

## **AIP Interim Measure 12: Water Quality Monitoring Activities Monitoring Year 2009**

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### ***1. Introduction and Overview***

On November 13, 2008, the United States, the states of California and Oregon, and PacifiCorp executed an Agreement in Principle (AIP) describing the framework for an approach to study the water quality conditions of the Klamath River pursuant to the possible removal of several PacifiCorp's dams on the Klamath River. Interim Measure 12 of the AIP stipulates to a water quality monitoring program, including on-going monitoring of blue-green algae (cyanobacteria) and associated toxins. Interim Measure 12 of the AIP further stipulates that PacifiCorp will provide funding of \$500,000 per year for this measure, and that monitoring will be performed by an entity or entities agreed upon by the parties to the AIP and in consultation with the appropriate water quality agencies.

The funding provided by PacifiCorp under Interim Measure 12 is not intended to replace existing funding for ongoing monitoring efforts by other parties for other programs, but is intended to coordinate PacifiCorp's monitoring efforts with other ongoing monitoring efforts, and to involve the AIP signatories and responsible water quality agencies in this coordination. This plan is for the monitoring period from May 2009 through December 2009, and is referred to hereafter as the AIP 2009 Monitoring Plan. A separate plan will be developed for subsequent monitoring years.

The AIP 2009 Monitoring Plan includes monitoring of the Klamath River mainstem (including reservoirs) from Link River dam downstream through the estuary. The sampling stations are illustrated in Figure 1. This plan is being conducted as one of numerous monitoring and/or study efforts in the Klamath River Basin, including annual monitoring of: tributaries above Upper Klamath Lake, Upper Klamath Lake, the Klamath River from Upper Klamath Lake through the estuary, and tributaries to the Klamath River including the Lost River basin. These other efforts are being captured in a basinwide plan currently being developed by the Klamath Basin Water Quality Monitoring Coordination Group (KBWQMCG). The scope of the larger KBWQMCG basinwide monitoring effort (still in draft) is illustrated in Figure 2 (including monitoring activities to be done by other parties) to provide the larger framework within which this AIP monitoring effort will occur.

PacifiCorp and other parties to the AIP agreed to a cooperative effort for the finalization of this AIP 2009 Monitoring Plan. The cooperative effort was organized by the NCRWQCB and ODEQ, and involved members of the KBWQMCG as the participatory forum. Through this cooperative effort, the participants have identified objectives and recommended water quality monitoring activities. The work presented in this plan represents the highest level of consensus regarding monitoring priorities for the mainstem Klamath River. This plan addresses public health monitoring of cyanobacteria and associated toxins, and comprehensive baseline water quality monitoring in the Klamath River.

Other priorities identified during the cooperative effort to plan 2009 monitoring that were not addressed by this AIP 2009 Monitoring Plan or funded for this year but remain as candidate priorities should additional funding become available include:

- Monitoring to provide time-critical information should it be needed to support monitoring when KFHAT-identified critical conditions are exceeded and monitoring entities throughout the Basin are called upon to conduct increased monitoring to characterize conditions in support of management decisions for actions. At such a time, California Department of Fish and Game (CDFG) as the KFHAT lead agency would contact monitoring entities along the River to request increased levels of monitoring (e.g., frequency and density).
- Continued sampling for cyanotoxins in steelhead trout and other salmonids in the River below Iron Gate Dam i to identify reaches and periods when there would likely be co-occurrence of salmonids and elevated cell counts and/or cyanotoxin levels in water or mussel samples, and evaluate toxicological and histological impacts to those species. In addition to LC/MS/MS findings, Cyanotoxin impacts to fish (livers, cell necrosis, RNA:DNA transcription) have been demonstrated (Shawn Acuna/UCDavis presentation on microcystin effects on Delta fish; SWBGAWG presentation in 2008).
- Sampling timing should be in accordance with that recommended by OEHHHA.
- Monitoring to address identified data gaps, in response to interim management activities, or to address other high priority needs (e.g., extended droughts, special operations, etc.).
- Monitoring below burn areas for turbidity and sediment;
- Sampling of tributaries to better understand their contribution to the nutrient and organic matter budget within the mainstem Klamath River; and
- Biological monitoring monthly from June through September for the Klamath River mainstem below Iron Gate Dam for an improved understanding of periphyton densities, the impact of periphyton on water quality (DO, pH), and the role of natural controls on periphyton density.
- Assessing the possible linkages between water quality in the Klamath River and fish disease.
- Increase the frequency of physical and chemical monitoring in the Klamath River to improve the understanding of nutrient dynamics and seasonal and annual variability.

Modification of the program beyond Monitoring Year 2009 is anticipated as science and monitoring program designs evolve. Planning for the AIP 2010 Monitoring Plan will again be conducted between the parties to the AIP, in consultation with the appropriate water quality agencies, and in coordination with the KBWQMCG.

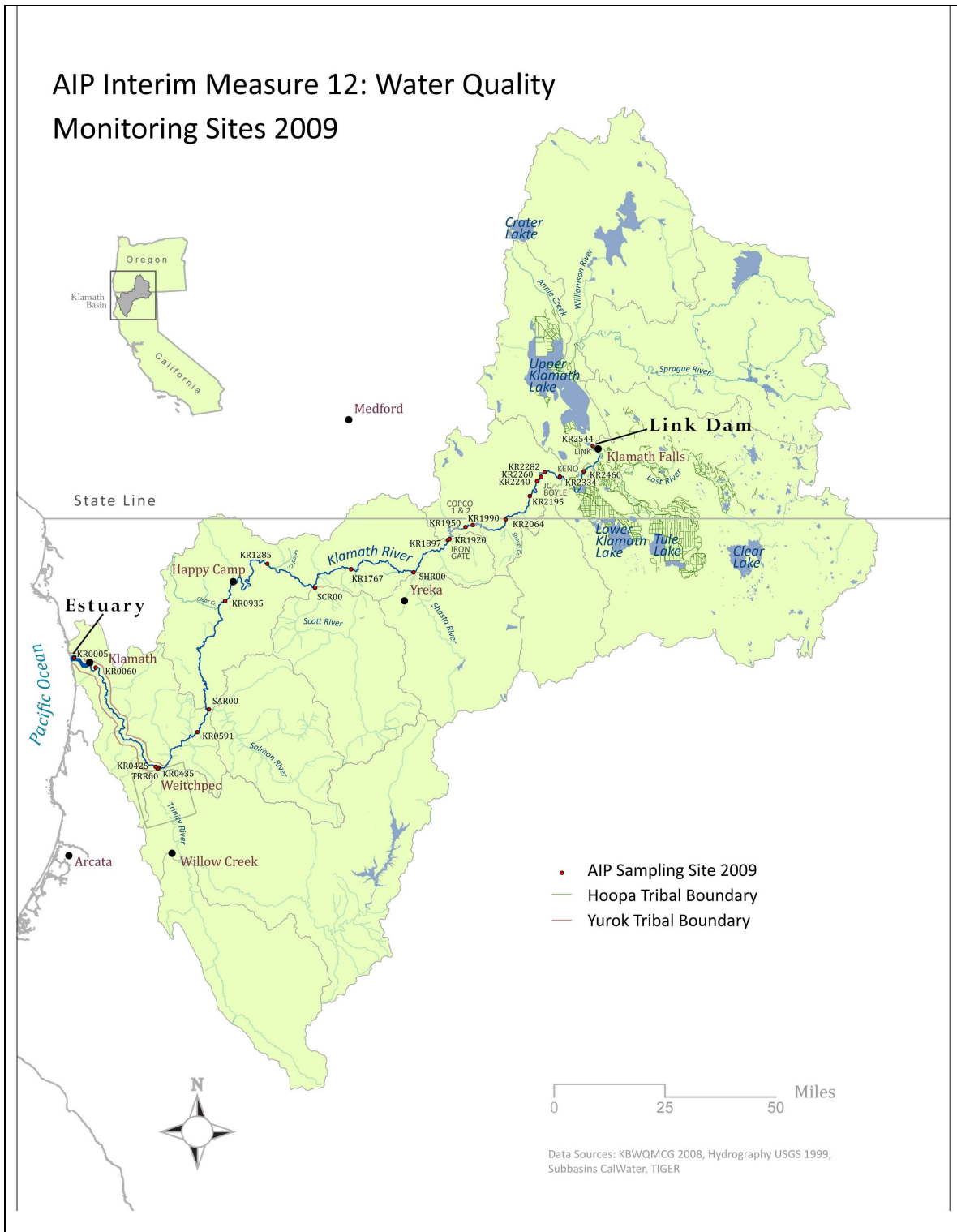


Figure 1: AIP Monitoring Program station network locations for 2009. Stations include AIP and joint AIP / USBR stations. Key to locations is included in Tables 3 and 4.

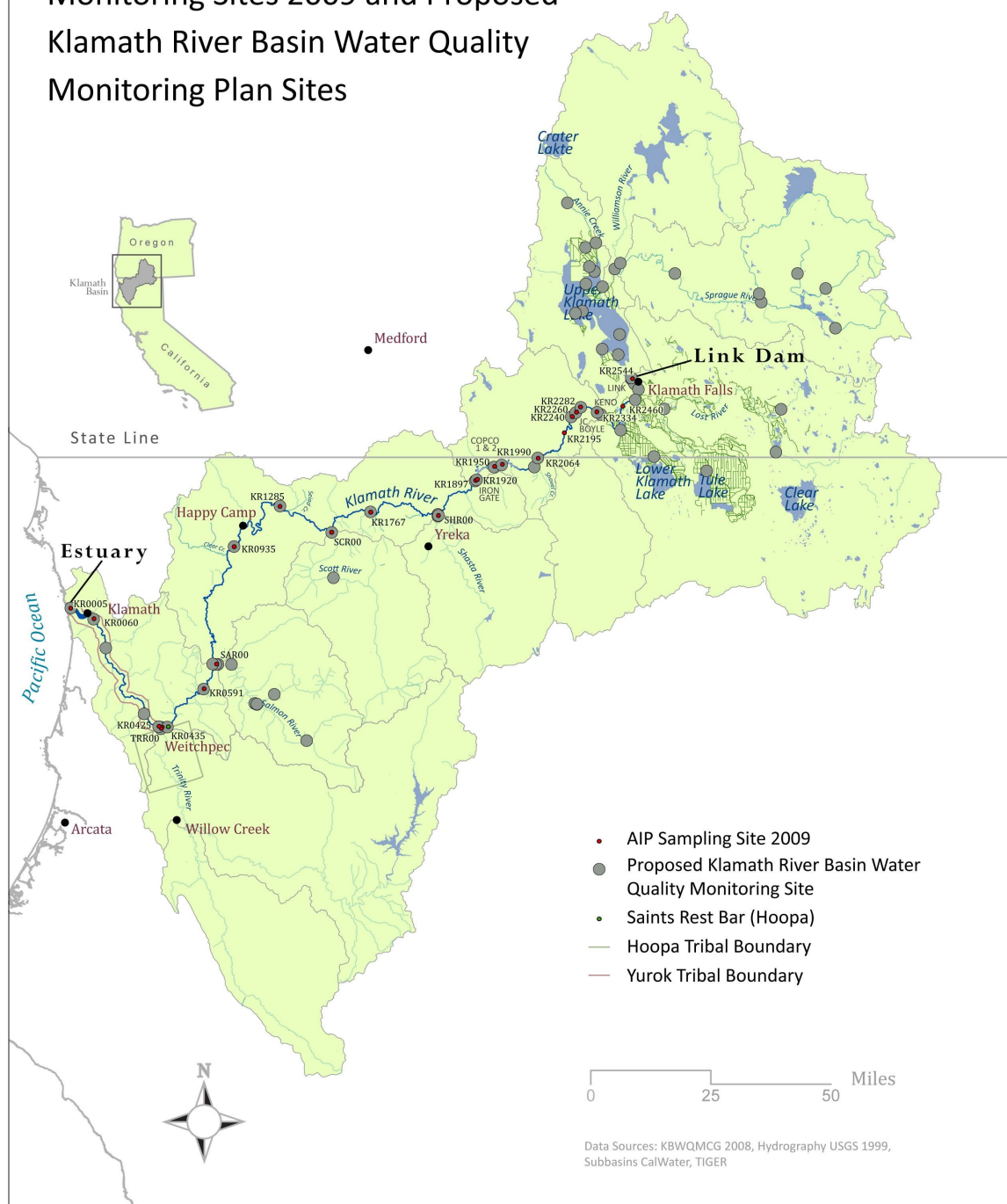


Figure 2: Monitoring stations within the Klamath Basin Water Quality Monitoring Coordination Group framework – candidates for reporting into the Klamath Basin Water Quality Monitoring database. Not all stations are represented; recruitment is continuing.

## **2. Objectives**

The AIP 2009 Monitoring Plan includes both public health monitoring for blue-green algae and base-line monitoring. This work will be done collaboratively with several entities (state, federal, tribal, county and private), most of whom are members of the KBWQMCG. Common objectives of the AIP 2009 Monitoring Plan and the KBWQMCG framework include the following:

- Provide data on cyanobacteria and related toxins in a timely manner to support public health decisions.
- Improve the current understanding of seasonal, annual, and long-term variations in a wide range of water quality parameters for Klamath River from Link Dam to the estuary. A system wide approach is necessary because influences from upstream sources extend downstream.
- Form a long-term program that captures the effects of other activities in the system potentially affecting water quality in the Klamath River, regulatory actions (e.g., Biological Opinions, adjudications, etc.), potential climate change impacts, fires, and land use activities, as well as other factors.
- Provide a long-term baseline data set of water quality conditions that can be readily extended to assess impacts of management actions and restoration processes, including:
  - Clearly identifying current conditions for a wide range of hydrology, meteorology, and water quality conditions.
  - Identifying and quantifying potential water quality changes, impacts, and implementation measures.
  - Determining progress towards restoration of the river system and evaluation of possible mitigation measures to minimize long term impacts or promote/accelerate recovery
- Collect data under a consistent Quality Assurance (QA) framework
- Disseminate data in a timely fashion.

## **3. Monitoring Components**

The AIP 2009 Monitoring Plan includes the following two components.

### **3.1 Monitoring Component 1: Public health monitoring of Cyanobacteria and toxins**

To assess potential risks to public health, due to exposure to cyanobacteria and their toxins occurring in the Klamath River, this monitoring component includes water column and fish and mussel tissue sampling within the Klamath River and reservoirs. A number of species of cyanobacteria have been documented in the Klamath River and reservoirs; the most abundant species include: *Aphanizomenon flos-aquae*, *Microcystis aeruginosa*, *Anabaena flos-aquae*, and *Oscillatoria sp.* Monitoring data from 2007 found *Anabaena flos-aquae* present at highest levels in the early summer (e.g., June/July), and blooms of *Aphanizomenon flos-aquae* and *Microcystis aeruginosa* starting in July in the Iron Gate and Copco reservoirs (Raymond, 2008, and Kann, 2007). All of these cyanobacteria are capable of producing variants of the microcystin toxins; and, *Anabaena* and *Aphanizomenon* can also produce toxins known as cylindrospermopsins and anatoxins

(Graham et al 2008). All four of these species are capable of producing cyanotoxins; however, the strain of *Aphanizomenon flos-aquae* found in Upper Klamath Lake, and subsequently transported downstream to the Klamath River, has not yet been shown to produce any toxins (Carmichael et al. 2000; Li et al. 2000).

Since 2004, Klamath River monitoring has documented elevated levels of cyanobacteria including *Microcystis aeruginosa* (MSAE) and the toxin microcystin. Microcystins are a class of toxic chemicals produced by some strains of cyanobacteria including MSAE, and are released into waters when cyanobacterial cells die or cell membranes degrade. MSAE counts and microcystin concentrations found in Klamath River waters within Copco and Iron Gate Reservoirs have exceeded action levels defined by the California State Water Resources Control Board Blue Green Algae Work Group and the Klamath Blue Green Algae Work Group. Late summer conditions are typically characterized by dense cyanobacterial blooms that form thick scums in parts of the reservoirs. The blooms at times can span much of the open water areas within the reservoirs. Since 2005, Copco and Iron Gate reservoirs were posted with public health advisories as a result of summer blooms of MSAE; and in 2005 and 2008, reaches of the Klamath River down stream of Iron Gate dam were also posted.

MSAE blooms and microcystins at elevated levels can present risks to human health and to terrestrial and aquatic species, resulting in impairments to a number of beneficial uses for the waterbody. Microcystin toxins are capable of inducing skin rashes, sore throat, oral blistering, nausea, gastroenteritis, fever, and liver toxicity (World Health Organization [WHO] 2003). These toxins have also been shown to produce toxic effects in aquatic species (fish and mussels) and terrestrial animals, including acute liver toxicity and tumor production (de Figueiredo et al. 2004, Lehman et al. 2005, and Xie et al. 2005).

This monitoring is intended to provide timely information that can be used to inform public health agencies in determining the need to post warning notices and issue advisories for the reservoirs and/or areas of the river, in the event that cyanobacteria (such as MSAE) and/or cyanotoxins (e.g., microcystin) are present at levels that pose potential health risks. Monitoring is proposed to begin slightly before the bloom season (e.g., May) and continue through the period when blooms are occurring and high-risk conditions tend to prevail, and to end following collapse of the bloom and after toxin levels have dropped below the public health criteria (e.g., late October).

Parameters associated with Monitoring Component 1 (Public Health ) are listed in Table 3. Monitoring approaches associated with Monitoring Component 1 are further described in Section 6 “Sampling Constituents and Frequency.”

### **3.2 Monitoring Component 2: Baseline water quality monitoring of the Klamath River**

This component is designed to characterize water quality conditions, by monitoring for known impairments and related indicators of impairments. Monitoring is intended to

establish current data trends for the evaluation of implementation activities, and management actions and remedies.

The Clean Water Act (CWA) Section 303(d) requires the listing of impaired waterbodies. The states of Oregon and California have prepared such lists, which identify several impairments for Upper Klamath Lake and the Klamath River. Impairments to Upper Klamath Lake include dissolved oxygen (DO), chlorophyll *a*, and pH.<sup>1</sup> Impairments to the Oregon portion of the Klamath River include: DO, pH, ammonia toxicity, temperature, and chlorophyll *a*. Identified impairments to the California portion of the Klamath River include: nutrients, organic enrichment/low DO, temperature, and sediment. Additionally, microcystin is listed as an impairment for Copco and Iron Gate reservoirs, and the reach of Klamath River between those reservoirs; California's Draft 2008 303(d) list expands that range to include the Klamath River from Iron Gate dam to the Trinity River.

To address these listed impairments, together with related surrogate or indicator parameters, the proposed baseline monitoring builds on ongoing water quality monitoring programs for the Klamath River and larger basin. Proposed sampling enhances the current understanding of temporal and spatial variation in temperature, nutrients, organic matter, and algae production throughout the Klamath River system from Link River Dam to the estuary, and complements monitoring being conducted in Upper Klamath Lake by others. Data from this monitoring is intended to support ongoing and potential future studies and decisions regarding future management actions.

Parameters associated with Monitoring Component 2 are listed in Table 5.

#### **4. Plan Adaptability**

Using an adaptive management program, the AIP 2009 Monitoring Plan will be revisited following the 2009 monitoring year, and yearly thereafter as needed, to develop an optimized long-term AIP monitoring plan. Each year the monitoring plan sampling locations, parameters, and frequency will be reviewed to determine if changes should be made. New questions and hypotheses may arise as the program matures, thus necessitating additional sampling or modifications to the sampling program (e.g., to increase the density of sampling locations or frequency of sampling).

This annual adaptive management review of the AIP Monitoring program should be completed in November<sup>2</sup> in order to identify needed updates and modifications to the following year monitoring plan. The annual adaptive management review will be conducted within the KBWQMCG framework to the extent practicable. Within a sampling year, modifications to the monitoring plan should be limited to those modifications needed to address safety, access, or extraordinary events.

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<sup>1</sup> ODEQ completed TMDLs in 2002 to address these parameters in the Sprague River, Williamson River, and Upper Klamath Lake.

<sup>2</sup> The monitoring year ends in December, however the majority of sampling will be completed by November. Therefore, this schedule presumes that data needed to inform this adaptive management review (e.g., laboratories have reported data) will be available to the reach monitoring entities.

## ***5. Quality Assurance, Data Management, and Dissemination***

### **5.1 AIP Program Quality Assurance Strategy for 2009**

The AIP 2009 Monitoring Plan reach monitoring entities are striving to use common laboratories where possible; however, at this point and unless otherwise specified, it is the responsibility of each monitoring entity to individually contract the services of laboratories for the analysis of water quality samples. Contracts with laboratories should include a minimum level of laboratory QA procedures; development of QA requirements is described below. The analysis of water quality samples by multiple labs will require that additional QA procedures be in place to provide the information to enable comparisons among participating laboratories. This will include a percentage of samples (described in the QA requirements) that will be split and sent to all of the contracted labs for analysis.

Development and implementation of a full QA program prior to the 2009 AIP monitoring season was not possible. Participating entities agreed to submit their existing QA plans and standard operating procedures to the North Coast Regional Water Quality Control Board for a consistency and minimum standards review. The scope of the review was to ensure that minimum standards and compatibility of methods among participants are applied for the following program elements:

- Field sampling SOPs and QA/QC requirements (e.g., duplicates, blanks)
- Laboratory and sampling accuracy and precision
  - Minimally acceptable method detection limits (MDLs) and reporting limits (RLs) for each analyte
  - Frequencies for duplicates, blanks, and sample spikes
  - Sample split requirements to evaluate comparability where multiple labs are used to evaluate a given parameter
  - Lab QA measures and reporting requirements
  - Required Actions should a lab fail to meet Lab QA measures and/or reporting requirements

The review was completed in May 2009 prior to collection of any samples. The review concluded that minimum standards were met or exceeded by all reach monitoring entity's QA plans and that there was a high level of compatibility for QA procedures. The reach monitoring entity QA plans and standard operating procedures (for activities not addressed in the cyanobacterial SOP, Appendix A) that were included in the 2009 consistency review have been included as Appendix B. A subcommittee has been formed to begin planning for a more complete and unified AIP QA plan for future monitoring years.

Each monitoring entity will be responsible for conducting QA review of lab data results prior to disseminating data to the public. Data and laboratory QA documents from the AIP 2009 effort will be made available to the public and interested parties in a timely manner following internal QA and quality control procedures by the reach monitoring



entities. If a laboratory should fail to meet the QA requirements as set forth by the AIP lab subgroup, and laboratories fail to adequately implement corrective actions, then contracts with that lab will cease and a new contract will be established with one of the labs currently contracted by a monitoring entity.

## **5.2 Data Management and Dissemination for 2009**

Data availability and dissemination are intended to be an ongoing element of future AIP monitoring plans. Each sampling entity is responsible for producing a memorandum every two weeks presenting the most recent cyanobacteria analyses (cell count and toxin sample) for public health and baseline monitoring lab results, and distributing that memo to interested parties including KBWQMCG and Klamath BGA workgroup members. Additionally, river monitoring entities will provide memoranda, including usable spreadsheets (e.g. Excel), of baseline monitoring analytical results on a quarterly basis by the last day of the following months: July, October, and January (annual report, described below may replace the January quarterly memoranda). This data dissemination procedure may be revised pending development of the KBWQMCG data portal described in the following paragraph.

A description of the data management element has been included in text box 1 below. Additionally, following the 2009 year of data collection the identified program manager for each reach monitoring entity is responsible for preparing and distributing a comprehensive annual report of the data and interpretation of results. Drafts of these annual reports will be prepared by each sampling entity by the end of January, in order to guide monitoring decisions for the following season. A final report of all data and interpretation of results will be completed by each sampling entity prior to the commencement of monitoring work for the following year (i.e., April).

In an effort to maintain continuity with the long-term basinwide water quality monitoring plan, the KBWQMCG is currently developing a searchable web based database for the collection and dissemination of data characterizing the Klamath River Basin. Data from the AIP 2009 monitoring plan will be posted on this website when it becomes active. The AIP Measure 12 is not the source of the funding to support the web portal for 2009, rather the funding is part of an existing contract that the Regional Water Board has with the Klamath Watershed Institute to support the Klamath Basin Water Quality Monitoring Coordination Work Group.

## **5.3 Public Health Monitoring Data Dissemination**

Public health monitoring of cyanobacteria and toxins requires prompt and effective communication of data to the local and state agencies to support management decisions regarding the need to issue health advisories or post of waterbodies. Thus, results from cyanobacterial cell counts and toxin analyses (e.g., MSAE counts and/or associated toxin concentrations) should be forwarded promptly to the appropriate local and state health agencies (e.g., the ODEQ, the California Regional Board and State Board, and County Health Departments). Specifically, reach monitoring entities will provide all provisional laboratory data (i.e., prior to reanalysis requests and QC review) for cyanobacterial cell counts and toxin levels, to regulatory and public health agencies (e.g., ODEQ, CA

RWQCB, CDPH, EPA) **within 48 hours of receipt**, to support management decision-making. This applies to data for monitoring Component 1, and cyanobacterial count and toxin data from monitoring Component 2. If the results of sampling suggest that cyanobacteria populations or toxin levels present a potential public health risk at any site, river monitoring entities shall clearly identify those locations and data results when notifying the public health agencies. Public notices will be issued by the relevant authorities in accordance with regulatory requirements and guidance (e.g., SWRCB BGAWG Guidelines for BGA) and according to established procedures.

**Text Box 1.** Description of third party data management element for future editions of Klamath River AIP Monitoring Plan

An independent third party may be contracted to conduct the following tasks in support of the AIP Monitoring program and other monitoring entities within the basin. Tasks would include development of a basic, searchable, web-based database for the compilation of data relating to these AIP monitoring program activities. This site will provide public access to QA/QC reviewed datasets provided by the reach monitoring entities that collect and prepare water quality data as part of the AIP monitoring program. The third party will organize, store and make data available as provided. Specifically, the third party will provide the following services as part of this agreement.

1. Create a publicly accessible, web presence for accessing the AIP data;
2. Receive data from reach monitoring entities collecting water quality data;
3. Post data to the site in a timely manner;
4. Maintain the data system through the project period; and

Work towards integration of the AIP data and data system with parallel processes as appropriate (e.g. data systems developed in collaboration with KBWQMCG).

Currently the third party data management is an unfunded element for 2009

## ***6. Sampling Constituents and Frequency***

This section presents protocols to be used in conducting sampling for Monitoring Components 1 and 2, including sampling locations, frequency and procedures. Table 1 provides a summary of public health monitoring locations, constituents, method, and frequency. To facilitate timely shipment of samples to the various laboratories, and as a cost saving measure, PacifiCorp has established a shipping account and provided a common shipping number to the identified reach monitoring entities for use in shipping samples collected as part of this AIP 2009 Monitoring Plan to designated laboratories.

Table 1: Klamath River AIP Monitoring Program 2009 – Summary Table of Public Health monitoring locations, constituents, method, and frequency

Site ID	Location	Phyto-plankton Species	Microcystin - EPA	Fish Tissue	Mussel Tissue	LCMS microcystin confirmation	LCMS water for mussels	Sampling Entity
KR2008	Copco Reservoir at Mallard Cove	J/J1	M3/BM3	S2	-	BM5	-	PacifiCorp
KR1985	Copco Reservoir at Copco Cove	J/J2	M3/BM3	-	-	-	-	PacifiCorp
KR1928	Iron Gate Reservoir at Camp Creek	J/J2	M3/BM3	-	-	-	-	PacifiCorp
KR1924	Iron Gate Reservoir at Williams Boat Ramp	J/J1	M3/BM3	S2	-	-	-	PacifiCorp
KR1897	Klamath River below Iron Gate Dam (Hatchery Bridge)	BM/W	BM/W	-	-	-	-	PacifiCorp
KR1760	Klamath River at I-5 Rest Area	BM/W	BM/W	-	S4	-	S4	Karuk
KR1575	Klamath River at Brown Bear River Access	BM/W	BM/W	-	S4	-	S4	Karuk
KR1285	Klamath River at Seiad Valley	BM/W	BM/W	-	S4	BM5	S4	Karuk
KR1084	Klamath River at Happy Camp	BM/W	BM/W	-	S4	-	S4	Karuk
KR0591	Klamath River at Orleans	BM/W	BM/W	-	S4	-	S4	Karuk
KR0425	Klamath River at Weitchpec	BM/W	BM/W	-	S4	-	S4	Yurok
KR0060	Klamath River at Turwar	BM/W	BM/W	-	S4	-	-	Yurok
TRR000	Trinity River near mouth	-	-	-	SI	-	S1	Yurok

J/J1 June-July bimonthly rushed, than monthly phytoplankton through Nov  
J/J2 June-July bimonthly rushed  
M3/BM3 bimonthly June through October and monthly in May and November  
BM/W bimonthly June through October, weekly Aug/Sept  
S2 Two seasonal sampling events  
S4 Four seasonal sampling events  
S1 One seasonal sampling event  
BM5 bimonthly June through October

## 6.1 Monitoring Component 1: Public health monitoring of cyanobacteria and toxins

Risks to public health related to cyanobacteria and toxin exposure will be evaluated through water sampling, tissue sampling, and identification of the presence of scums, using the monitoring procedures described in the standard operating procedures (SOPs) presented in Appendix A. Water quality monitoring of cyanobacteria and related toxins for purposes other than public health evaluation is addressed under Monitoring Component #2, described below.

### 6.1.1 WATER SAMPLING

#### Locations

Public health monitoring for cyanobacteria and microcystin toxin in water samples will occur during 2009 at a total of 12 designated locations used for public access and recreation. These are listed in Table 2, and include:

- Four shoreline sites in coves on Copco (Mallard Cove and Copco Cove) and Iron Gate reservoirs (Camp Creek and Williams Boat Ramp). These cove sites provide public access, are known areas of likely accumulation during blooms, and have been monitored since 2005.
- Eight (8) river sites stretching from Iron Gate dam (RM 189.7) to Turwar (RM 6.0). Most of these sites have been monitored since 2005, and all represent areas of public access.

In recent years, monitoring programs have also been conducted to evaluate cyanobacteria and toxin levels in reaches of the Klamath River between Upper Klamath Lake (Link River Dam) and Copco 1 Reservoir.

Table 2: 2009 Klamath River sampling sites for public health monitoring of cyanobacteria and cyanotoxins in surface water samples.

Location	Approx RM	Sampling Entity
Copco Reservoir and Mallard Cove	200.8	PacifiCorp
Copco Reservoir at Copco Cove	198.5	PacifiCorp
Iron Gate Reservoir at Camp Creek	192.8	PacifiCorp
Iron Gate Reservoir at Williams Boat Ramp	192.4	PacifiCorp
Klamath River below Iron Gate Dam (Hatchery Bridge)	189.7	PacifiCorp
Klamath River at I-5 Rest Area	176	Karuk
Klamath River at Brown Bear River Access	157.5	Karuk
Klamath River at Seiad Valley	128.5	Karuk
Klamath River at Happy Camp	108.4	Karuk
Klamath River at Orleans	59.1	Karuk
Klamath River at Weitchpec	42.5	Yurok
Klamath River at Turwar	6.0	Yurok

### **Sampling Frequency**

Sampling for public health monitoring under this plan will occur at each of the sites listed in Table 1, at the following frequencies:

- Prior to and following cyanobacteria blooms, once per month (May and November).
- During the presence of visible cyanobacterial populations or blooms, and cyanotoxins at levels approaching concentrations that warrant the posting of public health advisories by regulatory agencies (e.g., California's North Coast Regional Water Quality Control Board), biweekly (aka, every two weeks) (June through October). Sampling will continue at a biweekly frequency until State board criteria for posting have been met for *Microcystis aeruginosa*.
- Following the posting of public health advisories for *Microcystis aeruginosa*, sampling at selected shoreline locations will be reduced to monthly until bloom densities and toxin levels in those areas have reduced and risks to public health are no longer a concern. Sampling at those locations will then resume as in Items 1 or 2, above, depending on the time of year.

### **Sampling Procedures**

Water samples will be collected, by all reach monitoring entities, for species identification/enumeration, and for toxin analysis, in accordance with the *Standard Operating Procedures, Environmental Sampling of Cyanobacteria for cell enumeration, identification and toxin analysis* (see Appendix A). To address public health concerns, water samples will be collected at sampling depths representative of reasonable maximum exposure by incidental ingestion exposures to sensitive populations (e.g., children).

Under the AIP 2009 Monitoring program, Microcystin toxins in water samples will be analyzed by the U.S. EPA Region 9 laboratory, in accordance with the U.S. EPA Region 9 Laboratory Standard Operating Procedure (SOP 1305 for Microcystin analysis by ELISA). In accordance with the *Environmental Sampling SOP* (Appendix A) samples should be chilled immediately upon collection and maintained at or below 6 degrees C prior to and throughout shipping to the EPA laboratory.

Water samples will also be collected for cyanobacterial cell identification/enumeration to determine the presence and abundance of cyanobacterial species (e.g., *Anabaena sp.*, *Aphanizomenon sp.*, *Microcystis sp.*, etc). To provide data continuity with prior years of monitoring, the river monitoring entities have agreed to have cell identification and counting be done by Aquatic Analysts laboratory, contracted by the individual monitoring entities. These analyses will be conducted to the species level at minimum. Depending on the severity (e.g., density and size) of the algal bloom, river monitoring entities will specify whether the phytoplankton analysis samples will be rushed and/or enumerated using a 400 cell count protocol.

Analysis and data QA/QC review and reporting should be conducted in accordance with the Quality Assurance (QA) requirements for each reach monitoring entity identified in Appendix B.

### **6.1.2 TISSUE SAMPLING**

During 2009, public health monitoring will include sampling of yellow perch from Copco and Iron Gate Reservoirs, and mussel sampling from locations on the Klamath River below Iron Gate Dam. Sampling conducted in the summer of 2007, with analysis by CDFG using LC/MS/MS, found levels of microcystin in mussels collected in the Klamath River below Iron Gate Dam, and in fish tissue (yellow perch) collected from Copco and Iron Gate reservoirs, exceeding the advisory level of 26 ng total microcystin/gram tissue, developed by the California Office of Environmental Health Hazard Assessment (letter dated August 6, 2008, to Randy Landolt, PacifiCorp from OEHHA).

In 2008, PacifiCorp collected yellow perch and crappie samples from Iron Gate and Copco reservoirs, and rainbow trout from the Klamath River above Copco Reservoir and below Iron Gate dam prior to, during, and after the algal bloom season. Tissue samples were analyzed by Dr. Greg Boyer, University of Syracuse, New York, using HPLC with UV detection. Fish tissue samples collected in May, July, and September 2008 were below detection for total free microcystins (Carlson 2009). PacifiCorp also collected mussel samples below Iron Gate dam during the November 2008. A final report for these samples is expected by June 2009.

Exposures to microcystins are possible from ingestion of fish (e.g., caught during recreational fishing in the reservoirs), or consumption of freshwater mussels collected from the Klamath River. Mussels from the Klamath River are part of the traditional diet of tribal people. Additionally, mussels as filter feeders may be sensitive indicators of cyanobacteria levels and toxin levels in ambient water and food sources.

#### **Yellow Perch Tissue Sampling**

Yellow perch sampling will be conducted at both Copco and Iron Gate reservoirs. During each sampling event, a minimum of 5 (if possible) and up to 15 yellow perch, will be collected from each reservoir. Samples from each reservoir will be weighed and measured to fork length, wrapped in foil, and shipped in accordance with the SOP in Appendix A.

Sampling for yellow perch will occur during the anticipated bloom season. One sampling event will occur early in the bloom season (July) and the other towards the end of the bloom season (September).

#### **Mussel Tissue Sampling**

Mussel sampling will be conducted from a total of 7 locations and one control location, listed below in Table 3. The proposed locations on the Klamath River below Iron Gate Dam are known to be fishing/harvesting locations, and will be used to evaluate potential ingestion exposure related to recreational, commercial and subsistence fishing activities. Mussel tissue sampling will also be used to support analysis of elevated concentrations in mussel tissues co-occurring with cyanobacterial abundance and elevated cyanotoxin levels in water samples.

Table 3: Sample sites in the Klamath River for 2009-2010 Monitoring of cyanotoxins in mussel tissue.

Location	Approximate RM	Sampling Entity
Klamath River at I-5 Bridge/Rest Area	176	Karuk
Klamath River at Brown Bear River Access	157.5	Karuk
Klamath River at Seiad Valley	128.5	Karuk
Klamath River at Happy Camp	108.4	Karuk
Klamath River at Orleans Bridge	59.1	Karuk
Klamath River at Turwar	6.0	Yurok
Control sample from Trinity River (near mouth)	na	Yurok

For each Klamath River sampling event and location, five mussels will be collected from each location, and prepared for submittal to the laboratory in accordance with the *Environmental Sampling SOP* (Appendix A). Additionally, two water samples will be collected and analyzed for microcystin toxins by LC/MS/MS, and phytoplankton species and enumeration. The California Department of Fish and Game laboratory, in Rancho Cordova, CA, will be used to analyze these tissue samples.

The control sampling location will only be sampled once during the anticipated bloom season (July through September). For all other locations, there will be 4 sampling events; one pre-bloom (May/June), two during the bloom (August and September) and one post-bloom (late October/November).

### **Data Quality**

Water quality monitoring data (cell count, and ELISA data presenting total microcystin concentrations) for the protection of public health, will be evaluated against the following water quality criteria and guidance. Therefore, data should be of sufficient quality to fully and unquestionably meet the following criteria and guidance.

To evaluate water quality data, criteria to be used for purposes of protecting public health include those presented in the California State Water Board 2008 Guidance about Harmful Algal Blooms, for Monitoring and Public Notification<sup>3</sup>, and criteria issued by California's Office of Environmental Health and Hazard Assessment (OEHHHA). Exceedance of any of these criteria for the protection of human health and aquatic life may result in the posting of a waterbody by local health agencies:

- Surface scums are present containing toxigenic species<sup>4</sup>;
- *Microcystis aeruginosa* or *Planktothrix* cell densities  $\geq 40,000$  cells/mL;
- Total microcystin concentrations  $\geq 8$   $\mu\text{g/L}$ ; and
- Others as specified in the California State Water Board 2008 Guidance.

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<sup>3</sup> Per the posting guidelines established by the Blue Green Algae Work Group of the California State Water Resources Control Board, Department of Public Health, and Office of Environmental Health and Hazard Assessment; *Cyanobacteria in California Recreational Water Bodies; Providing Voluntary Guidance about Harmful Algal Blooms, Their Monitoring, and Public Notification*. Draft, September 2008.

<sup>4</sup> When using the presence of scums to establish the need to post, staff trained in recognizing *Microcystis aeruginosa* scums, must compile a photographic record as part of the monitoring program.

To evaluate tissue samples, an exceedance threshold of the Advisory Tissue Level for one serving (8 oz uncooked, 6 oz cooked) of 26 ng/g will be applied to analytical results for cyanotoxin concentrations in mussel tissues (OEHHA, August 6, 2008). For the protection of human health from tissue contaminated with microcystins, total microcystin concentrations for three or more individual mussels (samples composited, or discrete mussel data averaged) will be evaluated against that criteria (OEHHA 2008).

## **6.2 Monitoring Component #2: Comprehensive Baseline Water Quality Monitoring of the Klamath River**

### **6.2.1 LOCATIONS**

Initial water quality monitoring locations are presented in both Tables 4 and 5. Twenty mainstem sites including the estuary and the mouth of four major tributaries are identified. For monitoring purposes, reservoir sites are being sampled at multiple depths.

This plan relies on other efforts to quantify WQ conditions in tributaries, although there are clearly important flow and water quality considerations within tributary sub-basins. Similarly, there are considerable water quality challenges above Link Dam, in Upper Klamath Lake and the Wood, Williamson, and Sprague systems; however, this plan relies on other efforts to quantify conditions in those waterbodies. Water quality testing in Upper Klamath Lake on behalf of USBR will be conducted by contractual agreement (e.g., either with USGS or the Klamath Tribe) and is distinct from the AIP monitoring program. In addition, the Hoopa Tribe has established a monitoring station at Saints Rest Bar to coincide with the intersection of the Tribal reservation boundary with the Klamath River (Figure2).

Additional monitoring efforts are being conducted by others and will be reported to the comprehensive Klamath Basin water quality data management system described earlier in this document. The 2009 AIP program benefits from the inclusion of existing USBR Klamath River monitoring stations. AIP program funds will provide funding for analysis of chemical, phytoplankton, and blue-green algae related parameters while USBR will provide the labor for sampling at the Link Dam, Miller Island and below Keno Dam stations. See Table 4 for USBR stations included in the AIP monitoring program. Additionally, USBR will be collecting continuous Sonde measurements at 6 locations in the mainstem of the Klamath River: Link Dam, Link River, the train trestle (top and bottom), Miller Island (top and bottom), Rock Quarry (top and bottom), and Keno Bridge (top and bottom) and at two tributary locations (Lost River Diversion Channel and Klamath Straits Drain). The Sonde measurements include: pH, conductivity, dissolved oxygen, and temperature. Turbidity also will be measured at each site biweekly when the Sondes are visited for data retrieval. At two sampling sites (Link River near the bridge and at Keno Bridge) nutrient grab sampling will be conducted once every two weeks, and analyzed for: OP, TP, NH<sub>3</sub>, NO<sub>3</sub>+NO<sub>2</sub>, and TKN. PacifiCorp also has a data sonde stations below Iron Gate Dam that will be reported to the comprehensive Klamath Basin data management system.



Table 4: Proposed long-term baseline monitoring locations and rational/purpose

Location	~River Mile / Station ID	State	AIP	Other	Rational / Purpose	Sampling Entity
Link Dam	254.4 KR2544	OR		•	Continuous water quality monitoring of: water temperature, pH, dissolved oxygen, and specific conductance, to comply with ESA requirements.	USBR
			•		Blue-Green Algae (BGA) monitoring	
			•		Nutrient monitoring including CBOD	
			•	•	Data will be used to continue to refine UKL outflow quality understanding	
Keno Reservoir – at Miller Island	246.0 KR2460	OR	•	•	Support UKL TMDL activities and the Klamath River TMDL	USBR
					Continuous water quality monitoring at 1.0 meters below the surface and 1.0 meter above the bottom of: water temperature, pH, dissolved oxygen, and specific conductance, to comply with ESA requirements.	
			•		Nutrient monitoring including CBOD	
				•	Keno reservoir experiences complex flow and water quality conditions, and a separate sampling effort should be used to quantify the individual effects of the TMDL efforts through time. For example, inputs from the Lost River diversion channel and the Klamath Straits Drain should be quantified, municipal and industrial compliance tracked, comprehensive monitoring of water quality prescriptions (e.g., return flows from treatment wetlands, non-point source control BMP's). Sampling conducted by USBR will include vertical profiles (e.g., top and bottom observations) located at two to three longitudinal locations.	
Klamath River below Keno Dam	233.4 KR2334	OR	•		Blue-Green Algae (BGA) monitoring	USBR
			•	•	Support TMDL activities (UKL, Lost River, and Klamath River)	
			•		CBOD – see rationale for Link River below Link Dam	
			•		Blue-green algae monitoring	
Klamath River above J.C. Boyle Reservoir	228.2 KR2282	OR	•		Implement and maintain water quality management plans for J.C. reservoir, wherein inflows, outflows, and in-reservoir sampling are desirable.	PacifiCorp
			•		Support TMDL activities	
J.C. Boyle Reservoir	226.0 KR2260	OR	•		Supports implementation and assessment of in-reservoir water quality activities associated with reservoir water quality management plans.	PacifiCorp
			•		Support TMDL activities – Nutrient monitoring	
			•		Blue-Green Algae (BGA) monitoring	

Table 4 (cont.): Proposed long-term baseline monitoring locations and rational/purpose

Location	~River Mile / Station ID	State	AIP	Other	Rational / Purpose	Sampling Entity
Klamath River below J.C. Boyle Dam	224.0 KR2240	OR	•		This reservoir outflow point will support TMDL activities in Oregon regarding conditions in J.C. Boyle reservoir.	PacifiCorp
			•		Klamath River immediately below J.C. Boyle Dam supports implementation and assessment of in-reservoir water quality activities associated with reservoir water quality management plans.	
			•		Combined with the sampling point below the J.C. Boyle powerhouse, these data can be used to assess conditions in the bypass reach.	
			•		Dam removal baseline	
Klamath River below USGS Gage	219.5 KR2195	OR	•		This location is below both the J.C. Boyle powerhouse and the large springs complex which enters the river in the bypass reach and represents the last point in Oregon where compliance would be assessed. Access to stateline from the Oregon side of the border is challenging.	PacifiCorp
			•		Blue-Green Algae (BGA) monitoring	
			•		Dam removal baseline	
Klamath River above Shovel Creek (above Copco Reservoir)	206.4 KR2064	CA	•		Represents both Klamath River at Stateline and Klamath River above Copco Reservoir. ("Stateline" has been represented by agencies and other entities as the Klamath River above Shovel Creek for several years.)	PacifiCorp
			•		Assess TMDL activities in California.	
			•		CBOD – see rationale for Link River below Link Dam	
			•		Blue-Green Algae (BGA) monitoring	
			•		Dam removal baseline	
Copco Reservoir	199.0 KR1990	CA	•		Support TMDL activities	PacifiCorp
			•		Support reservoir management plan activities (e.g., nutrients)	
			•		Blue-Green Algae (BGA) monitoring	
			•		Dam removal baseline	
Klamath River below Copco Dam	195.0 KR1950	CA	•		Support reservoir management plan activities	PacifiCorp
			•		Blue-Green Algae (BGA) monitoring	
			•		Dam removal baseline	
Iron Gate Reservoir	192.0 KR1920	CA	•		Location to support TMDL activities	PacifiCorp
			•		Support reservoir management plan activities	
			•		Blue-Green Algae (BGA) monitoring	
			•		Dam removal baseline	

Table 4 (cont.): Proposed long-term baseline monitoring locations and rational/purpose

Location	~River Mile	State	AIP	Other	Rational / Purpose	Sampling Entity
Klamath River below Iron Gate Dam	189.7 KR1897	CA	•		Support TMDL activities	PacifiCorp
			•		Support reservoir management plan activities	
			•		CBOD – see rationale for Link River below Link Dam	
			•		Blue-Green Algae (BGA) monitoring	
			•		Dam removal baseline	
Klamath River at Shasta River at Walker Bridge	176.7 KR1767	CA	•		Location to support TMDL activities	Karuk
			•		Blue-Green Algae (BGA) monitoring	
			•		Dam removal baseline	
Klamath River near Seiad	128.5 KR1285	CA	•		Location to support TMDL activities	Karuk
			•		Blue-Green Algae (BGA) monitoring	
			•		Dam removal baseline	
Klamath River near Happy Camp	93.5 KR0935	CA	•		Location to support TMDL activities	Karuk
			•		Blue-Green Algae (BGA) monitoring	
			•		Dam removal baseline	
Klamath River near Orleans	59.1 KR0591	CA	•		Location to support TMDL activities	Karuk
			•		Blue-Green Algae (BGA) monitoring	
			•		Dam removal baseline	
Klamath River at Weitchpec	43.5 KR0435	CA	•		Long-term monitoring station is established at Weitchpec with relatively easier access than Saints Rest Bar. Compare representative characteristics with Saints Rest Bar to determine whether both sites are needed for 2010 – 2011 sampling season.	Yurok
			•		Location to support TMDL activities	
			•		Blue-Green Algae (BGA) monitoring	
			•		Dam removal baseline	
Klamath River below Trinity River	42.5 KR0425	CA	•		Location to support TMDL activities	Yurok
			•		Blue-Green Algae (BGA) monitoring	
			•		Dam removal baseline	
Klamath River near Klamath	6.0 KR0060	CA	•		Location to support TMDL activities	Yurok
			•		Blue-Green Algae (BGA) monitoring	
			•		Dam removal baseline	

Table 4 (cont.): Proposed long-term baseline monitoring locations and rational/purpose

Location	~River Mile	State	AIP	Other	Rational / Purpose	Sampling Entity
Klamath River Estuary	0.5 KR0005	CA	•		Location to support TMDL activities	Yurok
			•		Blue-Green Algae (BGA) monitoring	
			•		Dam removal baseline	
Shasta River near mouth	SHR00	CA	•		Major tributary contribution: nutrient and sondes	Karuk
Scott River near mouth	SCR00	CA	•		Major tributary contribution: nutrient and sondes	Karuk
Salmon River near mouth	SAR00	CA	•		Major tributary contribution: nutrient and sondes	Karuk
Trinity River near mouth	TR00	CA	•		Major tributary contribution: nutrient and sondes	Yurok

### 6.2.2 SAMPLING PROCEDURES

Standard operating procedures (SOPs) for cyanobacterial water and tissue sample collection methodologies are incorporated in Appendix A to this document. Other sampling methods for baseline monitoring will be conducted in accordance with river monitoring QA procedures (see Appendix B).

### 6.2.3 SAMPLING CONSTITUENTS AND FREQUENCY

Outlined herein are constituents that are proposed for the baseline monitoring plan. The purpose, or rationale, for each constituent is briefly introduced, as is the rationale for frequency of sampling.

#### **Data Collection Using Sondes**

For each of the following parameters, capturing sub-daily variability is important to understanding the dynamics present in the system. Continuous monitoring devices will be deployed to address the period May to November, important for characterizing current conditions. Winter deployments can be minimal (December 1-March 31), with certain exceptions that would include Keno Reservoir where winter water quality conditions are poorly understood.

- **Temperature** - controls rate reactions in aquatic system and can be a stressor to aquatic life.
- **Dissolved Oxygen** - is important to aquatic ecosystem function. Low concentrations can be a stressor to certain aquatic life.
- **pH** - conditions are important for aquatic life, with typical acceptable pH concentrations in a range of 6 to 9. At elevated pH, unionized ammonia can be toxic to aquatic life, a condition exacerbated by elevated temperatures.
- **Conductance** - represents ions that are in solution. This parameter is often used as a conservative constituent and to identify inputs or affects of land use practices.

#### **Data Collection Sampling**

For the following parameter, limited sampling (frequency and locations) is proposed:

- **CBOD** - To address TMDL issues, sampling of CBOD will occur every two weeks from June to October, and approximately monthly the remainder of the year. Sampling for CBOD will occur at the following locations: Link River Dam, below Keno Dam, above Copco Reservoir at Shovel Creek, and below Iron Gate Dam. Sampling procedures will be based on the USGS National Field Manual (2009) and as part of the recently completed studies on the Keno reach (Sullivan 2008).

Sampling for the following parameters will occur from May through December at frequencies noted in Table 5. Capturing short term variability (biweekly or daily) may be

important for several or all of these parameters, and could be added in future monitoring plans.

- **Inorganic/Organic N (ammonia, nitrate, nitrite, organic N)** - Inorganic nutrients (ammonia, nitrite, nitrate) are readily available for primary production. Total nitrogen (organic plus inorganic forms) is an indicator of overall status of an aquatic system. It is important to collect and assess/consider both organic and inorganic forms. Ammonia can be toxic (unionized ammonia) when elevated pH and temperature conditions are present. The conversion of ammonia to nitrite and nitrate consumes oxygen.
- **Inorganic/Organic P (orthophosphate, organic P)** - Inorganic nutrients (orthophosphate) are readily available for primary production. Total phosphorus (organic plus orthophosphate) is an indicator of overall status of an aquatic system. It is important to collect and assess/consider both organic and inorganic forms.
- **Particulate and Dissolved C (particulate and dissolved organic carbon)** - This is a measure of the organic matter within the system, and is necessary for the partitioning of organic matter fractions into particulate, dissolved, labile, and refractory. Organic matter consumes oxygen during decay and releases nutrients. Analysis of organic carbon is used to determine organic matter loads. Special studies will be used to identify stoichiometry of organic matter (C, N, and P fraction) and to partition particulate and dissolved matter into refractory and labile forms.
- **TSS/VSS (total and volatile suspended solids)** - TSS and VSS together define the organic (VSS) and inorganic (TSS-VSS) fraction of suspended material. This provides insight on bulk organic matter loads, and coupled with inorganic suspended solids can be used to estimate light extinction.
- **Alkalinity** - Understanding alkalinity, helps to identify the buffering capacity of waters and the ability of an aquatic system to resist changes in pH (e.g., in response to primary production).
- **Water Column Chl-A/Pheo** - This measure of Chl-A and Pheo in reservoirs can be used to estimate the standing crop of phytoplankton. Consideration should be given to further reducing the sampling frequency in mid-winter.
- **Phytoplankton species** - Sampling is needed to identify species presence and absence. Determination of population variations can provide insight into trophic status, nutrient availability, BGA species, potential toxins and health advisories. Consideration should be given to further reducing the sampling frequency in mid-winter.

- **Microcystin** - The California 2006 Section 303(d) list identified microcystin as an impairment in the segment from and including the Copco Reservoirs down to Iron Gate Dam, including the segment of Klamath River between those reservoirs. California's 2008 *Public Review Draft Staff Report for the 2008 Integrated Report for the Clean Water Act Section 305(b) Surface Water Quality Assessment and the 303(d) List of Impaired Waters* (Regional Water Board 2008) recommends that the mainstem Klamath River from downstream of Iron Gate Dam to the confluence of the Trinity River be listed as impaired for microcystin (Klamath River from Iron Gate Dam to Scott River - Middle Klamath River HA, and from Scott River to the Trinity River - Middle & Lower Klamath River HA).

Sampling occurs bi-weekly May through October when the greatest potential for shorter term variability exists and monthly for the remainder of the year. Additional sampling prior to June or after September may be required depending on field conditions. Additionally, the presence of scums should be documented to support listing decisions; in California, guidelines for documentation of scums to support the CWA 303(d) listing of waterbody reaches is provided in the Regional Board Guidelines for documentation.

Sampling constituents, locations, frequency, and monitoring entities are presented in Table 5.

Table 5: Klamath River AIP Monitoring Program 2009 – Summary Table of Baseline Monitoring

Monitoring Location	Temperature (°C)	Dissolved Oxygen (mg/l)	pH (log[H+])	Conductance (uS/cm)	Inorganic/Organic N (mg/l)	Inorganic/Organic P (µg/l)	Particulate and Dissolved C (mg/l)	TSS/VSS (mg/l)	Alkalinity (mg/l)	Water Column chl_a/Pheo (ug/l)	Phytoplankton species	Microcystin (ug/l)	LCMS confirmation	CBOD, mg/l	Sampling Entity
<i>Sampling Method:</i>	<i>T,P</i>	<i>P</i>	<i>P</i>	<i>P</i>	<i>G</i>	<i>G</i>	<i>G</i>	<i>G</i>	<i>G</i>	<i>G</i>	<i>G</i>	<i>G</i>	<i>G</i>	<i>G</i>	
Link Dam (RM - 254.4)	VP	VP	VP	VP	M/BM	M/BM	M/BM	M/BM	M/BM	M/BM	M/BM	M/BM	M	M/BM	USBR
Keno Reservoir (RM - 234.9)	VP	VP	VP	VP	M	M	M	M	M	M	M	M	-		USBR
Klamath River below Keno Dam (RM -233.4)	H	-	-	-	M	M	M	M	M	M	M	M	-	M/BM	USBR
Klamath River above J.C. Boyle Reservoir (RM-228.2)	H	-	-	-	M	M	M	M	M	M	M		-	-	PacifiCorp
J.C. Boyle Reservoir (RM-226.0)	VP	VP	VP	VP	M	M	M	M	M	M	M	M	-		PacifiCorp
Klamath River below J.C. Boyle Dam (RM-224.0)	H	-	-	-	M	M	M	M	M	M	M		-	-	PacifiCorp
Klamath River below USGS Gage (RM-219.5)	H	H	H	H	M	M	M	M	M	M	M	M	-	-	PacifiCorp
KR above Shovel Creek (Stateline) (RM-206.4)	H	-	-	-	M	M	M	M	M	M	M	M	-	M/BM-	PacifiCorp
Copco Reservoir (RM-199.0)	VP	VP	VP	VP	M	M	M	M	M	M	M	M	-		PacifiCorp
Klamath River below Copco Dam (RM-195.0)	H	-	-	-	M	M	M	M	M	M	M	M	-	-	PacificCorp
Iron Gate Reservoir (RM-192.0)	VP	VP	VP	VP	M	M	M	M	M	M	M	M			PacifiCorp
Klamath River below Iron Gate Dam (RM-189.7)	H	H	H	H	M/BM	M/BM	M/BM	M/BM	M/BM	M/BM	M/BM	W/S	M	M/BM-	PacifiCorp
Klamath River at Shasta River at Walker Bridge (RM- 176.7)	H	-	-	-	M	M	M	M	M	M	M	M		-	Karuk
Klamath River below Seiad (RM - 128.5)	H	H	H	H	M	M	M	M	M	M	M	M		-	Karuk



Table 5 (cont.): Klamath River AIP Monitoring Program 2009 – Summary Table

Monitoring Location	Temperature (°C)	Dissolved Oxygen (mg/l)	pH (log[H+])	Conductance (uS/cm)	Inorganic/Organic N (mg/l)	Inorganic/Organic P (g/l)	Particulate and Dissolved C (mg/l)	TSS/VSS (mg/l)	Alkalinity (mg/l)	Water Column chl_a/Pheo (ug/l)	Phytoplankton species	Microcystin (ug/l) <sup>xx</sup>	LCMS confirmation	CBOD, mg/l	Sampling Entity
<i>Sampling Method:</i>	<i>T,P</i>	<i>P</i>	<i>P</i>	<i>P</i>	<i>G</i>	<i>G</i>	<i>G</i>	<i>G</i>	<i>G</i>	<i>G</i>	<i>G</i>	<i>G</i>	<i>G</i>	<i>G</i>	
Klamath River near Happy Camp (RM-93.5)	H	-	-	-	M	M	M	M	M	M	M	M		-	Karuk
Klamath River at Orleans (USGS) (RM-59.1)	H	H	H	H	M	M	M	M	M	M	M	M		-	Karuk
Klamath River at Weitchpec (RM-43.5)	H	H	H	H	M	M	M	M	M	M	M	M			Yurok
Klamath River below Trinity River (RM-42.5)	H	-	-	-	M	M	M	M	M	M	M	M	M	-	Yurok
Klamath River near Klamath (RM-6.0)	H	H	H	H	M	M	M	M	M	M	M			-	Yurok
Klamath River Estuary (RM-0.5)	-	-	-	-	M	M	M	M	M	M	M	M		-	Yurok
Shasta River near mouth	H	H	H	H	M	M	M	M	M	M	M	-	-	-	Karuk
Scott River near mouth	H	H	H	H	M	M	M	M	M	M	M	-	-	-	Karuk
Salmon River near mouth	H	H	H	H	M	M	M	M	M	M	M	-	-	-	Karuk
Trinity River near mouth	H	-	-	-	M	M	M	M	M	M	M	-	-	-	Yurok

<b>Key:</b>	<u>Sampling Method</u>	<u>Sampling Frequency</u>	<u>Sampling Frequency</u>
	T – thermistor	VP – vertical profile at stated sampling frequency	M/S – monthly sampling, seasonally from May through October
	P – probe or data sonde (minimum seasonal deployment – April to November)	H – hourly measurements (in some instances sub-hourly data may be desired)	M/BM – Bi-monthly sampling May - October and monthly sampling the remainder of the year
	G – grab sample	M – monthly sampling	W/S – weekly sampling, seasonally from June through September

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# **Appendix A**

## **Standard Operating Procedures**

### **Environmental Sampling of Cyanobacteria for cell enumeration, identification and toxin analysis**

2009 AIP Interim Measure 12 Water Quality Monitoring Activities  
Klamath River

Cyanobacteria Sampling SOP. V6  
June 23, 2009

## **Appendix B**

### **2009 AIP Monitoring Program Reach Monitoring Entities:**

- PacifiCorp
- Karuk Tribe
- Yurok Tribe
- US Department of Interior – Bureau of Reclamation

### **Quality Assurance Plans and Standard Operating Procedures Reviewed for Minimum Standards and Compatibility**