

TECHNICAL MEMORANDUM

Results of Cyanobacteria and Microcystin Monitoring in the Vicinity of the Klamath Hydroelectric Project: November 25th

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Introduction

This technical memorandum summarizes the results for the public health monitoring conducted during 2013 for cyanobacteria species and the associated toxin, microcystin, in Copco and Iron Gate reservoirs within 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., *Planktothrix* (*Oscillatoria*) spp. and others. 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 2013 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 twice per month in June, July, August, September, October, and November. Samples to be collected from the river site below Iron Gate Dam are scheduled to be collected according to the discretion of the sampling entity (PacifiCorp) based on river 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.

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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.

| 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 coves (CRMC and CRCC) in Copco Reservoir are the only sites that are currently being monitored. The November 25th sampling results are below the California public health posting guidelines¹ (see Table 2). The last two sampling events at these coves demonstrate that the health advisory signs can be removed (Appendix 1). The health advisory signs at all the other PacifiCorp monitoring sites (Table 1) have been removed.

¹ 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.

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| Date | Time | Location | RM | Sample ID | Depth | MSAE ⁽¹⁾ | AFA ⁽²⁾ | ANA ⁽³⁾ | Other ^{(6), (7), (8), (9), or (10)} | Microcystin (µg/L) |
|------------|-------|----------|-------|-----------|-------|---------------------|--------------------|--------------------|--|--------------------|
| 11/25/2013 | 13:00 | CRMC | 201.5 | KR13943 | SG | *** | *** | *** | *** | 0 |
| 11/25/2013 | 11:00 | CRCC | 200.0 | KR13944 | SG | *** | *** | *** | *** | 0 |

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

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

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

Other = either ⁵*Planktothrix (Oscillatoria) sp.* or ⁶*Gloeotrichia echinulata* or ⁷*Anabaena sp.* or ⁸*Lyngbya sp.* (cells/mL) or

⁹*Anabaena circinalis* (cells/mL) or ¹⁰*Anabaena planctonica* (cells/mL)

“0” value indicates non-detect by analytical laboratory

“*” value indicates results were not available upon the date this memo was submitted and will be included in subsequent memos as availability allows

“***” indicates samples were not collected

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).

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Appendix 1

Cumulative Cyanobacteria Species data for 2013 Public Health Samples

Table 3. Summary of public health monitoring: 2013

| Date | Time | Location | RM | Sample ID | Depth | MSAE ⁽¹⁾ | AFA ⁽²⁾ | ANA ⁽³⁾ | Other ^{(6), (7), (8), (9), or (10)} | Microcystin (µg/L) |
|------------|-------|---------------------|-------|-----------|-------|---------------------|--------------------|--------------------|--|--------------------|
| 5/20/2013 | 9:40 | CRMC | 201.5 | KR13800 | SG | 0 | 0 | 0 | 0 | ND |
| 5/20/2013 | 11:15 | CRCC | 200.0 | KR13801 | SG | 0 | 0 | 90 | 0 | ND |
| 5/20/2013 | 10:45 | IRCC | 192.8 | KR13802 | SG | 0 | 0 | 0 | 0 | ND |
| 5/20/2013 | 10:30 | IRJW | 192.4 | KR13803 | SG | 0 | 0 | 0 | 0 | ND |
| 5/20/2013 | 11:20 | CRCC _{dup} | 201.5 | KR13804 | SG | 0 | 0 | 0 | 0 | ND |
| 6/06/2013 | 14:15 | CRMC | 201.5 | KR13805 | SG | 9,429 | 0 | 379,340 | 0 | 10 |
| 6/06/2013 | 16:00 | CRCC | 200.0 | KR13806 | SG | 12,403 | 0 | 88,088 | 0 | 2.4 |
| 6/06/2013 | 15:30 | IRCC | 192.8 | KR13807 | SG | 839 | 0 | 5,264 | 0 | 0.22 |
| 6/06/2013 | 15:15 | IRJW | 192.4 | KR13808 | SG | 29 | 0 | 615 | 0 | 0 |
| 6/06/2013 | 15:20 | IRJW _{dup} | 201.5 | KR13809 | SG | 18 | 0 | 483 | 0 | 0.15 |
| 6/20/2013 | 16:30 | CRMC | 201.5 | KR13811 | SG | 802,969 | 4,205 | 475,179 | 0 | 240 |
| 6/20/2013 | 15:45 | CRCC | 200.0 | KR13812 | SG | 13,903 | 303 | 454 | 0 | 2.1 |
| 6/20/2013 | 13:05 | IRCC | 192.8 | KR13813 | SG | 3,679 | 0 | 300,667 | 0 | 2.6 |
| 6/20/2013 | 12:45 | IRJW | 192.4 | KR13814 | SG | 61,419 | 2,967 | 665,967 | 14,539 | 24 |
| 6/20/2013 | 15:45 | CRCC _{dup} | 201.5 | KR13815 | SG | 3,794 | 0 | 3,502 | 0 | 2.0 |
| 7/11/2013 | 14:35 | KRBI | 189.7 | KR13821 | SG | 16,443 | 0 | 0 | 0 | 9.9 |
| 7/16/2013 | 12:20 | KRBI | 189.7 | KR13828 | SG | 10,585 | 537 | 0 | 0 | 1.2 |
| 7/29/2013 | 11:15 | KRBI | 189.7 | KR13835 | SG | 8,093 | 916 | 0 | 72 ⁽⁶⁾ | 6.4 |
| 7/29/2013 | 12:40 | KRBI | 189.7 | KR13841 | SG | 11,615 | 4,832 | 0 | 0 | 6.6 |
| 8/05/2013 | 14:15 | KRBI | 189.7 | KR13848 | SG | 15,967 | 33,451 | 0 | 128 ⁽⁷⁾ / 448 ⁽⁹⁾ | 4.0 |
| 8/13/2013 | 11:50 | KRBI | 189.7 | KR13855 | SG | 2,549 | 20,501 | 0 | 784 ⁽⁹⁾ | 1.8 |
| 8/21/2013 | 15:00 | KRBI | 189.7 | KR13862 | SG | 11,227 | 29,145 | 141 | 768 ⁽⁷⁾ / 1,024 ⁽⁹⁾ | 3.5 |
| 8/26/2013 | 13:25 | KRBI | 189.7 | KR13869 | SG | 16,356 | 22,730 | 0 | 1,684 ⁽⁷⁾ / 1,789 ⁽⁹⁾ | 5.6 |
| 9/02/2013 | 11:50 | KRBI | 189.7 | KR13876 | SG | 19,086 | 25,933 | 0 | 1,199 ⁽⁹⁾ / 2,583 ⁽⁷⁾ | 6.9 |
| 9/10/2013 | 11:40 | KRBI | 189.7 | KR13883 | SG | 45,741 | 12,108 | 0 | 1,948 ⁽⁷⁾ | 14 |
| 9/19/2013 | 15:00 | KRBI | 189.7 | KR13886 | SG | 36,080 | 884 | 0 | 295 ⁽⁷⁾ | 6.5 |
| 9/25/2013 | 17:00 | KRBI | 189.7 | KR13891 | SG | 44,155 | 209 | 0 | 472 ⁽⁷⁾ | 0.36 |
| 9/30/2013 | 11:40 | KRBI | 189.7 | KR13892 | SG | 2,190 | 0 | 0 | 0 | 0.56 |
| 10/09/2013 | 12:50 | KRBI | 189.7 | KR13905 | SG | 820 | 0 | 0 | 0 | 1.0 |
| 10/14/2013 | 16:25 | KRBI | 189.7 | KR13913 | SG | 510 | 0 | 0 | 0 | 0.21 |
| 10/23/2013 | 15:20 | CRMC | 201.5 | KR13915 | SG | 14,432,000 | 551,812 | 0 | 0 | 18,000 |
| 10/23/2013 | 17:00 | CRCC | 200.0 | KR13916 | SG | 8,493 | 0 | 0 | 0 | 6.0 |
| 10/23/2013 | 17:30 | IRCC | 192.8 | KR13917 | SG | 0 | 0 | 0 | 0 | 1.2 |
| 10/23/2013 | 17:45 | IRJW | 192.4 | KR13918 | SG | 0 | 0 | 0 | 0 | 1.1 |
| 10/23/2013 | 18:00 | KRBI | 189.7 | KR13919 | SG | 0 | 0 | 0 | 0 | 0.15 |
| 10/29/2013 | 18:20 | CRMC | 201.5 | KR13922 | SG | 26,458,667 | 2,201,732 | 0 | 0 | 5,200 |
| 10/29/2013 | 16:30 | CRCC | 200.0 | KR13923 | SG | 20,377,000 | 6,970,000 | 0 | 0 | 440 |
| 10/29/2013 | 15:45 | IRCC | 192.8 | KR13924 | SG | 177 | 0 | 0 | 0 | 0.17 |

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|------------|-------|----------|-------|-----------|-------|---------------------|--------------------|--------------------|--|--------------------|
| 10/29/2013 | 15:30 | IRJW | 192.4 | KR13925 | SG | 0 | 0 | 0 | 0 | 0.17 |
| 10/29/2013 | 14:40 | KRBI | 189.7 | KR13926 | SG | 0 | 0 | 0 | 0 | 0.20 |
| 11/04/2013 | 11:30 | CRMC | 201.5 | KR13928 | SG | 0 | 0 | 0 | 0 | 0.29 |
| 11/04/2013 | 13:20 | CRCC | 200.0 | KR13929 | SG | 14,099,444 | 3,674,815 | 0 | 0 | 12 |
| 11/04/2013 | 12:50 | IRCC | 192.8 | KR13930 | SG | 0 | 0 | 0 | 0 | 0.36 |
| 11/04/2013 | 12:35 | IRJW | 192.4 | KR13931 | SG | 0 | 0 | 0 | 0 | 0.17 |
| 11/04/2013 | 12:15 | KRBI | 189.7 | KR13932 | SG | 0 | 0 | 0 | 0 | ND |
| 11/11/2013 | 13:00 | CRMC | 201.5 | KR13934 | SG | 5,527 | 3,536,481 | 0 | 19,897 ⁽⁷⁾ | 210 |
| 11/11/2013 | 11:00 | CRCC | 200.0 | KR13935 | SG | 0 | 10,576,917 | 0 | 0 | 87 |
| 11/19/2013 | 10:25 | CRMC | 201.5 | KR13941 | SG | 0 | 0 | 0 | 0 | ND |
| 11/19/2013 | 13:20 | CRCC | 200.0 | KR13942 | SG | 0 | 572 | 0 | 0 | ND |
| 11/25/2013 | 13:00 | CRMC | 201.5 | KR13943 | SG | *** | *** | *** | *** | 0 |
| 11/25/2013 | 11:00 | CRCC | 200.0 | KR13944 | SG | *** | *** | *** | *** | 0 |

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

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

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

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

⁸*Lyngbya sp.* (cells/mL) or ⁹*Anabaena circinalis* (cells/mL) or ¹⁰*Anabaena planctonica*

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