks in the field that help define the past cross-section positions. The monitoring team will preferentially select cross-sections at each of the monitoring sites from cross-sections where the existing headpin alignments can be found in the field. If existing headpins cannot be relocated, then the monitoring team will use available aerial photos and maps, past study reports, and other background information to establish the selected monitoring cross-sections as close to their historic sites and alignments as feasible.

5. Schedule

Monitoring is to be conducted during summer or fall when streamflow levels are lowest for safe access and maximum data acquisition. As required, the monitoring is to be performed every five years, starting in year 5 after the license was issued (2006), so the first monitoring will be in 2011, followed by 2016, 2021 etc.

6. Data Collection

The monitoring and data collection procedures are discussed in this section.

CROSS-SECTION SURVEY

Headpins will be established for the cross-section survey endpoints at past and/or existing headpin locations, wherever these can be identified. If there is no existing headpin, then new headpins will be established behind the top of right and left banks. Headpins are to be located sufficiently back from the top of bank to ensure that they are secure in the case of future bank erosion. Cross-sections will be monumented so that they can be relocated in each five year monitoring period. The GPS position of headpins and the cross-section alignment will be recorded, photographed, and described in the field notes. Additionally, two temporary benchmarks will be established near one headpin for each cross-section, or group of cross-sections, and the GPS position recorded, photographed, and described in field notes. The benchmarks and cross-section survey do not need to tie into any known vertical datum, but must tie to the established temporary benchmarks. Multiple cross-sections through the same reach do not need to be tied to each other, but if they are tied together, then only one benchmark is needed for the group of cross-sections that are tied together.

The cross-section survey will be conducted in sufficient detail to capture any change in grade and to characterize the channel geometry, following standard survey procedures established by the USDA-FS

(Harrelson, 1994). The left and right water surface elevation, thalweg, bankfull width, and ground at both headpins will be included in the survey. The survey will be conducted to capture all grade breaks across the channel cross-section, in addition to ensuring that all of the same horizontal stations will be surveyed. Additional survey points will be added as needed to capture any changes in grade.

LONGITUDINAL PROFILE SURVEY

A longitudinal profile of the channel will be surveyed for a minimum distance of ten times the bankfull width, if that length of river can be safely accessed. . A longitudinal profile of the channel will be surveyed for a minimum distance of ten times the bankfull width, if that length of river can be safely accessed. The longitudinal survey reach will be positioned to encompass all three cross-sections; if the three cross-sections cannot be encompassed by a distance of ten times the bankfull width, the longitudinal survey reach will either be extended the appropriate distance to encompass all three cross-sections or surveys will be performed at each cross-section (i.e. for a distance of approximately five times the bankfull width upstream and five times the bankfull width downstream). The starting and ending points of the longitudinal profile will be selected to best accommodate safe access and effort to conduct the survey. The longitudinal profile will be surveyed for both the channel bed and the water surface elevation using standard survey procedures established by the USDA-FS (Harrelson, 1994). The longitudinal profile will characterize any substantial changes in channel gradient, including the topography of pool, riffles, and other habitat features of the channel that may occur within the longitudinal profile survey.

BED PARTICLE SIZE COMPOSITION

Along each cross-section a pebble count (Wolman, 1954) will be performed to characterize the particle size composition. A minimum of 100 particles are to be randomly selected using the "first blind touch" method across the bankfull channel width. Particles 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 may be classified as "less than 2mm."

BANK EROSION POTENTIAL

The bank erosion potential rating as described in Rosgen (1996) will be performed at each cross-section monitoring site, for both left and right banks. The bank erosion potential rating (very low, low, moderate, high, very high, or extreme) is based on five parameters including: bank height/bankfull height, root depth/bank height, root density, bank angle, and surface protection.

SITE MAP

A site map depicting the position of the three cross-sections and the long-profile survey area will be provided for each monitoring reach.

PHOTO-MONITORING

Photographs will be taken upstream and downstream from each cross-section site with views of the left and right streambanks. The purpose of the photo-monitoring is to provide information on changes in bank erosion and vegetative conditions over time.

7. Data Analysis

CROSS-SECTIONS

Cross-section surveys will be graphically plotted. If there are past surveys available for a given cross-section, EID will select at least the most recent past survey for comparative plotting. All future surveys will be plotted together to show any change in the shape, width, or depth of the channel. For Oyster Creek, the comparison will be to the as-built baseline survey only.

Two indices will be used to compare channel morphology changes over time. The indices are:

- net percent change in area ($\Delta A\%$)
- absolute percent change in area ($|\Delta A\%|$)

Net percent change in area quantifies the net change in cross-sectional area of a cross-section computed as:

$$\Delta A\% = \frac{\Sigma\,(A_i \text{ before} - A_i \text{ after})}{\Sigma\, A_i \text{ before}} \times 100$$

Where:

A_i is the partial area measured and calculated between each horizontal ground station. The sum of the partial areas is the total cross-sectional area.

The net channel cross-sectional area represents the total capacity of the channel available to carry streamflow. Expressed as a net change in area, it quantifies the extent to which a channel may be widening, narrowing, deepening, or incising (i.e., down-cutting) from year to year. However, a channel can experience aggradation (i.e., filling) or degradation (i.e., incision) without a net change in area since erosion in one part of the channel may balance an equal amount of deposition in another part of the channel. Therefore, it is possible that a computed net change in area is at or near zero, but may incorrectly characterize the channel as static or stable. To avoid this potential bias, absolute percent change is a useful companion indicator. Absolute percent change in area quantifies cumulative channel change ($|\Delta A\%|$ = erosion + deposition).

It is computed as:

$$|\Delta A\%| = \frac{\Sigma\ |(A_i \text{ before} - A_i \text{ after})|}{\Sigma\, A_i \text{ before}} \times 100$$

Absolute change in area is useful because it represents the total amount of streambed material movement during the monitoring period. The absolute percent change is never less than the net percent change at any given cross-section since it represents cumulative channel changes, quantifying areas of erosion and deposition. Frequent changes in channel shape (e.g., high values of absolute percent area change) may be indicative of high erosion and deposition rates, and therefore may be detrimental to aquatic habitat conditions.

In order to determine the net percent change in area and the absolute change in percent area, it is most efficient to survey the same horizontal stations across the channel width during each 5 year monitoring period.

LONGITUDINAL PROFILE

The longitudinal profile surveys of the channel bed and water surface will be graphically plotted. If there are past surveys available for a given profile, EID will select at least the most recent past survey for comparative plotting. All future surveys will be plotted together to show any change in the gradient or habitat features of the channel.

BED PARTICLE SIZE

Pebble count data will be displayed as frequency histograms and cumulative particle size distribution curves. The d_{50}, d_{16} and d_{84} and dominant bed material will be identified using the particle size distribution analysis of the pebble count data collected at each cross-section. If there are past pebble count data available for the cross-section, then EID will select at least the most recent past survey for comparative plotting. All future pebble count data will be plotted together to show any changes and the d_{50}, d_{16} and d_{84} and dominant bed material will be compared.

PHOTO-MONITORING

Photographs upstream and downstream from each surveyed cross-section will be compiled into the report to facilitate comparison of bank erosion and vegetative conditions during each 5-year monitoring period.

HYDROLOGIC DATA

The data analysis will include a summary description of the annual flow conditions over the five year monitoring period. This may include a review of available gaging records pertinent to each monitoring location, and reporting on EID's determination of water year types based on the annual snowpack. The background on hydrology for each monitoring period is important for interpreting any changes in channel morphology. The hydrologic summary will rely on existing and available information. No new gaging stations or streamflow measurements will be performed for this monitoring.

8. Reporting

The data collected under this plan will be compiled into a report and distributed to the FS, ERC, and SWRCB for review and consideration at least two weeks prior to the annual ERC meeting immediately following the last year in the five year cycle of monitoring. The annual report will include discussion appropriate to results and supportive of analyses and conclusions will be provided. All reports will be prepared in a format so that they can easily be reviewed by the ERC and filed with the FERC after approval.

A summary of the findings of the monitoring effort and an electronic copy of the report will be included in the Project 184 annual monitoring report, which the District is required to file with FERC by June 30 of each year. The District will distribute the draft annual monitoring report to the FS, ERC, and SWRCB to review at least 30 days prior to filing with FERC.

9. Literature Cited

ENTRIX, Inc 2002. EID Project 184 Geomorphic Sites Assessment. Prepared for El Dorado Irrigation District.

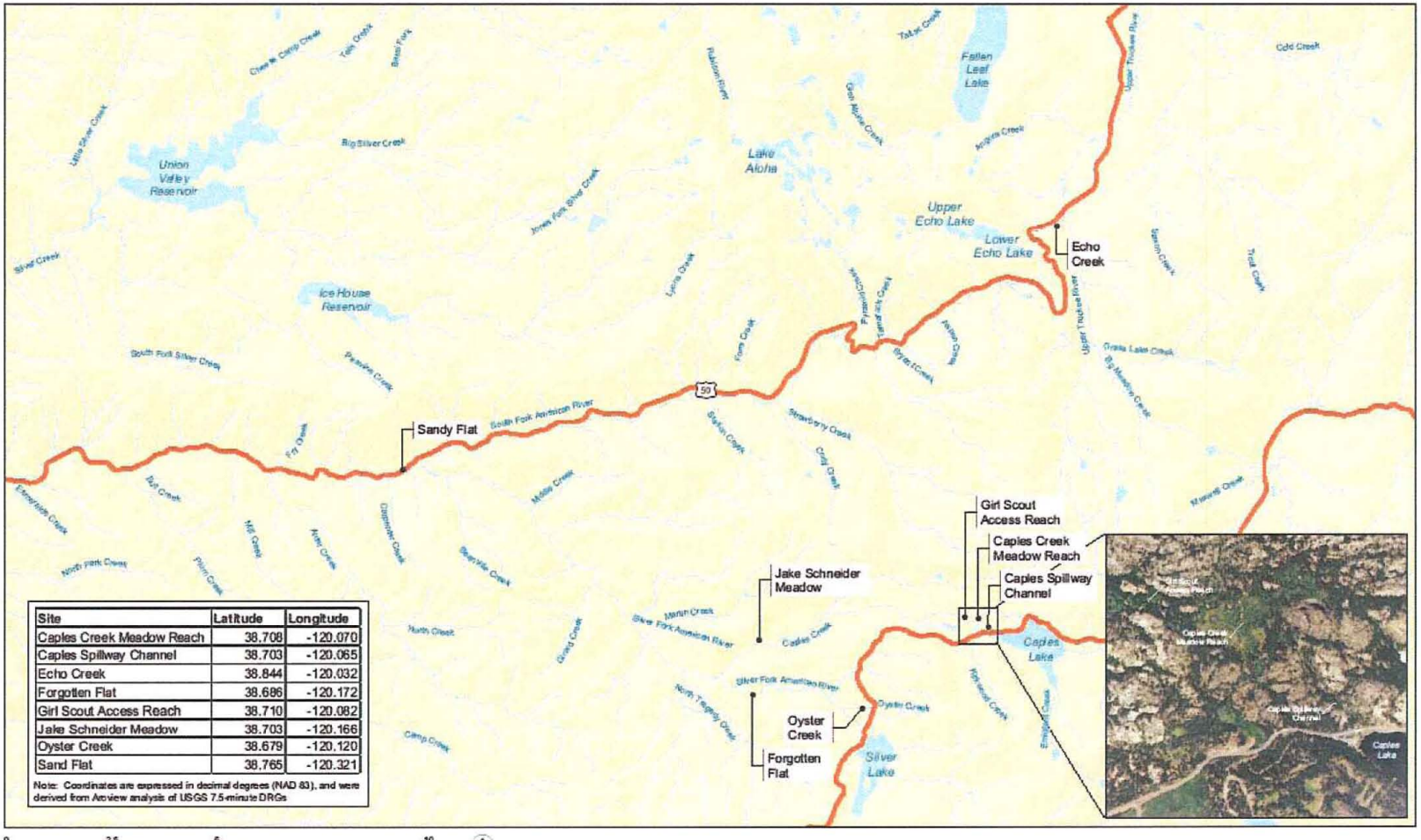
ENTRIX, Inc 2010. Caples Spillway Channel Sensitive Site Investigation Project 184 Geomorphology Monitoring.

Harrelson, Cheryl C, C.L. Rawlins, and John P. Potyondy. 1994. Stream channel reference sites: an illustrated guide to field technique. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, GTR RM-245.

Rosgen, D. 1996. Applied River Morphology. Second Edition. Wildland Hydrology.

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

Figure 1. Location of Geomorphic Monitoring Sites



Site	Latitude	Longitude
Caples Creek Meadow Reach	38.708	-120.070
Caples Spillway Channel	38.703	-120.065
Echo Creek	38.844	-120.032
Forgotten Flat	38.686	-120.172
Girl Scout Access Reach	38.710	-120.082
Jake Schneider Meadow	38.703	-120.166
Oyster Creek	38.679	-120.120
Sand Flat	38.765	-120.321

Note: Coordinates are expressed in decimal degrees (NAD 83), and were derived from Arcview analysis of USGS 7.5-minute DRGs

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El Dorado Irrigation District

FIGURE 1: LOCATION OF GEOMORPHIC MONITORING SITES

137 FERC ¶ 62,016
UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

El Dorado Irrigation District Project No. 184-226

ORDER APPROVING GEOMORPHOLOGY MONITORING PLAN CONTINUING EVALUATION OF REPRESENTATIVE CHANNEL AREAS

(Issued October 6, 2011)

1. On September 26, 2011, the El Dorado Irrigation District (El Dorado or licensee) filed its Geomorphology Monitoring Plan Continuing Evaluation of Representative Channel Areas (Plan) for the El Dorado Hydroelectric Project (FERC Project No. 184). The licensee filed its plan pursuant to Article 401 of the license for the El Dorado Project;[1] the U.S. Forest Service's (FS) Section 4(e) condition 37; the California Water Resources Control Board's (CWRCB) Water Quality Certificate (WQC) condition 13; and Section 7 of Appendix A to the El Dorado Relicensing Settlement Agreement (SA). The El Dorado Project is located on the South Fork American River, Silver Fork American River, Echo Creek, Pyramid Creek, Caples Creek, and Alder Creek in El Dorado, Alpine, and Amador counties, California.

License Requirements

2. Article 401 requires the licensee to file with the Commission, for approval, the final Geomorphology Monitoring Plan Continuing Evaluation of Representative Channel Areas as required by the FS's 4(e) condition 37, and condition 13 of the WQC. Article 401 also requires the licensee to submit documentation of its consultation with the 184 Ecological Resources Committee (ERC), FS, and CWRCB required in drafting the plan. Specifically, the FS's 4(e) condition 37, condition 13 of the WQC, and condition 7 of Appendix A to the SA require the licensee to monitor permanent cross-sections, in combination with channel properties, to provide the basis for evaluating changes in channel condition. The relicensing process provided baseline data prior to stream flow modification and/or measurable response to stream flow modification. Monitoring at the end of each 5-year period provides an index of changes in channel condition relative to changes in stream flow regime.

Licensee's Plan

[1] *El Dorado Irrigation District*, 117 FERC ¶ 62,044 (2006).

3. In the September 26, 2011 proposed Plan, the licensee states it will monitor permanent cross-sections and channel properties at selected stream reaches for comparison to the ecological resource objectives as a basis for evaluating changes in channel conditions. The Plan will also help determine if the ecological resource objectives are achievable and being met as specified in the 184 Adaptive Management Program set forth in section 7 of the SA, and the FS's 4(e) condition 37. The licensee proposes to conduct geomorphic monitoring at eight locations, and proposes to monitor three cross sections at each location. Of the eight locations, seven have had prior geomorphic assessments done, with the exception being Lower Echo Creek. The locations are: 1) Lower Echo Creek, 2) SFAR below the diversion dam, 3) Silver Fork American River at Forgotten Flat, 4) Caples Creek at Caples Meadow, 5) Caples Creek at Girl Scout Access, 6) Caples Creek at Jake Schneider Meadow, 7) Caples Creek at Caples Spillway Channel, and 8) Oyster Creek below Highway 88.

4. The data collection will consist of six elements: cross-section survey, longitudinal profile survey, streambed particle size composition, bank erosion potential, site map, and photo monitoring. The monitoring will be conducted during the summer or fall when stream flow levels are lowest and are safe to access. This will allow for maximum data acquisition. The monitoring will be performed every five years, starting in year five after license issuance, so the first monitoring will be in 2011, followed by 2016, 2021, etc.

5. The licensee proposes to compile the results into a report and distribute it to the ERC, FS, and CWRCB for review and consideration two weeks before the annual ERC meeting. The annual report will include a discussion of appropriate results, supportive analyses, and conclusions.

6. A summary of the findings of the monitoring report will be included in the Project 184 Annual Monitoring Report, which is required to be filed with the Commission by June 30 each year. The licensee will distribute a draft monitoring report to the ERC, FS, and CWRCB to review 30 days before filing with the Commission.

Pre-filing Consultation

7. The Plan was developed in consultation with the ERC, FS, and CWRCB. The licensee submitted the final plan to the ERC, FS, and CWRCB for review on October 1, 2010. ERC approved the plan on February 1, 2011, the CWRCB approved the plan on February 9, 2011, and the FS approved the plan on September 21, 2011.

Review

8. We reviewed the licensee's filed Geomorphology Monitoring Plan Continuing Evaluation of Representative Channel Areas and it satisfies the requirements of Article 401 of the license for the El Dorado Project, FS's Section 4(e) condition 37, the WQC

condition 13, and Section 7 of Appendix A to the SA. The Plan was prepared in consultation with the ERC, FS, and CWRCB, and received approval from these agencies. The Plan will provide an index to changes in the channel conditions relative to changes in the stream flow regime. The Plan will also provide the basis for any needed corrective or restorative measures. Therefore, the licensee's plan should be approved.

The Director orders:

(A) El Dorado Irrigation District's Geomorphology Monitoring Plan Continuing Evaluation of Representative Channel Areas filed on September 26, 2011, pursuant to Article 401 of the license for the El Dorado Project; U.S. Forest Service (FS) Section 4(e) condition 37; the California Water Resources Control Board's (CWRCB) Water Quality Certificate (WQC) condition 13; and Section 7 of Appendix A to the El Dorado Relicensing Settlement Agreement, is approved.

(B) This order constitutes final agency action. Any party may file a request for rehearing of this order within 30 days from the date of its issuance, as provided in section 313(a) of the FPA, 16 U.S.C. § 8251 (2006), and the Commission's regulations at 18 C.F.R. § 385.713 (2011). The filing of a request for rehearing does not operate as a stay of the effective date of this order, or of any other date specified in this order. The licensee's failure to file a request for rehearing shall constitute acceptance of this order.

William Guey-Lee
Chief, Engineering Resources Branch
Division of Hydropower Administration
and Compliance