

## TECHNICAL MEMORANDUM

Results of Cyanobacteria and Microcystin Monitoring in the Vicinity of the Klamath Hydroelectric Project: December 18<sup>th</sup>, 2012

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## Introduction

This technical memorandum summarizes the results for the public health monitoring conducted December 18<sup>th</sup>, 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 include results the previous 2012 public health sampling events (see Appendix 1).

## 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 August; 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.

| <b>Table 1. Sites of cyanobacteria and microcystin public health monitoring in Copco and Iron Gate reservoirs and the Klamath River during 2012.</b> |                               |                |
|--|-------------------------------|----------------|
| <b>Location</b>  | <b>Approximate River Mile</b> | <b>Site ID</b> |
| 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 and Discussion

The July 11<sup>th</sup> sampling had cell counts at Copco Reservoir at Copco Cove and microcystin levels at Iron Gate Reservoir (John Williams campground) above the California posting guidelines<sup>1</sup> (SWRCB 2010) and public health advisories were posted at each reservoir on July 17, 2012. Public health sampling was discontinued for the remainder of the summer. Public health sampling in the reservoirs resumed at the end of October for the purpose of lifting the public health advisories.

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<sup>1</sup> The California State Water Resources Control Board provides guidelines for posting advisories in recreation water (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.

Microcystin levels at Iron Gate reservoir were below the posting guidelines since the November 6, sampling event and the health advisories signs were lifted on this reservoir on December 3, 2012. Although the bloom appeared to be declining, both MSAE cell counts and toxin levels remained above the posting guidelines at the beginning of December at Copco reservoir (Appendix 1). Therefore, public health monitoring at Copco reservoir continued through December. The December 12, 2012 sampling event showed MSAE cell counts and toxin levels below the posting guidelines and were confirmed with the December 18<sup>th</sup> sampling (Table 2). The health advisory signs for Copco reservoir were removed on January 4, 2013.

Laboratory data sheets for the December 18<sup>th</sup> sampling are provided in Appendix 2. A summary of these result sheets is contained within Table 2.

The public health advisory was posted at the Klamath River below Iron Gate dam (KRBI) on August 31, 2012 and was removed at this site on October 26, 2012. This site is no longer being sampled for public health purposes

**Table 2.** Summary of public health monitoring on December 18<sup>th</sup>, 2012.

| Date     | Time  | Location | RM    | Sample ID | Depth | MSAE <sup>(1)</sup> | AFA <sup>(2)</sup> | ANA <sup>(3)</sup> | Other <sup>(6),(7),(8),or(9)</sup> | Microcystin (µg/l) |
|----------|-------|----------|-------|-----------|-------|---------------------|--------------------|--------------------|------------------------------------|--------------------|
| 12/18/12 | 12:45 | CRMC     | 201.5 | KR12878   | SG    | 0                   | 0                  | 0                  | 0                                  | 0.19               |
| 12/18/12 | 13:15 | CRCC     | 200.0 | KR12879   | SG    | 0                   | 0                  | 0                  | 0                                  | 0.16               |

<sup>1</sup>MSAE = *Microcystis aeruginosa* (cells/mL)

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

<sup>3</sup>ANA = *Anabaena flos-aquae* (cells/mL)

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

<sup>8</sup>*Lyngbya sp.* (cells/mL) or <sup>9</sup>*Anabaena circinalis* (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 Cyanobacteria Species data for 2012 Public Health Samples

**Table 3.** Summary of 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 <sup>(5)</sup> / 329 <sup>(8)</sup> | **                 |
| 5/21/2012  | 13:10 | CRCC     | 200.0        | KR12801   | SG    | 0          | 0         | 0         | 58 <sup>(5)</sup>                       | **                 |
| 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 <sup>(5)</sup>                    | 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 <sup>(5)</sup>                       | ND                 |
| 6/25/2012  | 12:45 | CRCC     | 200.0        | KR12811   | SG    | 284        | 0         | 56        | 111 <sup>(5)</sup>                      | 0.37               |
| 6/25/2012  | 14:15 | IRCC     | 192.8        | KR12812   | SG    | 0          | 0         | 0         | 28 <sup>(5)</sup>                       | 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 <sup>(7)</sup>                      | 0.86               |
| 7/11/2012  | 14:15 | IRJW     | 192.4        | KR12819   | SG    | 26,670     | 0         | 3,196     | 499 <sup>(7)</sup>                      | 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 <sup>(7)</sup>                       | 0.32               |
| 7/17/2012  | 19:30 | IRJW     | 192.4        | KR12825   | SG    | 0          | 893       | 3,046     | 7,527 <sup>(6)</sup>                    | 0.32               |
| 7/24/2012  | 11:00 | CRMC     | 201.5        | KR12826   | SG    | 1,973,811  | 0         | 11,504    | 0                                       | 660                |
| 7/24/2012  | 12:35 | CRCC     | 200.0        | KR12827   | SG    | 9,616,424  | 0         | 156,930   | 0                                       | 2,300              |
| 7/24/2012  | 12:00 | IRCC     | 192.8        | KR12828   | SG    | 8,016      | 0         | 0         | 847 <sup>(7)</sup>                      | 2.3                |
| 7/24/2012  | 11:45 | IRJW     | 192.4        | KR12829   | SG    | 6,497      | 43        | 107       | 64 <sup>(7)</sup>                       | 1.4                |
| 7/24/2012  | 11:30 | KRBI     | 189.7        | KR12831   | SG    | 322        | 107       | 43        | 0                                       | 0.44               |
| 8/06/2012  | 18:30 | KRBI     | 189.7<br>*** | KR12832   | SG    | 22,812     | 2,619     | 0         | 83 <sup>(7)</sup>                       | 3.8                |
| 8/08/2012  | 12:15 | CRMC     | 200.0        | KR12833   | SG    | 1,903,433  | 3,833,500 | 0         | 0                                       | 2,400              |
| 8/08/2012  | 13:00 | CRCC     | 192.8        | KR12834   | SG    | 59,757,500 | 183,937   | 0         | 45,100 <sup>(7)</sup>                   | 43,000             |
| 8/08/2012  | 14:10 | IRCC     | 192.4        | KR12835   | SG    | 63,140     | 26,914    | 649       | 487 <sup>(7)</sup>                      | 14                 |
| 8/08/2012  | 14:30 | IRJW     | 189.7        | KR12836   | SG    | 355,455    | 269,932   | 0         | 1,114 <sup>(7)</sup>                    | 98                 |
| 8/13/2012  | 9:20  | KRBI     | 189.7        | KR12837   | SG    | 31,839     | 1,616     | 0         | 224 <sup>(7)</sup>                      | 1.4                |
| 8/19/2012  | 15:50 | KRBI     | 189.7        | KR12838   | SG    | 20,412     | 2,793     | 0         | 0                                       | 0.48               |
| 8/27/2012  | 14:20 | KRBI     | 189.7        | KR12839   | SG    | 60,188     | 12,983    | 0         | 0                                       | 1.8                |
| 9/03/2012  | 11:00 | KRBI     | 189.7        | KR12840   | SG    | 112,782    | 6,592     | 0         | 0                                       | 13                 |
| 9/11/2012  | 15:45 | KRBI     | 189.7        | KR12841   | SG    | 78,880     | 1,263     | 0         | 0                                       | 14                 |
| 9/17/2012  | 18:30 | KRBI     | 189.7        | KR12842   | SG    | 139,420    | 320       | 0         | 51 <sup>(7)</sup>                       | 18                 |
| 9/25/2012  | 11:00 | KRBI     | 189.7        | KR12843   | SG    | 51,305     | 0         | 0         | 95 <sup>(5)</sup> /76 <sup>(7)</sup>    | 14                 |
| 10/08/2012 | 16:15 | KRBI     | 189.7        | KR12844   | SG    | 22,516     | 0         | 0         | 870 <sup>(7)</sup>                      | 8.6                |
| 10/17/2012 | 18:15 | KRBI     | 189.7        | KR12846a  | SG    | 11,592     | 111       | 0         | 0                                       | 4.0                |
| 10/22/2012 | 11:50 | KRBI     | 189.7        | KR12845   | SG    | 5,092      | 149       | 0         | 0                                       | 2.1                |

| Date       | Time  | Location | RM    | Sample ID | Depth | MSAE      | AFA       | ANA        | Other                  | Microcystin (µg/L) |
|------------|-------|----------|-------|-----------|-------|-----------|-----------|------------|------------------------|--------------------|
| 10/28/2012 | 10:20 | CRMC     | 201.5 | KR12846b  | SG    | 434,219   | 13,984    | 62,930     | 29,367 <sup>(7)</sup>  | 2,400              |
| 10/28/2012 | 9:30  | CRCC     | 200.0 | KR12847   | SG    | 3,555,383 | 541,200   | 12,898,600 | 112,750 <sup>(7)</sup> | 1,600              |
| 10/28/2012 | 11:30 | IRCC     | 192.8 | KR12848   | SG    | 170,959   | 0         | 0          | 0                      | 21                 |
| 10/28/2012 | 11:20 | IRJW     | 192.4 | KR12849   | SG    | 5,116,031 | 125,636   | 0          | 36,241 <sup>(9)</sup>  | 6,400              |
| 10/28/2012 | 11:00 | KRBI     | 189.7 | KR12850   | SG    | 3,028     | 59        | 0          | 0                      | 1.2                |
| 11/06/2012 | 15:50 | CRMC     | 201.5 | KR12851   | SG    | 133,339   | 700,946   | 0          | 27,452 <sup>(7)</sup>  | 5,900              |
| 11/06/2012 | 14:15 | CRCC     | 200.0 | KR12852   | SG    | 0         | 9,594     |            | 273 <sup>(7)</sup>     | 0.22               |
| 11/06/2012 | 17:30 | IRCC     | 192.8 | KR12853   | SG    | 1,800     | 32        | 0          | 0                      | 1.5                |
| 11/06/2012 | 17:20 | IRJW     | 192.4 | KR12854   | SG    | 8,556     | 3,975     | 0          | 0                      | 7.4                |
| 11/13/2012 | 10:15 | CRMC     | 201.5 | KR12856   | SG    | 6,443     | 393,873   | 0          | 195,863 <sup>(7)</sup> | 2,100              |
| 11/13/2012 | 12:15 | CRCC     | 192.8 | KR12857   | SG    | 95,211    | 2,706,000 | 0          | 200,444 <sup>(7)</sup> | 1,700              |
| 11/13/2012 | 11:30 | IRCC     | 200.0 | KR12858   | SG    | 158       | 0         | 0          | 0                      | 0.30               |
| 11/13/2012 | 11:05 | IRJW     | 192.4 | KR12859   | SG    | 4,544     | 0         | 0          | 0                      | 0.98               |
| 11/22/2012 | 12:35 | CRMC     | 201.5 | KR12860   | SG    | 0         | 0         | 0          | 0                      | 0.76               |
| 11/22/2012 | 13:15 | CRCC     | 200.0 | KR12861   | SG    | 0         | 0         | 0          | 0                      | 0.24               |
| 11/22/2012 | 11:40 | IRCC     | 192.8 | KR12862   | SG    | 1,089     | 0         | 0          | 0                      | 0.15               |
| 11/22/2012 | 11:50 | IRJW     | 192.4 | KR12863   | SG    | 103,354   | 0         | 0          | 0                      | 1.1                |
| 11/28/2012 | 11:20 | CRMC     | 201.5 | KR12865   | SG    | 185,422   | 109,150   | 0          | 22,171 <sup>(7)</sup>  | 830                |
| 11/28/2012 | 15:10 | CRCC     | 200.0 | KR12866   | SG    | 714       | 94        | 0          | 0                      | 0.79               |
| 11/28/2012 | 14:25 | IRCC     | 192.8 | KR12867   | SG    | 0         | 0         | 0          | 0                      | 0.27               |
| 11/28/2012 | 12:40 | IRJW     | 192.4 | KR12868   | SG    | 23,086    | 0         | 0          | 0                      | **                 |
| 12/05/2012 | 13:00 | CRMC     | 201.5 | KR12870   | SG    | 1,037     | 3,525     | 0          | 0                      | 0.55               |
| 12/05/2012 | 13:30 | CRCC     | 200.0 | KR12871   | SG    | 56,906    | 26,507    | 0          | 0                      | 20                 |
| 12/12/2012 | 13:50 | CRMC     | 201.5 | KR12875   | SG    | 0         | 0         | 0          | 0                      | 0.36               |
| 12/12/2012 | 12:20 | CRCC     | 200.0 | KR12876   | SG    | 106       | 0         | 0          | 0                      | 0.69               |
| 12/18/2012 | 12:45 | CRMC     | 201.5 | KR12878   | SG    | 0         | 0         | 0          | 0                      | 0.19               |
| 12/18/2012 | 13:15 | CRCC     | 200.0 | KR12879   | SG    | 0         | 0         | 0          | 0                      | 0.16               |

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

\*\*\* Previously listed incorrectly as 201.5

## Appendix 2

### Laboratory Data Sheets December 18<sup>th</sup>, 2012 Public Health Sampling

| Phytoplankton Sample Analysis          |               |                 |                               |                   |       |
|--|---------------|-----------------|-------------------------------|-------------------|-------|
| Sample:                                | Klamath Basin |                 |                               |                   |       |
| Sample Site:                           | KR 12878      |                 |                               |                   |       |
| Sample Depth:                          |               |                 |                               |                   |       |
| Sample Date:                           | 18-Dec-12     |                 |                               |                   |       |
| Total Density (#/mL):                  | <5            |                 |                               |                   |       |
| Total Biovolume (um <sup>3</sup> /mL): |               |                 |                               |                   |       |
| Trophic State Index:                   |               |                 |                               |                   |       |
| Species                                | Density #/mL  | Density Percent | Biovolume um <sup>3</sup> /mL | Biovolume Percent | Group |
| 1 No Toxic Algae Present               | <5            |                 |                               |                   |       |
| Note: Toxic Algae Only                 |               |                 |                               |                   |       |
| Aquatic Analysts                       |               |                 | Sample ID:                    | QG84              |       |

| Phytoplankton Sample Analysis          |               |                 |                               |                   |       |
|--|---------------|-----------------|-------------------------------|-------------------|-------|
| Sample:                                | Klamath Basin |                 |                               |                   |       |
| Sample Site:                           | KR 12879      |                 |                               |                   |       |
| Sample Depth:                          |               |                 |                               |                   |       |
| Sample Date:                           | 18-Dec-12     |                 |                               |                   |       |
| Total Density (#/mL):                  | <7            |                 |                               |                   |       |
| Total Biovolume (um <sup>3</sup> /mL): |               |                 |                               |                   |       |
| Trophic State Index:                   |               |                 |                               |                   |       |
| Species                                | Density #/mL  | Density Percent | Biovolume um <sup>3</sup> /mL | Biovolume Percent | Group |
| 1 No Toxic Algae Present               | <7            |                 |                               |                   |       |
| Note: Toxic Algae Only                 |               |                 |                               |                   |       |
| Aquatic Analysts                       |               |                 | Sample ID:                    | QG85              |       |