

TECHNICAL MEMORANDUM

Results of Cyanobacteria and Microcystin Monitoring in the Vicinity of the Klamath Hydroelectric Project: August 6th and 8th, 2012

Prepared for: Tim Hemstreet (PacifiCorp)
Linda Prendergast (PacifiCorp)

Prepared by: Sam Mackey

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Introduction

This technical memorandum summarizes the results for the public health monitoring conducted August 6th and 8th, 2012 for cyanobacteria species and the associated toxin microcystin in Copco and Iron Gate reservoirs in PacifiCorp's Klamath Hydroelectric Project (Project) and at one monitoring station in the Klamath River below Iron Gate Dam. This monitoring is particularly focused on *Microcystis aeruginosa* (MSAE), a cyanobacterium with a recent history of summertime blooms in Copco and Iron Gate reservoirs and that is known to produce microcystin. This monitoring also estimates the presence of other potentially-toxic cyanobacteria, including *Anabaena* spp. and *Planktothrix (Oscillatoria)* spp. This monitoring is being conducted pursuant to Interim Measure 15, Water Quality Monitoring Activities, contained in the Klamath Hydroelectric Settlement Agreement (KHSA) executed between the United States Department of Interior, the states of California and Oregon, PacifiCorp, and other parties.

The data summarized in this memorandum also includes the available results for the previous 2012 public health sampling events (see Appendix 1). Subsequent memoranda will be prepared approximately every two weeks to report the results of continued monitoring.

Methods

PacifiCorp is conducting phytoplankton sampling at 5 sites (Table 1) for laboratory analysis of potentially toxic cyanobacteria, notably MSAE, and microcystin at:

- Four shoreline sites in coves in Copco and Iron Gate reservoirs (i.e., two cove sites in each reservoir).
- One Klamath River site below Iron Gate Dam near the hatchery bridge.

Samples are planned to be taken at shoreline locations in the reservoirs once in May; and twice per month in June, July, October, and November. Samples for the river site below Iron Gate Dam are scheduled to be collected twice per month in June, July and October and weekly in August and September, but the sampling schedule may change due to river and/or reservoir conditions.

Phytoplankton samples from the river sites are taken as grab samples offshore according to the standard operating procedure (SOP) developed by the Klamath Blue Green Algae Working Group (<http://www.kbmp.net/collaboration/klamath-hydroelectric-settlement-agreement-monitoring>). Additional samples, collected at open water sites in Copco and Iron Gate reservoirs, including a grab sample at 0.5 m depth and an integrated sample over 8 m depth, will be collected as part of the baseline water quality monitoring.

Samples for potentially toxic phytoplankton are preserved in Lugol's solution and sent to Aquatic Analysts in Friday Harbor, Washington for analysis. The laboratory analysis of phytoplankton speciation and abundance is performed on prepared microscope slides of filtered samples using phase contrast microscopy. Species are counted as algal units of cell, filament, or colony depending on the natural growth form of the species. Algal forms are identified to species or otherwise to the lowest practicable taxonomic level. Results for cyanobacteria species are reported as individual cells per milliliter.

Samples for determination of microcystin toxin are placed in a cooler on ice and shipped to the EPA Region 9 Laboratory in Richmond, California. The samples are analyzed using the competitive Enzyme-Linked ImmunoSorbent Assay (ELISA) method based on the EnviroLogix QuantiPlate Kit for microcystins. The quantitation limit is 0.18 µg/L or parts per billion (ppb). This test method does not distinguish between the specific microcystin congeners, but detects their presence to differing degrees. That is, ELISA test results yield one value as the sum of measurable microcystin variants.

Table 1. Sites of cyanobacteria and microcystin public health monitoring in Copco and Iron Gate reservoirs and the Klamath River during 2012.		
Location	Approximate River Mile	Site ID
Copco Reservoir at Mallard Cove	201.5	CRMC
Copco Reservoir at Copco Cove	200.0	CRCC
Iron Gate Reservoir at Camp Creek	192.8	IRCC
Iron Gate Reservoir at John Williams campground	192.4	IRJW
Klamath River below Iron Gate dam near hatchery bridge	189.7	KRBI

Results

The July 11th sampling had cell counts at Copco Reservoir at Copco Cove and microcystin levels at Iron Gate Reservoir (John Williams campground) above the California posting guidelines¹ (SWRCB 2010). Both of these reservoirs are currently posted with health advisory guidelines. The results from the August 8th sampling in Copco and Iron Gate reservoirs show cell densities above posting guidelines (Table 2). Both reservoirs will remain posted and public health sampling will resume in the reservoirs when the blooms begin to recede for the purpose of lifting the health advisories. It is anticipated that sampling will resume by mid-October.

Public health sampling will continue on a weekly basis for the Klamath River below Iron Gate dam (KRBI). Results from this site are still below the posting criteria (Table 2 and Appendix 1).

¹ The California State Water Resources Control Board provides guidelines for posting advisories in recreation waters (SWRCB 2010). SWRCB recommends posting advisories in recreation waters under three circumstances: (1) if "scum is present associated with toxigenic species"; (2) if scum is not present, but the density of *Microcystis* or *Planktothrix* is 40,000 cells/ml or greater; and (3) if scum is not present, but the density of all potentially toxigenic BGA is 100,000 cells/ml or greater. Based on WHO (2003) information, SWRCB indicate that cell counts of 40,000 cells/mL and 100,000 cells/mL equate to microcystin toxin concentrations of 8 µg/L and 20 µg/L, respectively.

Table 2. Summary of public health monitoring on August 6th and 8th, 2012.

Date	Time	Location	RM	Sample ID	Depth	MSAE	AFA	ANA	Other	Microcystin (µg/l)
8/6/2012	18:30	KRBI	201.5	KR12832	SG	22,812	2,619	83		*
8/8/2012	12:15	CRMC	200.0	KR12833	SG	1,903,433	3,833,500	0		*
8/8/2012	13:00	CRCC	192.8	KR12834	SG	59,757,500	183,937	45,100		*
8/8/2012	14:10	IRCC	192.4	KR12835	SG	63,140	26,914	1,136		*
8/8/2012	14:30	IRJW	189.7	KR12836	SG	355,455	269,932	1,114		*

* Results from microcystin analyses were not available upon released of this memo and will be released with a subsequent memo

¹MSAE = *Microcystis aeruginosa* (cells/mL)

²AFA = *Aphanizomenon flos-aquae* (cells/mL)

³ANA = *Anabaena flos-aquae* and/or *Anabaena sp.* (cells/mL)

Other = either ⁵*Planktothrix (Oscillatoria) sp.* or ⁶*Gloeotrichia echinulata* or ⁷*Anabaena sp.* or

⁸*Lyngbya sp.* (cells/mL)

“0” value indicates non-detect by analytical laboratory

References

SWRCB. 2010. Cyanobacteria in California Recreational Water Bodies: Providing Voluntary Guidance about Harmful Algal Blooms, Their Monitoring, and Public Notification. July 2010. Document provided as part of Blue-green Algae Work Group of State Water Resources Control Board (SWRCB) and Office of Environmental Health and Hazard Assessment (OEHHA).

Appendix 1

Cumulative Species data for 2012 Public Health Samples

Table 3. Summary of cyanobacteria public health monitoring (2012).

Date	Time	Location	RM	Sample ID	Depth	MSAE	AFA	ANA	Other	Microcystin (µg/L)
5/21/2012	12:40	CRMC	201.5	KR12800	SG	0	0	26	290 ⁽⁵⁾ / 329 ⁽⁸⁾	**
5/21/2012	13:10	CRCC	200.0	KR12801	SG	0	0	0	58 ⁽⁵⁾	**
5/21/2012	11:30	IRCC	192.8	KR12802	SG	0	0	0	0	ND
5/21/2012	11:50	IRJW	192.4	KR12803	SG	0	0	0	0	ND
6/12/2012	15:00	CRMC	201.5	KR12804	SG	2,832	0	2,124	1,035 ⁽⁵⁾	0.29
6/12/2012	16:00	CRCC	200.0	KR12805	SG	8,575	0	0	0	0.74
6/12/2012	13:50	IRCC	192.8	KR12806	SG	0	0	0	0	0.3
6/12/2012	14:00	IRJW	192.4	KR12807	SG	0	0	67	0	ND
6/12/2012	14:10	KRBI	189.7	KR12809	SG	0	0	0	0	ND
6/25/2012	13:25	CRMC	201.5	KR12810	SG	119	0	0	24 ⁽⁵⁾	ND
6/25/2012	12:45	CRCC	200.0	KR12811	SG	284	0	56	111 ⁽⁵⁾	0.37
6/25/2012	14:15	IRCC	192.8	KR12812	SG	0	0	0	28 ⁽⁵⁾	0.16
6/25/2012	14:05	IRJW	192.4	KR12813	SG	117	0	87	0	0.19
6/25/2012	13:50	KRBI	189.7	KR12815	SG	0	0	0	0	ND
7/11/2012	11:50	CRMC	201.5	KR12816	SG	2,019	0	2,042	0	5.9
7/11/2012	12:30	CRCC	200.0	KR12817	SG	694,479	0	1,173,209	0	460
7/11/2012	14:00	IRCC	192.8	KR12818	SG	821	0	1,195	112 ⁽⁷⁾	0.86
7/11/2012	14:15	IRJW	192.4	KR12819	SG	26,670	0	3,196	499 ⁽⁷⁾	9.8
7/11/2012	14:30	KRBI	189.7	KR12821	SG	0	0	0	0	0.17
7/17/2012	18:15	CRMC	201.5	KR12822	SG	7,362	0	0	0	1.6
7/17/2012	18:45	CRCC	200.0	KR12823	SG	9,095	167	543	0	2.7
7/17/2012	19:15	IRCC	192.8	KR12824	SG	259	0	0	35 ⁽⁷⁾	0.32
7/17/2012	19:30	IRJW	192.4	KR12825	SG	0	893	3,046	7,527 ⁽⁶⁾	0.32
7/24/2012	11:00	CRMC	201.5	KR12826	SG	1,973,811	0	11,504	0	*
7/24/2012	12:35	CRCC	200.0	KR12827	SG	9,616,424	0	156,930	0	*
7/24/2012	12:00	IRCC	192.8	KR12828	SG	8,016	0	0	847 ⁽⁷⁾	*
7/24/2012	11:45	IRJW	192.4	KR12829	SG	6,497	43	107	64 ⁽⁷⁾	*
7/24/2012	11:30	KRBI	189.7	KR12831	SG	322	107	43	0	*
8/6/2012	18:30	KRBI	201.5	KR12832	SG	22,812	2,619	0	83 ⁽⁷⁾	*
8/8/2012	12:15	CRMC	200.0	KR12833	SG	1,903,433	3,833,500	0	0	*
8/8/2012	13:00	CRCC	192.8	KR12834	SG	59,757,500	183,937	0	45,100 ⁽⁷⁾	*
8/8/2012	14:10	IRCC	192.4	KR12835	SG	63,140	26,914	649	487 ⁽⁷⁾	*
8/8/2012	14:30	IRJW	189.7	KR12836	SG	355,455	269,932	0	1,114 ⁽⁷⁾	*

* Results were not available upon release of this memo and will be release with the subsequent memo

**Bottles were damaged during shipping and could not be analyzed

Appendix 2

Laboratory Data Sheets August 6th and 8th, 2012 Public Health Sampling

Phytoplankton Sample Analysis					
Sample:	Klamath Basin				
Sample Site:	KR 12832				
Sample Depth:					
Sample Date:	6-Aug-12				
Total Density (#/mL):	1,555				
Total Biovolume (um ³ /mL):	353,127				
Trophic State Index:	42.3				
Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent	Group
1 Microcystis aeruginosa	1,426	91.7	182,495	51.7	bluegreen
2 Aphanizomenon flos-aquae	125	8.0	164,979	46.7	bluegreen
3 Anabaena sp.	4	0.3	5,653	1.6	bluegreen
Microcystis aeruginosa cells/mL =	22,812				
Aphanizomenon flos-aquae cells/mL =	2,619				
Anabaena sp. cells/mL =	83				
Note: Toxic Algae Only					
Aquatic Analysts	Sample ID: QF96				

Phytoplankton Sample Analysis					
Sample:	Klamath Basin				
Sample Site:	KR 12833				
Sample Depth:					
Sample Date:	8-Aug-12				
Total Density (#/mL):	284,982				
Total Biovolume (um ³ /mL):	256,737,965				
Trophic State Index:	89.9				
Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent	Group
1 Aphanizomenon flos-aquae	225,500	79.1	241,510,500	94.1	bluegreen
2 Microcystis aeruginosa	59,482	20.9	15,227,465	5.9	bluegreen
Microcystis aeruginosa cells/mL =	1,903,433				
Aphanizomenon flos-aquae cells/mL =	3,833,500				
Note: Toxic Algae Only					
Aquatic Analysts	Sample ID: QF97				

Phytoplankton Sample Analysis					
Sample:		Klamath Basin			
Sample Site:		KR 12834			
Sample Depth:					
Sample Date:		8-Aug-12			
Total Density (#/mL):		157,408			
Total Biovolume (um ³ /mL):		492,714,847			
Trophic State Index:		94.6			
Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent	Group
1 Microcystis aeruginosa	140,606	89.3	478,060,000	97.0	bluegreen
2 Aphanizomenon flos-aquae	14,149	9.0	11,588,047	2.4	bluegreen
3 Anabaena sp.	2,653	1.7	3,066,800	0.6	bluegreen
Microcystis aeruginosa cells/mL =		59,757,500			
Aphanizomenon flos-aquae cells/mL =		183,937			
Anabaena sp. cells/mL =		45,100			
Note: Toxic Algae Only					
Aquatic Analysts			Sample ID: QF98		

Phytoplankton Sample Analysis					
Sample:		Klamath Basin			
Sample Site:		KR 12835			
Sample Depth:					
Sample Date:		8-Aug-12			
Total Density (#/mL):		5,840			
Total Biovolume (um ³ /mL):		2,277,274			
Trophic State Index:		55.8			
Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent	Group
1 Microcystis aeruginosa	4,510	77.2	505,120	22.2	bluegreen
2 Aphanizomenon flos-aquae	1,282	21.9	1,695,582	74.5	bluegreen
3 Anabaena flos-aquae	32	0.6	43,478	1.9	bluegreen
4 Anabaena sp.	16	0.3	33,095	1.5	bluegreen
Microcystis aeruginosa cells/mL =		63,140			
Aphanizomenon flos-aquae cells/mL =		26,914			
Anabaena flos-aquae cells/mL =		649			
Anabaena sp. cells/mL =		487			
Note: Toxic Algae Only					
Aquatic Analysts			Sample ID: QF99		

Phytoplankton Sample Analysis					
Sample:		Klamath Basin			
Sample Site:		KR 12836			
Sample Depth:					
Sample Date:		8-Aug-12			
Total Density (#/mL):		28,229			
Total Biovolume (um ³ /mL):		19,925,069			
Trophic State Index:		71.4			
Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent	Group
1 Microcystis aeruginosa	16,926	60.0	2,843,639	14.3	bluegreen
2 Aphanizomenon flos-aquae	11,247	39.8	17,005,707	85.3	bluegreen
3 Anabaena sp.	56	0.2	75,723	0.4	bluegreen
Microcystis aeruginosa cells/mL =	355,455				
Aphanizomenon flos-aquae cells/mL =	269,932				
Anabaena sp. cells/mL =	1,114				
Note: Toxic Algae Only					
Aquatic Analysts			Sample ID: QF00		