SWAMP
Surface Water Ambient Monitoring Program

| *Monitoring Plan* | 2012 |
|---|---|

# Tulare Lake Basin
# Rotational Watershed Monitoring Plan, 2012-2016

**Version 1.1**

**March 2012**

Water Boards

www.waterboards.ca.gov/swamp

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# I. Introduction

The Tulare Lake Basin Rotational Watershed Monitoring Plan, 2012-2016 (Monitoring Plan) describes a four-year plan to examine current water quality conditions in the Tulare Lake Basin (Basin). The Basin's largest river systems are the Kings, Kaweah, Tule, and Kern Rivers. Each year the Monitoring Plan will focus on one of the four major river systems. The Monitoring Plan, scheduled to begin in March 2012, is sponsored by the Central Valley Regional Water Quality Control Board (Central Valley Water Board). The Monitoring Plan addresses the Surface Water Ambient Monitoring Program (SWAMP) objectives, as described in Study Design Overview (Section III).

Most significant water quality problems in the Basin are believed to result from nonpoint sources (California Environmental Protection Agency Regional Water Quality Control Board Central Valley Region, 2003). However, water quality in the upper reaches, as well as spatial and temporal trends within each of the four major river systems are not well documented. Additionally, the last regional sampling effort was conducted in 2006 with the exception of the Seasonal Trend Monitoring at Central Valley Integrator Sites, limited data has been collected by SWAMP since 2006. To address these data gaps the Monitoring Plan will provide data to better document water quality within the Basin.

Previously collected data (2001-2006) by the SWAMP will be compared to data collected by the Monitoring Plan to determine whether discernible changes in water quality have occurred over the past decade. The Monitoring Plan will also examine spatial variability of surface water quality by collecting data in areas above and below the reservoirs on each of the four main river systems within the Basin.

Each year a revision will be added to the Monitoring Plan describing objectives and questions relevant to the selected river system, including any necessary changes to sampling frequency and constituents. The revision will also include suggested follow up studies to be conducted on the river system sampled that year. Follow up studies will address specific areas of interest resulting from sampling data and allow for broader characterization of water quality conditions.

# II. Background

The following sections briefly describe the hydrology and geography of the Basin and historical monitoring efforts of the Central Valley Water Board.

### II.a. Characterization of Region

The Basin comprises the drainage area of the San Joaquin Valley and is bound by the crests of the Sierra Nevada Mountains to the east, the Coast Ranges to

the west, the Tehachapi Range to the south, and the San Joaquin River to the north (California Regional Water Quality Control Board, Central Valley Region, 2004). There are four major rivers within the Basin: the Kings River, the Kaweah River, the Tule River, and the Kern River. Each river originates in the Sierra Nevada Mountain Range, flows southwest toward the San Joaquin Valley (except for portions of the Kern River which flow south following geologic structures), and is joined by tributary streams. Water from each of the four main rivers is retained by a dam and reservoir as it emerges from the Sierra. Under natural conditions, waters from each stream entered various distributary channels once it emerged from the Sierra. Deposition of sediment by these distributaries built several alluvial fans that compose the soils and aquifers of the east side of the San Joaquin Valley. In recent time, the distributary systems have been supplemented with man-made structures to assist the movement of water across the valley floor, largely for purposes of agricultural supply.

### II.b. Historical Monitoring

Surface water monitoring for each fiscal year (FY) between 2001 and 2006 was designed to address potential nonpoint source influences within the Kings, Kaweah, Tule, and Kern River systems. Sites were monitored quarterly for nutrients, bacteria, temperature, dissolved oxygen (DO), pH, electrical conductivity (EC), and selected metals. Data from 2001-2004 were collected using SWAMP protocols, at the time, and reports are available at the website for California Environmental Data Exchange Network (CEDEN) www.ceden.org.

## III. Study Design Overview

Water quality data collected during the course of the Monitoring Plan will be useful to other Central Valley Water Board programs such as the Total Maximum Daily Load (TMDL) program, the Irrigated Lands Regulatory Program (ILRP), and the Confined Animal Facility Program. The Monitoring Plan is designed to address the SWAMP objective to collect data relevant to beneficial uses as defined in the Basin Plan (Surface Water Ambient Monitoring Program, 2010). The Basin Plan identifies beneficial uses for surface waters as: municipal and domestic, agricultural, industrial service supply, hydropower generation, water contact, recreation, non-contact water recreation, warm and cold freshwater habitat, wildlife habitat, rare, threatened or endangered species, spawning, reproduction or early development habitat, migration of aquatic organisms, preservation of significant biological habitat and navigation waters. Not all beneficial uses listed in the Basin Plan apply to all surface waters; notably, Valley Floor waters may not carry the municipal and domestic supply beneficial use.

The Monitoring Plan will also assist in identifying river reaches that are minimally disturbed. Minimally disturbed conditions of streams assume there are some anthropogenic stresses (swimming, fishing, boating, etc.), but in most cases will

approach true reference conditions (natural, undisturbed stream systems, absent of human disturbance) (Ode & Schiff, 2009).

The following sections provide details of the Monitoring Plan, including design, constituents to be analyzed, and monitoring sites.

### III.a. Monitoring Design

The primary objective of the Monitoring Plan is to characterize surface water quality of the four main rivers in the Basin. Primary objectives and questions addressed by the Monitoring Plan are listed below.

#### III.a.1. Primary Objectives

1) Implement water quality monitoring to document current surface water quality conditions.
2) Provide water quality data within the Basin to federal, state, local agencies and programs, and the interested public.
3) Characterize the current water quality conditions of surface waters in relation to beneficial uses.
4) Evaluate potential interactions of land use and observed water quality.

#### III.a.2. Questions Addressed

The Monitoring Plan is designed to provide information to answer the following questions:

1) What is the quality of water at minimally disturbed sites in the accessible upper reaches of the four main rivers in the Tulare Lake Basin versus the sites on the lower reaches that may have more anthropogenic stresses?
2) Are seasonal trends of water quality observed within each river system?
3) At a minimum does pH, EC, DO, ammonia, total coliform and nitrate water quality objectives at sampled sites support beneficial uses listed in the Basin Plan?
4) Does comparison of current data and previously collected data (2001-2006) indicate changes in water quality in the intervening period?

### III.b. Sampling Frequency and Methods

The monitoring frequency for each site will be monthly for dissolved metals, twice/per month for nutrients, quarterly for dissolved general minerals, and twice/per month for total suspended solids and bacteria. Table 1 summarizes each constituent to be analyzed. Analytical services, other than bacteriological,

will be provided by the Central Valley Water Board's contract laboratory, currently Moore Twining Associates, Inc., in Fresno.

## TABLE
## CONSTITUENT LABORATORY INFORMATION

| Constituent and Sampling Frequency | EPA Method | Lab Delivery Hold Time | Detection Limit | Lab Reporting Limit |
|---|---|---|---|---|
| **Metals - dissolved** (sample monthly) | | | | |
| Copper | 200.8 | 6 months | 0.0095 mg/L | 0.002 mg/L |
| Molybdenum | 200.8 | 6 months | 0.00075 mg/L | 0.0050 mg/L |
| Lead | 200.8 | 6 months | 0.000029 mg/L | 0.00050 mg/L |
| **Nutrients** (sample twice per month) | | | | |
| Total Phosphorous | 365.4 | 48 hours | 0.083 mg/L | 0.50 mg/L |
| Total Kjeldahl Nitrogen | 351.3 | 28 days | 0.36 mg/L | 1.0 mg/L |
| Nitrate (as Nitrogen) | 300.0 | 48 hours | 0.085 mg/L | 0.30 mg/L |
| Ammonia (as Nitrogen) | 350.2 | 28 days | 0.48 mg/L | 1.0 mg/L |
| **General Minerals – dissolved** (sample quarterly) | | | | |
| Alkalinity (as CaCO3) | SM2320B | 48 hours | 2.5 mg/L | 20 mg/L |
| Bicarbonate (as CaCO3) | SM2320B | 48 hours | 2.5 mg/L | 20 mg/L |
| Boron | 200.7 | 48 hours | 0.00083 mg/L | 0.02 mg/L |
| Calcium | 200.7 | 48 hours | 0.0076 mg/L | 0.1 mg/L |
| Carbonate (as CaCO3) | SM2320B | 48 hours | 2.5 mg/L | 20 mg/L |
| Chloride | 300.0 | 48 hours | 0.15 mg/L | 2.0 mg/L |
| Hardness (as CaCO3/L) (sampled monthly) | 200.7 | 48 hours | 1.3 mg CaCO3/L | 0.10 mg CaCO3/L |
| Iron | 200.7 | 48 hours | 0.017 mg/L | 0.10 mg/L |
| Magnesium | 200.7 | 48 hours | 0.0091 mg/L | 0.10 mg/L |
| Manganese | 200.7 | 48 hours | 0.00017 mg/L | 0.0050 mg/L |
| Potassium | 200.7 | 48 hours | 0.077 mg/L | 1.0 mg/L |
| Sodium | 200.7 | 48 hours | 0.26 mg/L | 1.0 mg/L |
| Sulfate (as SO4) | 300.0 | 48 hours | 0.29 mg/L | 2.0 mg/L |
| Total Dissolved Solids | SM2540C | 48 hours | 8.1 mg/L | 10 mg/L |
| Specific Conductance (EC) | measured | 48 hours | NA | NA |
| Cation/Anion Balance | calculated | 48 hours | NA | NA |
| **Total Suspended Solids** (sample twice per month) | 160.2 | 7 days | 10 mg/L | 4 mg/L |
| **Bacteria** (sample twice per month) | | | | |
| *E. coli* | SM9223B | 6 hours | 1/100 MPN/mL | NA |
| Total Coliform | SM9223B | 6 hours | 1/100 MPN/mL | NA |

### III.b.1. Field Observations and Measured Parameters

Water quality samples will be collected following the SWAMP Standard Operating Procedures (SOPs) for Conducting Field Measurements (Marine Pollution Studies – Department of Fish and Game, 2007). Samples will be collected from the center of the stream using either the SWAMP clean hands protocol or by sampling pole. In-field observations of weather, dominate substrate, algal growth, scum, odor, and other indications of water and habitat conditions will be recorded on field sheets. Photographs will be taken of upstream, downstream, and bank-to-bank river conditions. All photographs will be labeled according to the SWAMP's standard procedure. At sample sites a YSI multiparameter will be used to collect data for water temperature, DO, pH, and EC. The YSI meter will correct EC for temperature (also known as specific conductance). This data will be recorded on field sheets. Turbidity samples will be collected in the field and analyzed using a Hach Turbidimeter in the Central Valley Water Board's Fresno laboratory. All field and laboratory equipment will be calibrated using certified calibration standards according to manufacturer specifications prior to and following each sampling event. Calibration records are maintained at the Central Valley Water Board's Fresno laboratory and are used to determine instrument accuracy.

### III.b.2. Nutrients

Agriculture is a substantial portion of land use within the Tulare Lake Basin. Nitrates and phosphates, commonly used in agricultural production, have the potential to interact with natural surface waters. Elevated nutrient levels are an indicator of potential impairment to aquatic life and municipal beneficial uses.

Fluctuations in nutrient levels due to increased application of fertilizers, storm events, and irrigation run off can be missed if a water body is sampled once a month. Weekly sampling has been found to significantly reduce error in nutrient monitoring studies (Bowes, Smith, & Neal, 2009). Sampling for nutrients twice each month has been determined to be the most frequent sampling interval possible given personnel and budget limitations.

Nutrient samples to be collected include: nitrate as nitrogen, Total Kjeldahl Nitrogen (TKN), total phosphorous (TP) as phosphate, and ammonia. Ammonia and TKN will be collected and preserved with sulfuric acid. Nitrate as nitrogen and TP will be collected and delivered to the laboratory unpreserved. All nutrient samples will be analyzed by Moore Twining Associates, Inc., using the United States Environmental Protection Agency (EPA) approved methods specified in Table 1.

### III.b.3. Metals

Previous monitoring data collected by the ILRP found elevated levels of copper, lead, and molybdenum in surface waters within the Basin. Dissolved metals will be monitored to better determine water quality conditions and habitat related influences.

Lead and copper both have water quality criteria relevant to beneficial uses for municipal, agricultural, and aquatic life protection. Samples will be analyzed for hardness to evaluate the protection of aquatic life (Marshack, 2011).

The Lower Kings River is listed on the Clean Water Act Section 303(d) list as impaired for high concentrations of molybdenum. Additional data on molybdenum concentrations in the Kings River will assist the Central Valley Water Board in the assessment of 303(d) impaired waterbodies.

Dissolved molybdenum, dissolved copper, and dissolved lead samples will be collected without preservative and transported on wet ice to Moore Twining Associates, Inc., for filtering, preservation, and analysis using the EPA methods specified in Table 1 above.

### III.b.4. General Minerals

Dissolved general mineral samples will be collected to characterize natural surface waters above the reservoirs, and to document changes in general water quality below the reservoirs. General minerals analyses will include constituents listed in Table 1.

Dissolved general mineral samples will be collected in a non-acidified bottle, then filtered and analyzed by Moore Twining Associates, Inc. using the EPA methods specified in Table 1 above.

### III.b.5. Bacteria

*Escherichia coli (E. coli)* are a fecal indicator bacteria and are an important water quality parameter in areas designated for recreational beneficial uses. Higher densities of bacteria may indicate areas affected by anthropogenic activities.

Bacteria samples will be collected in bottles preserved with sodium thiosulfate. Bacteria samples will be processed by Central Valley Water Board staff using the IDEXX Colilert® QuantiTray system, as specified by EPA methods listed in Table 1. Staff will evaluate samples for most probable number (MPN) of total coliform and *E. coli* per 100 mL of sample water.

## III.c. Monitoring Sites

Table 2 provides a preliminary list of potential sampling sites. The Moss Landing Marine Pollution Studies Laboratory's database was used to locate historical SWAMP sites. Monitoring sites were selected based on accessibility, safety, proximity to residential areas, and dominate land use. Sites were evaluated to ensure that traveling time did not exceed hold time. An application for a research permit is required for sampling sites located within the Kings Canyon National Park and has been submitted for the 2012-2013 sampling year. A new permit will need to be filed for each additional year of sampling. Appendix 1 provides additional monitoring site information for each sampling site in the Kings River system. Appendix 2, Revisions to the Monitoring Plan, will include final sampling sites for the Kaweah River, Tule River, and Kern River will be added after final reconnaissance.

**TABLE**
**SAMPLING SITES**
**2012-2016**

| Kings River Monitoring Sites (2012-2013) | | | |
|---|---|---|---|
| Site Code | Site Description | Latitude | Longitude |
| 551LKI040 | Kings River Lower – South Fork | 36.2558 | -119.8551 |
| 551LKI050 | Kings River Lower – South Fork 2 | 36.1789 | -119.8348 |
| 552KIN900 | Kings River South Fork @ Muir Rock | 36.7935 | -118.5838 |
| 552KIN901 | Kings River South Fork @ Hotel Creek and Cedar Grove | 36.7893 | -118.6691 |
| 552KIN902 | Kings River South Fork @ Lewis Creek Trailhead | 36.7993 | -118.6916 |
| 552KIN903 | South Fork Kings River @ 180 & Cedar Grove | 36.7981 | -118.6875 |
| 552FRE510 | Kings River at Winton Park | 36.8163 | -119.3869 |
| 552FRE511 | Kings River at Reedley Beach | 36.5869 | -119.4593 |
| 552FRE515 | Kings River at Kirch Flat | 36.8802 | -119.1518 |
| 552FRE516 | Kings River at Big Creek | 36.9091 | -119.2430 |
| 551KIN060 | Kings River at Laton-Kingston Park | 36.4276 | -119.6898 |
| 551KIN065 | Kings River at North 7th Ave Roads End | 36.4636 | -119.5822 |
| 551FRE101 | Fresno Slough at Elkhorn Ave. | 36.4850 | -120.0056 |

| Kaweah River Monitoring Sites (2013-2014) | | | |
|---|---|---|---|
| Site Code | Site Description | Latitude | Longitude |
| 553KAR010 | Kaweah River – Ash Mountain | 36.4841 | -118.8359 |
| 553KAR040 | Kaweah River – Slick Rock Rec. Area | 36.4124 | -118.9378 |
| 558KAR050 | 245 Bridge | 36.4009 | -119.0294 |
| 558STJ010 | St. Johns River – Rd. 108 bridge | 36.3746 | -119.3316 |
| 558STJ020 | Rd. 80 bridge | 36.4144 | -119.3947 |
| 558CCR010 | Cross Creek – Rd. 60 and Hwy 99 | 36.4044 | -119.4570 |

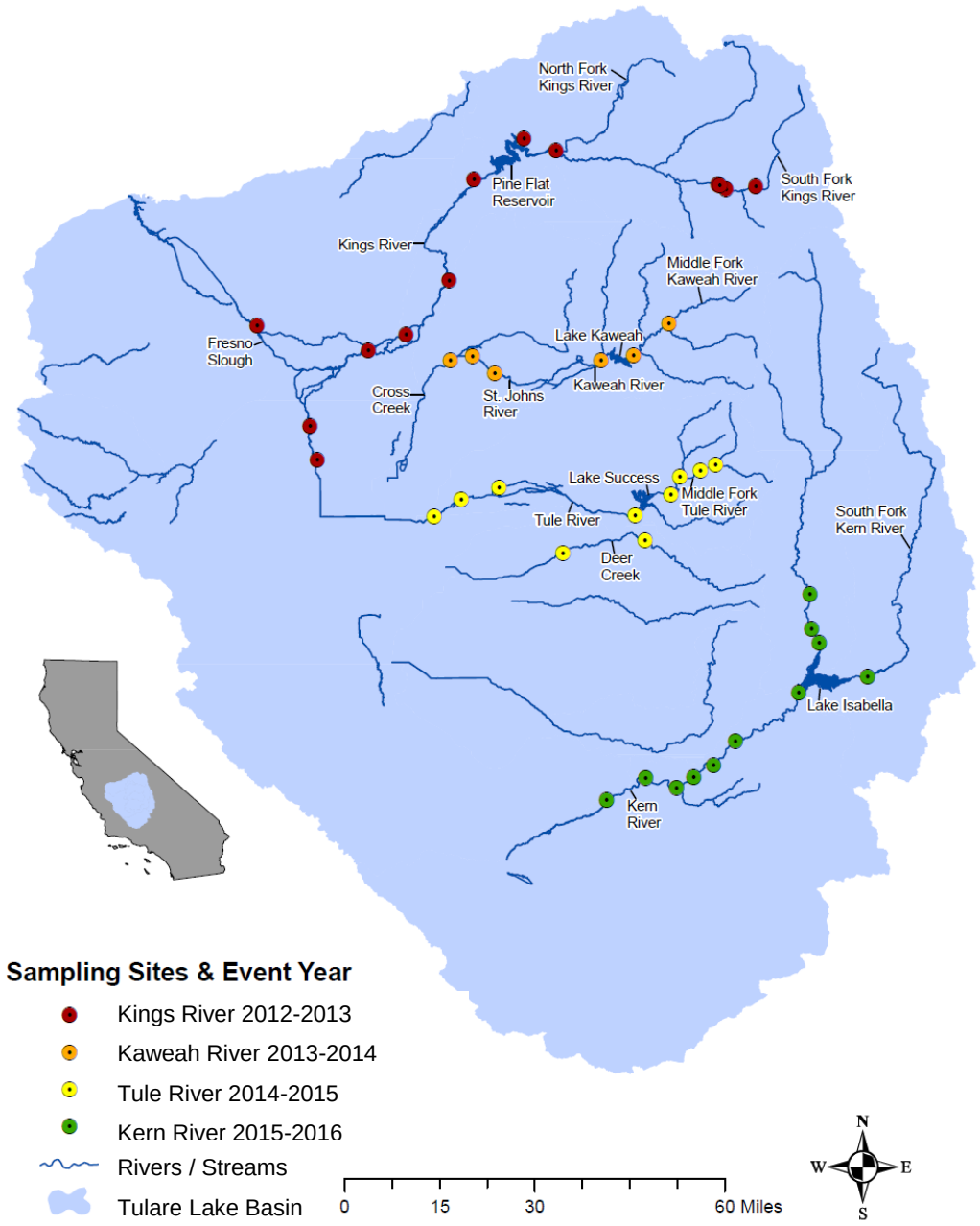
## TABLE 2 (continued)
## SAMPLING SITES
## 2012-2016

| Tule River Monitoring Sites (2014-2015) | | | |
|---|---|---|---|
| Site Code | Site Description | Latitude | Longitude |
| 555TUR010 | Tule River – Power House | 36.1614 | -118.7095 |
| 555TUR020 | Tule River – Lower Coffee Camp | 36.1489 | -118.7524 |
| 555TUR040 | Tule River – Sequoia N'tl Forest Fire Station | 36.1346 | -118.8105 |
| 555TUR050 | Tule River – Globe Rd. West | 36.0949 | -118.8370 |
| 558TUR060 | Tule River – J42 northwest corner of bridge over river | 36.0488 | -118.9377 |
| 558TUR070 | Tule River – Rd.112 | 36.1130 | -119.3218 |
| 558TUR090 | Tule River – Rd. 64 bridge | 36.0884 | -119.4289 |
| 558TUR100 | Tule River – off of Ave. 100 | 36.0496 | -119.5051 |
| 558DER010 | Deer Creek – Rd. 98 crossing | 35.9913 | -118.9109 |
| 558DER050 | Deer Creek West of 99 | 35.9640 | -119.1430 |

| Kern River Monitoring Sites (2015-2016) | | | |
|---|---|---|---|
| Site Code | Site Description | Latitude | Longitude |
| 554KER010 | Springhill | 35.8636 | -118.4483 |
| 554KER020 | River Kern Beach | 35.7838 | -118.4451 |
| 554KER030 | Riverside Park | 35.7521 | -118.4243 |
| 554SKR010 | Kern River @ Fay Ranch Road – South Fork | 35.6724 | -118.2900 |
| 554KER040 | Keyesville Rec Area | 35.6390 | -118.4846 |
| 554KER050 | Democrat | 35.5313 | -118.6636 |
| 554KER060 | Lower Richbar | 35.4762 | -118.7263 |
| 554KER070 | Ker MM14/MM15 | 35.4501 | -118.7826 |
| 558KER080 | Rancheria Road | 35.4265 | -118.8307 |
| 558KER090 | Hart Park | 35.4499 | -118.9162 |
| 558KER110 | Calloway Weir | 35.3995 | -119.0266 |

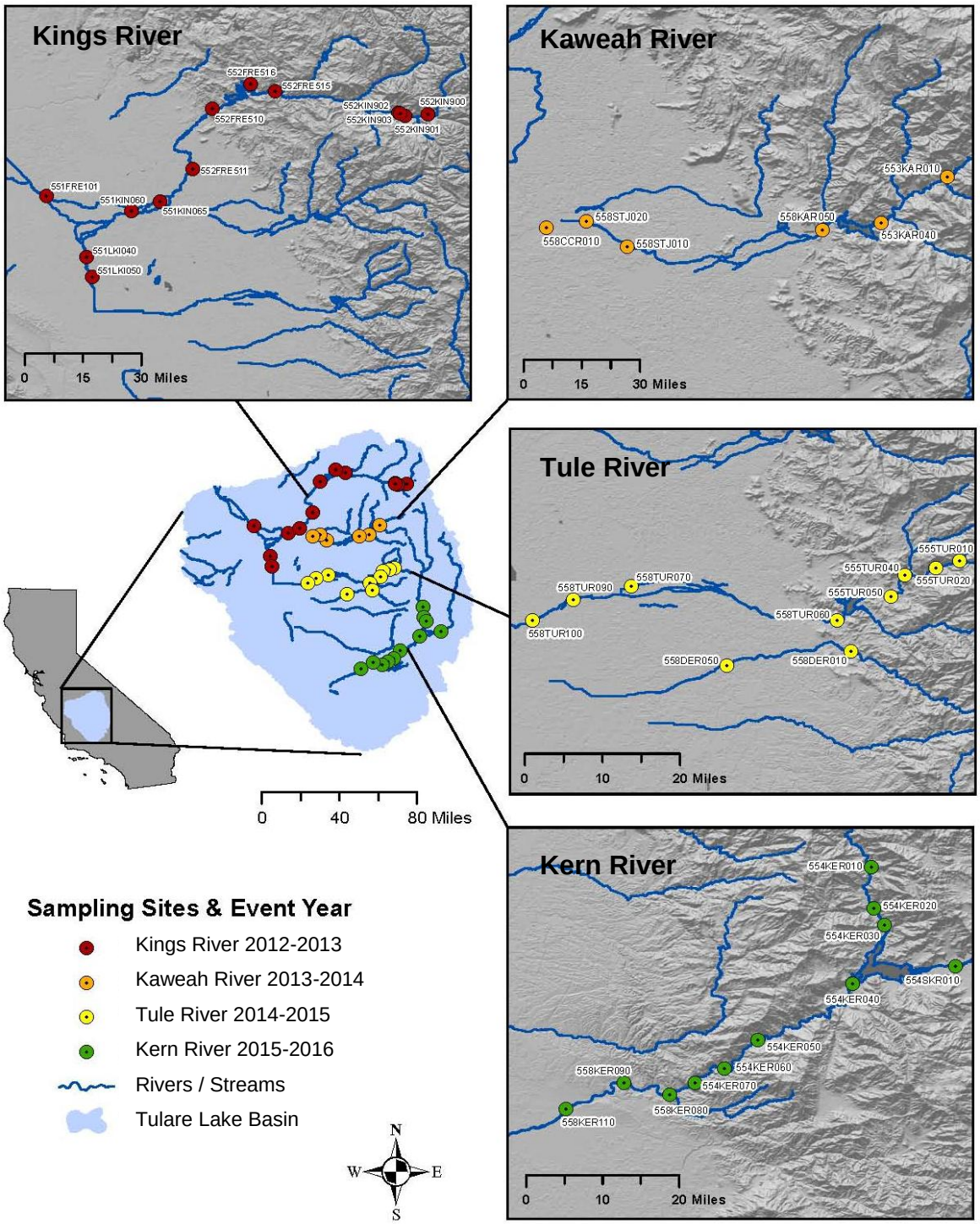
## FIGURE

## TULARE LAKE BASIN ROTATIONAL WATERSHED MONITORING PLAN, 2012-2016



## FIGURE

## SAMPLING SITES BY RIVER



# IV. Quality Assurance/Quality Control

This monitoring plan will follow quality (QA) and quality control (QC) procedures of SWAMP as described in the SWAMP Quality Assurance Program Plan (QAPrP) (The Surface Water Ambient Monitoring Program Quality Assurance Team, et al., 2008). Quality Assurance and Quality Control (QA/QC) methods will be implemented for every 20 samples or per analytical batch, if total samples are fewer than 20. Methods include: field duplicates, field blanks, lab duplicates, and lab blanks. All samples will be held at 4°C with wet ice in an ice chest until delivered to Moore Twining Associates, Inc. laboratory. As described in the SWAMP QAPrP, all samples will be delivered to Moore Twining Associates, Inc., with a chain-of-custody to ensure the integrity of the samples and to track analytical processes.

Sampling events and sample delivery will be coordinated with the contract laboratory Moore Twining Associates, Inc. by Central Valley Water Board staff. Central Valley Water Board staff will also verify that Environmental Laboratory Accreditation Program (ELAP) certification is maintained by the contracted laboratory. Quality assurance procedures at Moore Twining Associates, Inc. are consistent with the SWAMP approved quality assurance requirements and follow EPA approved methods.

# V. Data Assessment and Reporting

### V.a. Data Assessment

Site 552KIN900 best represents water quality of a minimally disturbed area within the Kings River system. This site is in Kings Canyon National Park on the upper south fork of the Kings River and is the furthest upstream location that is accessible by road. Known anthropogenic influences for this site include; hiking, fishing, camping, and swimming. This site meets criteria for a minimally disturbed location (Ode & Schiff, 2009) and samples from 552KIN900 will serve as an approximation of reference conditions.

To identify whether Basin Plan water quality objectives are being met, results will be compared with the Basin Plan water quality objectives for pH, dissolved oxygen, maximum electrical conductivity, and un-ionized ammonia. Un-ionized ammonia will be calculated using laboratory results of total ammonia (as nitrogen), and field measurements of ambient pH and temperature. “A Compilation of Water Quality Goals”, 16$^{th}$ Edition (Marshack, 2011) may also be used to set appropriate water quality benchmarks as they pertain to designated beneficial uses.

Analytical data will be tabulated and described using various descriptive statistical methods and provided that the data is amendable to more than

descriptive statistical test other statistical methods (e.g. inferential statistics) may be applied. Sample size and distribution will be examined prior to application of any inferential statistical test. Piper and stiff diagrams will be developed to graphically show the similarities and differences of the constituents at each monitoring site.

Measures of central tendency (means, medians, and modes) for each constituent will be determined to identifying the central position within the data. Standard deviation and skewness will be calculated to describe the deviation of the distribution from the central tendency (symmetry) and help identify whether the data are normally distributed. Kurtosis will be calculated to identify whether the data are peaked or flat relative to a normal distribution. Time series plots and box and whisker diagrams will be used to view the data and in comparisons between minimally disturbed sites and sites further downstream or from previous sampling events.

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Land use evaluation will be performed in a geographic information system (GIS). Land use layers from DWR will be imported to the GIS along with hydrography and other applicable layers (e.g. monitoring site locations). Parcels of land adjacent to the monitored site will be considered areas with the greatest potential to discharge to waters. To further isolate land use with the greatest potential to discharge to surface waters, parcels adjacent to the site within one kilometer of selected monitoring site will be categorized by land use and ranked in order of descending total acreage per land use (Ode & Schiff, 2009).

### V.b. Reporting

The Central Valley Water Board staff will prepare fact sheets highlighting significant results and findings. Laboratory data, field data, and associated QA/QC will be submitted in standardized formats and entered into the SWAMP Information Management System (IMS) version 2.5 database. Once verified, data will be available for public access, and other programs or groups in need of monitoring information, through the California Environmental Data Exchange Network (CEDEN) website at www.ceden.org.

Upon completion of one year of sampling a final report will be prepared that summarizes the collected water quality data, explains data gaps, evaluates temporal and spatial trends, and correlates data to beneficial uses as defined in the Basin Plan. Fact sheets and final reports will be available to the public on the Central Valley Water Board's SWAMP webpage at: http://www.swrcb.ca.gov/rwqcb5/water_issues/swamp/water_quality_reports/index.shtml.

# VI. Project Schedule

Anticipated schedule for river system sampling is shown in Table 3. The Kings River system is scheduled to be monitored during 2012-2013. Target completion and deliverable dates for 2012-2013 are listed in Table 4. Project schedules for future years will be finalized prior to the scheduled sampling year and included each year as part Monitoring Plan revisions.

**TABLE**
**SAMPLING SCHEDULE**
**2012-2016**

| Sampling Schedule | | | | |
|---|---|---|---|---|
| | 2012-2013 | 2013-2014 | 2014-2015 | 2015-2016 |
| Kings River | | | | |
| Kaweah River | | | | |
| Tule River | | | | |
| Kern River | | | | |
| | Scheduled sampling year | | | |

**TABLE**
**PROJECT SCHEDULE**
**KINGS RIVER 2012-2013**

| Activity | Anticipated Date of Initiation | Anticipated Date of Completion | Deliverable | Deliverable Due Date |
|---|---|---|---|---|
| **Field Sampling and Analyses** | | | | |
| Conventional Water Quality Parameters | 2012 | 2013 | Data Set | Day of Sampling |
| Nutrient Monitoring<br>Metals Monitoring<br>General Minerals Monitoring | 2012 | 2013 | Data Set | 15 days from sampling |
| Bacteria Monitoring | 2012 | 2013 | Data Set | Day following sampling |
| **Data Posted to SWAMP Database** | Upon receipt of lab results | Within 30 days of receipt of lab results | Data Posting | Final Posting 2013 |
| **Fact Sheets** | 2013 | 2013 | Fact Sheet Web Posting | 2013 |
| **Draft Report** | 2013 | 2013 | Draft Report to Water Board | 2013 |
| **Final Report** | 2013 | 2014 | Final Report to Water Board | 2014 |
| **Focused Follow-Up Sampling** | 2013 | 2014 | Data Set | 2014 |

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## APPENDIX 1: MONITORING SITE INFORMATION

MONITORING SITE INFORMATION

Site Name: Kings River at Kirch Flat
Site ID: 552FRE515
Latitude/Longitude: 36.88021 / -119.15182
County: Fresno
Elevation: 948 feet above mean sea level

Location/Site Description: From Fresno, drive east on Highway 180 (6 miles), merge onto Kings Canyon Road (8 miles), turn left onto Academy Avenue (1 mile), turn right onto Belmont Avenue, continue onto East Trimmer Springs Road (12 miles), keep right at the fork (16 miles), turn right onto Trimmer Springs Road (9 miles), turn right at Kirch Flat campground entrance. Follow "raft pull out" signs to the west end of campground. An entry fee is not required to access campground. Vault restrooms and picnic tables are available. This portion of the Kings River is in Sequoia National Forest and is frequently used for kayaking and rafting. The Kings River power house is downstream from the sampling site and the surrounding area is used for cattle grazing.

Water Source: Kirch Flat is downstream from the confluence of the Upper North, Middle, and South Forks tributaries of the Kings River. These tributaries drain approximately 863,000 acres of the high western Sierra Nevada. This portion of the river flows through oak woodlands. The monitoring site is underlain by Mesozoic granitic rocks (hornblend-biotite granodiorite), directly adjacent to a pre-Cretaceous calcschist (diopside-plagioclase schist) and limestone units.

## MONITORING SITE INFORMATION

Site Name: Kings River at Big Creek
Site ID: 552FRE516
Latitude/Longitude: 36.90914 / -119.24296
County: Fresno
Elevation: 958 feet above mean sea level

Location/Site Description: From Fresno, drive east on Highway 180 (6 miles), merge onto Kings Canyon (8 miles), turn left onto Academy Avenue (1 mile), turn right onto Belmont Avenue, continue onto East Trimmer Springs Road (12 miles), keep right at the fork (16 miles), turn right onto Trimmer Springs Road (0.2 miles). Parking for the site is located at a pull out east of Big Creek Bridge on the south side of the road. A trailhead at the pull out leads to the sampling site. This site is within Sequoia National Forest and is not a maintained recreational area, however fishing, swimming, and picnicking are common recreational activities. Oaks and shrubs are sparsely dispersed across the largely undeveloped drainage.

Water Source: The Big Creek drainage in Fresno County “rises in the northwestern part of Mount Diablo base and meridian, in Summit Meadow and takes a general southerly course to its junction the (Upper) Kings River” (Wood, 1912, p. 10). The Big Creek watershed, approximately 32,000 acres, is primarily underlain by Mesozoic granitic rocks with lesser amounts of meta-sedimentary rocks. The monitoring site is located in the lowland foothills of the Sierra Nevada and is underlain by pre-Cretaceous meta-sedimentary rocks.

## MONITORING SITE INFORMATION

Site Name: South Fork Kings River at Muir Rock
Site ID: 552KIN900
Latitude/Longitude: 36.79353 / -118.5838
County: Fresno
Elevation: 5027 feet above mean sea level

Location/Site Description: From Fresno, drive east on Highway 180 (89 miles) into Kings Canyon National Park. The sampling site is located at the end of Highway 180, near the Muir Rock short term parking lot. The area is used for recreational purposes including: swimming, fishing, hiking, and picnicking.

Water Source: The monitoring site is located approximately 2 miles west of the Bubbs Creek tributary junction with the South Fork Kings River. The South Fork Kings River watershed contains many of the highest peaks in the Sierra, some reaching over 10,000 feet. The crest of the Sierra separates the Kings River from the central part of the Owens River divide. This site is located on the South Fork of the Upper Kings River and receives water primarily from high Sierra snowmelt (Wood, 1912). The South Fork Kings River watershed has an area of approximately 294,000 acres underlain primarily by Mesozoic granitic rocks with lesser amounts of Mesozoic felsic volcanic rocks, Paleozoic limestone, and Quaternary glacial deposits.

## MONITORING SITE INFORMATION

Site Name: South Fork Kings River - HWY 180, Cedar Grove Site ID: 552KIN903
Latitude/Longitude: 36.79807 / -118.68753 County: Fresno
Elevation: 4602 feet above mean sea level

Location/Site Description: From Fresno, drive east on Highway 180 (82 miles) into Kings Canyon National Park. The monitoring site is on the southeast corner of the bridge, just east of the Cedar Grove turn off. Parking is available at a pull out on the south side of Highway 180. There are no maintained facilities, although swimming and fishing are possible recreational activities.

Water Source: The monitoring site is located approximately 7.5 miles west of the Bubbs Creek tributary junction with the South Fork Kings River. The South Fork Kings River watershed has an area of approximately 294,000 acres underlain primarily by Mesozoic granitic rocks with lesser amounts of Mesozoic felsic volcanic rocks, Paleozoic limestone, and Quaternary glacial deposits. The South Fork Kings River watershed contains many of the highest peaks in the Sierra, some reaching over 10,000 feet. The crest of the Sierra separates the Kings River from the central part of the Owens River divide. This site is on the South Fork of the Upper Kings River and receives water primarily from high Sierra snowmelt (Wood, 1912).

## MONITORING SITE INFORMATION

Site Name: South Fork Kings at Hotel Creek & Cedar Grove Site ID: 552KIN901
Latitude/Longitude: 36.78925 / -118.66905 County: Fresno
Elevation: 4522 feet above mean sea level

Location/Site Description: From Fresno, drive east on Highway 180 (82 miles) into Kings Canyon National Park. The monitoring site is located south of the Cedar Grove Hotel parking lot. Lodging, a grocery store, restrooms, dining, and picnicking are located nearby.

Water Source: The monitoring site is located approximately 550 feet downstream from the Hotel Creek tributary junction with the Upper South Fork of the Kings River. "Hotel Creek rises in the northwestern part of Sierra National Forest at an altitude of 8,500 and flows southwestward three miles into the Upper South Fork of the Kings River" (Wood, 1912, p. 43). This reach is within a mixed conifer forest where high Sierra and local snowmelt are the main sources of water. This area is underlain by Quaternary alluvium on Mesozoic granitic bedrock. The South Fork Kings River watershed has an area of approximately 294,000 acres primarily underlain by Mesozoic granitic rocks with lesser amounts of Mesozoic felsic volcanic rocks, Paleozoic limestone, and Quaternary glacial deposits.

## MONITORING SITE INFORMATION

Site Name: South Fork Kings River at Lewis Creek Trailhead Site ID: 552KIN902
Latitude/Longitude: 36.79934 / -118.6916 County: Fresno
Elevation: 4514 feet above mean sea level

Location/Site Description: From Fresno, drive east on Highway 180 (82 miles) into Kings Canyon National Park. The sampling site is located south of the Lewis Creek Trailhead parking lot where vault restrooms are available for public use.

Water Source: This reach is within a mixed conifer forest where high Sierra and local snowmelt are the main sources of water. The sampling site is located upstream from the Lewis Creek inflow to the Upper South Fork of the Kings River and is underlain by Quaternary alluvium on Mesozoic granitic bedrock. The South Fork Kings River watershed has an area of approximately 294,000 acres composed primarily of Mesozoic granitic rocks with lesser amounts of Mesozoic felsic volcanic rocks, Paleozoic limestone, and Quaternary glacial deposits.

## MONITORING SITE INFORMATION

Site Name: Kings River at Winton Park
Site ID: 552FRE510
Latitude/Longitude: 36.81634 / -119.38689
County: Fresno
Elevation: 518 feet above mean sea level

Location/Site Description: From Fresno, drive east on Highway 180 (6 miles), merge onto Kings Canyon (8 miles), turn left onto Academy Avenue (1 mile), turn right onto Belmont Avenue, continue onto East Trimmer Springs Road (9 miles), turn right onto North Piedra Road, where the Winton Park entrance is located on the right side of Piedra Road. Winton Park is a public access park managed by Fresno County Parks. Recreational activities include: fishing, kayaking, picnic facilities, and swimming.

Water Source: The site is on the Main Channel of the Lower Kings River, in an area with minimal urban or agricultural development, where the valley floor transitions into the foothills. Winton Park is approximately four miles downstream from Pine Flat Reservoir where water is released from the bottom of the dam and ranges in flow from 600 to 7,000 cubic feet per second. The monitoring site is underlain by Mesozoic basic intrusive rocks directly adjacent a metamorphosed clinopyroxene gabbro unit which is part of the Kings River ophiolite complex.

## MONITORING SITE INFORMATION

Site Name: Kings River at Reedley Beach Site ID: 552FRE511
Latitude/Longitude: 36.5868951 / -119.4592921 County: Fresno
Elevation: 295 feet above mean sea level

Location/Site Description: From Fresno, drive south on Freeway 99 (10 miles), take exit 121, merge onto East Manning Avenue (11 miles), continue onto "I" street (0.3 miles), take a slight right onto North Reed Avenue. Located in Reedley at the corner of Olsen and Reed Avenues, Reedley Beach is a public park managed by Fresno County Parks. Possible recreational activities include: fishing, picnicking, and swimming. The park is opened to the public on Memorial Day and closes on Labor Day.

Water Source: "Below Pine Flat Dam, the (Lower) Kings River follows its natural course southwesterly out into the lowlands and splits into numerous channels in the Centerville Bottoms. These channels then re-join to form a single channel. This section of the river is slightly incised below the main valley floor and is flanked by small, intermittent levees" (ECORP Consulting, Inc. Environmental Consultants, 2007, p. 16). Soils underlying the monitoring site were derived primarily from igneous rocks from the Sierra Nevada and consist mostly of sandy loam and fine sandy loam.

## MONITORING SITE INFORMATION

Site Name: Kings River at North 7th Avenue Roads End Site ID: 551KIN065
Latitude/Longitude: 36.46363 / -119.58217 County: Kings
Elevation: 278 feet above mean sea level

Location/Site Description: From Fresno, drive south on Freeway 99 (13 miles), take exit 118, drive south on Highway 43 (6 miles), turn left on East Elkhorn Avenue (2.6 miles), turn right onto Bethel Avenue (0.5 miles) where it curves into North 7th Avenue. Follow North 7th Avenue (1.3 miles), until the road dead ends at the sampling site. The Kings River is accessible where the paved road ends, adjacent to a dirt lot.

Water Source: The sampling site is located directly downstream from the town of Kingsburg and is surrounded by crops, orchards, and multiple residences. This section of the Lower Kings River "emerges onto its delta and must be continuously leveed to contain high flows. Numerous permanent weirs cross the river and the resulting pools are used to facilitate diversion of water into large canals" (ECORP Consulting, Inc. Environmental Consultants, 2007, p. 16). Soils underlying the monitoring site were derived primarily from igneous rocks from the Sierra Nevada and consist mostly of fine sandy loam and sandy loam.

## MONITORING SITE INFORMATION

Site Name: Kings River at Laton-Kingston Park
Site ID: 551KIN060
Latitude/Longitude: 36.4276147 / -119.6897505
County: Fresno
Elevation: 256 feet above mean sea level

Location/Site Description: From Fresno, drive south on Highway 41 (22 miles), turn left onto Mount Whitney Avenue (6.4 miles), turn right onto Fowler Avenue (0.3 miles) where the Laton-Kingston Park is located on the right. The park is managed by Fresno County Parks and consists of 22 developed acres with picnic facilities, playgrounds, and soccer fields.

Water Source: Laton-Kingston Park is on the South Fork of the Lower Kings River. Directly upstream from the site, the Lower Kings River is separated into the North and South Forks at Army Weir (ECORP Consulting, Inc. Environmental Consultants, 2007). Soils underlying the monitoring site consist of alluvium derived primarily from igneous rocks from the Sierra Nevada and consist mostly of sandy loam. Agricultural and residential land uses are common in this area.

## MONITORING SITE INFORMATION

Site Name: Kings River Lower – South Fork
Site ID: 551LKI040
Latitude/Longitude: 36.2558 / -119.8551
County: Kings
Elevation: 198 feet above mean sea level

Location/Site Description: From Fresno, drive south on Highway 41 (34 miles), turn right onto Jackson Avenue (2.6 miles), where the site is located on the right, 1 mile west of Highway 198. Parking is available in a dirt lot on the north side of Jackson Avenue.

Water Source: Located on the South Fork of the Lower Kings River, this portion of the river is a braided delta. Agricultural and residential land use is common in this area. Soils underlying the monitoring site consist of alluvium derived primarily from igneous rocks from the Sierra Nevada and consist mostly of clay with lesser amounts of loam.

## MONITORING SITE INFORMATION

Site Name: Kings River – South Fork 2
Site ID: 551LKI050
Latitude/Longitude: 36.1789 / -119.8348
County: Kings
Elevation: 197 feet above mean sea level

Location/Site Description: Also known as Kings River at Empire Weir No. 2. From Fresno, drive south on Highway 41 (40 miles), 0.8 miles south of Laurel Avenue the site is located on the west side of Highway 41. Parking is available in a dirt lot, south of the bridge. The sample site is located across a foot bridge on the middle fork of a trifurcation of the Kings River.

Water Source: Located on the South Fork of the Kings River, Empire Weir No. 2 receives water from the Clark's Fork of the Kings River. "At Empire Weir No. 2 water can be diverted into the Blakely Canal and the Tulare Lake Canal, or continue over the weir to the South Fork Canal. The Lateral A Canal also delivers water from the California Aqueduct to the Kings River system at Empire Weir No. 2" (ECORP Consulting, Inc. Environmental Consultants, 2007, p. 18). Soils underlying the monitoring site consist of alluvium derived primarily from igneous rocks from the Sierra Nevada and consist mostly of sandy loam with lesser amounts of clay.

## MONITORING SITE INFORMATION

Site Name: Kings River at Elkhorn Ave. Site ID: 551FRE101
Latitude/Longitude: 36.48502 / -120.00563 County: Kings
Elevation: 197 feet above mean sea level

Location/Site Description: From Fresno, drive south on Highway 41 (18 miles), turn left onto Elkhorn Avenue (12 miles), the monitoring site is located on the southwest corner of the bridge, directly west of the Elkhorn Avenue and Elkhorn Grade intersection.

Water Source: During periods of high flow weirs, bypasses, and canals are used to intentionally direct Kings River water north into the Fresno Slough and the San Joaquin River (ECORP Consulting, Inc. Environmental Consultants, 2007). Soils underlying the monitoring site consist of alluvium derived primarily from igneous rocks from the Sierra Nevada and consist mostly of clay with lesser amounts of clay loam and loam.

## APPENDIX 2: REVISIONS TO THE MONITORING PLAN

There are no changes at this time.