

TECHNICAL MEMORANDUM

Results of Cyanobacteria and Microcystin Monitoring in the Vicinity of the Klamath Hydroelectric Project

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Date: September 1, 2017



Introduction

This technical memorandum summarizes the results for the 2017 public health monitoring for cyanobacteria species and an associated toxin, microcystin, from Upper Klamath Lake and within PacifiCorp's Klamath Hydroelectric Project (Project) from Keno reservoir to the Klamath River downstream Iron Gate Dam. Microcystin results from 2017 baseline monitoring are also included in the results summaries below. This monitoring is particularly focused on *Microcystis aeruginosa* (MSAE) which is known to produce microcystin. This monitoring also assesses the presence of other potentially-toxic cyanobacteria, including *Dolichospermum* sp., and others. 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.

Results from the baseline and public health sampling are used in coordination with the appropriate public health authority to determine if public health advisories are warranted^{1,2}. In addition to PacifiCorp's website (www.pacificorp.com/es/hydro/hl/kr.html#), these memos are also posted on the Klamath Basin Monitoring Program's (KBMP) website (www.kbmp.net) and inform the Blue Green Algae tracker on the KBMP website.

The data in Appendix 1 and Appendix 2 summarize results from all of the 2017 public health sampling events to date and microcystin results from the 2017 baseline sampling events.

¹ The California State Water Resources Control Board (SWRCB) provides guidelines for posting advisories in recreation water (California SWRCB 2016) for Project waters in California. SWRCB recommends posting advisories in recreation waters at three levels based on laboratory testing for microcystin. The posting levels are Caution, Warning, and Danger at microcystin concentrations of 0.8, 6, and 20 µg/L respectively. Toxin producing cells at concentrations of over 4,000 cells/ml or blooms, scums, or mats would result in posting at the Caution level.

² Postings of Project waters in Oregon are coordinated with the Oregon Health Authority (OHA; 2016). The health advisory guideline in Oregon waters is microcystin concentrations of 10 µg/L or more, over 100,000 cells/mL of all toxicogenic species combined, or over 40,000 cells/mL of *Microcystis* spp. or *Planktothrix* spp.

Methods

PacifiCorp and the Oregon Department of Environmental Quality (ODEQ) are conducting public health sampling at ten sites (Table 1). Samples are collected and sent for laboratory analysis of potentially toxigenic cyanobacteria, notably MSAE and microcystin, from:

- Three shoreline sites in Upper Klamath Lake, Oregon
- One shoreline site in Keno Reservoir, Oregon
- One shoreline site in J.C. Boyle Reservoir, Oregon
- Four shoreline sites in coves in Copco and Iron Gate reservoirs (i.e., two cove sites in each reservoir), California
- One Klamath River site below Iron Gate Dam near the hatchery bridge, California

| Table 1. Sites of cyanobacteria and microcystin public health monitoring in Upper Klamath Lake, Keno Reservoir, J.C Boyle Reservoir, Copco Reservoir, Iron Gate Reservoir, and the Klamath River during 2017. | | | |
|--|------------------------|-----------------|---------|
| Location | Approximate River Mile | Sampling Entity | Site ID |
| Upper Klamath Lake at Eagle Ridge County Park | N/A | ODEQ | UKEP |
| Upper Klamath Lake at Howard's Bay Park | N/A | ODEQ | UKHP |
| Upper Klamath Lake at Moore Park | N/A | ODEQ | UKMP |
| Keno Reservoir at Keno Park | 234.0 | ODEQ | KEKP |
| J.C. Boyle Reservoir at Topsy Campground | 225.0 | ODEQ | BRTC |
| Copco Reservoir at Mallard Cove | 201.5 | PacifiCorp | CRMC |
| Copco Reservoir at Copco Cove | 200.0 | PacifiCorp | CRCC |
| Iron Gate Reservoir at Camp Creek | 192.8 | PacifiCorp | IRCC |
| Iron Gate Reservoir at Jay Williams Campground | 192.4 | PacifiCorp | IRJW |
| Klamath River below Iron Gate dam near Hatchery Bridge | 189.7 | PacifiCorp | KRBI |

Samples are planned to be taken once in May, November and December and twice per month in June, July, August, September, and October.

In addition to public health sampling, monthly and bi-monthly baseline sampling for microcystin is conducted by PacifiCorp and the U.S. Bureau of Reclamation (BOR) from May through October at 12 locations extending from Link Dam to the Klamath River downstream of Iron Gate Reservoir (Table 2).

| Table 2. Sites of microcystin baseline monitoring from Link Dam to the Klamath River downstream of Iron Gate reservoir during 2017. | | | | |
|--|------------------------|-----------|-----------------|---------|
| Site Description | Approximate River Mile | Depth (m) | Sampling Entity | Site ID |
| Link Dam | 254.4 | 0.5 | BOR | KR254.4 |
| Keno Reservoir at Miller Island | 246.0 | 0.5 | BOR | KR246.0 |
| Klamath River below Keno Dam near a USGS Gage | 231.8 | 0.5 | BOR | KBK |
| Klamath River below JC Boyle Reservoir | 224.6 | 0.5 | PacifiCorp | KR22460 |
| Klamath River at USGS Gage | 219.5 | 0.5 | PacifiCorp | KR21950 |
| Klamath River above Shovel Creek | 206.4 | 0.5 | PacifiCorp | KR20642 |
| Copco Reservoir at Buoy Line (surface) | 198.7 | 0.5 | PacifiCorp | KR19874 |
| Copco Reservoir at Buoy Line (integrated) | 198.7 | 0-8 | PacifiCorp | KR19874 |
| Klamath River below Copco 2 Reservoir | 196.5 | 0.5 | PacifiCorp | KR19645 |
| Iron Gate Reservoir at Log Boom (surface) | 190.2 | 0.5 | PacifiCorp | KR19019 |
| Iron Gate Reservoir at Log Boom (integrated) | 190.2 | 0-8 | PacifiCorp | KR19019 |
| Klamath River below Hatchery Bridge | 189.7 | 0.5 | PacifiCorp | KR18973 |

Public health samples are taken as grab samples offshore according to the standard operating procedure (SOP) developed by the Klamath Blue Green Algae Working Group (www.kbmp.net/collaboration/klamath-hydroelectric-settlement-agreement-monitoring). Samples collected for potentially toxic phytoplankton are preserved in Lugol’s solution and sent to Aquatic Analysts in Friday Harbor, Washington for analysis. The samples are labeled “Rush” for timely analysis and only potentially toxic cyanobacteria are identified and enumerated. 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 U.S. Environmental Protection Agency (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 with a detection limit of 0.10 µg/L and a quantification limit of 0.15 µg/L. 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.

Results

All public health samples (Table 3) and baseline microcystin samples (Tables 4 and 5) were collected as planned. Appendix 3 includes the raw phytoplankton results for the samples reported in Table 3. One public health sample (KR17831) was shipped to GreenWater Laboratories for anatoxin-a analysis via LC-MS/MS and results are pending.

Table 3. Summary of available public health laboratory algal identification and enumeration and microcystin results from sampling August 2017.

| Date | Time | Site ID | RM | Sampling Entity | Sample ID | Depth | MSAE ⁽¹⁾ | AFA ⁽²⁾ | DKFA ⁽³⁾ | Other ^{(4),(5), (6), (7), (8), (9), (10), (11), or (12)} | Microcystin (µg/L) |
|-----------|-------|---------|-------|-----------------|-----------|-------|---------------------|--------------------|---------------------|---|-----------------------|
| 8/07/2017 | 18:15 | CRMC | 201.5 | PacifiCorp | KR17825 | SG | * | * | * | * | 560 |
| 8/07/2017 | 15:30 | CRCC | 200.0 | PacifiCorp | KR17826 | SG | * | * | * | * | 36 |
| 8/07/2017 | 14:30 | IRCC | 192.8 | PacifiCorp | KR17827 | SG | * | * | * | * | 7.9 |
| 8/07/2017 | 14:00 | IRJW | 192.4 | PacifiCorp | KR17828 | SG | * | * | * | * | 19 |
| 8/07/2017 | 19:30 | KRBI | 189.7 | PacifiCorp | KR17829 | SG | * | * | * | * | 0.23 |
| 8/02/2017 | 11:46 | UKEP | N/A | ODEQ | UKEP17005 | SG | 90,200 | 5,267,235 | 0 | 0 | 37 ^{A2, J} |
| 8/02/2017 | 12:08 | UKHP | N/A | ODEQ | UKHP17005 | SG | * | * | * | * | 0.45 ^{A2, J} |
| 8/02/2017 | 12:39 | UKMP | N/A | ODEQ | UKMP17005 | SG | 0 | 632,052 | 0 | 0 | 1.1 ^{A2, J} |
| 8/02/2017 | 10:55 | KEKP | 234.0 | ODEQ | KEKP17005 | SG | 0 | 0 | 332 | 0 | 0.9 ^{A2, J} |
| 8/02/2017 | 10:36 | BRTC | 225.0 | ODEQ | BRTC17005 | SG | 0 | 0 | 0 | 0 | 0.19 ^{A2, J} |
| 8/27/2017 | 12:40 | CRMC | 201.5 | PacifiCorp | KR17830 | SG | * | * | * | * | 3,000 |
| 8/27/2017 | 11:40 | CRCC | 200.0 | PacifiCorp | KR17831 | SG | * | * | * | * | 380,000 |
| 8/27/2017 | 11:10 | IRCC | 192.8 | PacifiCorp | KR17832 | SG | * | * | * | * | 240 |
| 8/27/2017 | 10:30 | IRJW | 192.4 | PacifiCorp | KR17833 | SG | * | * | * | * | 450 |
| 8/27/2017 | 13:25 | KRBI | 189.7 | PacifiCorp | KR17834 | SG | * | * | * | * | 18 |

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

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

³DKFA = *Dolichospermum flos-aquae* (cells/mL)

Other = Cells/mL of either ⁴*Planktothrix (Oscillatoria)* sp., ⁵*Gloeotrichia echinulata*, ⁶*Dolichospermum* sp., ⁷*Lyngbya* sp.,

⁸*Dolichospermum circinalis*, ⁹*Dolichospermum planctonica*, ¹⁰*Planktothrix (Oscillatoria) limosa*, ¹¹*Pseudanabaena* spp., or

¹²*Limnothrix* sp.

"ND" value indicates a result less than the laboratory analytical detection limit (0.1 µg/L)

"0" value indicates non-detect by analytical laboratory

"*" value indicates no result available

^{C1} indicates the reported concentration for this analyte is below the quantitation limit.

^J indicates the reported result for this analyte should be considered an estimated value.

^{A2} indicates the sample was received above the recommended temperature range.

Table 4. Summary of August 2017 baseline laboratory microcystin results for samples collected in Oregon.

| Date | Time | Site ID | RM | Sampling Entity | Sample ID | Depth (m) | Microcystin (µg/L) |
|-----------|------|---------|-------|-----------------|-------------|-----------|-----------------------|
| 8/08/2017 | 8:15 | KR254.4 | 254.4 | BOR | 2017KHSA-51 | 0.5 | 0.29 |
| 8/08/2017 | 9:55 | KR246.0 | 246.0 | BOR | 2017KHSA-54 | 0.5 | 0.26 |
| 8/08/2017 | 7:20 | KBK | 231.8 | BOR | 2017KHSA-55 | 0.5 | 0.14 ^{C1, J} |
| 8/08/2017 | 8:50 | KR22460 | 224.6 | PacifiCorp | KR17086 | 0.5 | ND |
| 8/08/2017 | 8:00 | KR21950 | 219.5 | PacifiCorp | KR17087 | 0.5 | ND |

"ND" value indicates a result less than the laboratory analytical detection limit (0.1 µg/L)

^{C1} indicates the reported concentration for this analyte is below the quantitation limit.

^J indicates the reported result for this analyte should be considered an estimated value.

Table 5. Summary of August 2017 baseline laboratory microcystin results for samples collected in California.

| Date | Time | Site ID | RM | Sampling Entity | Sample ID | Depth (m) | Microcystin (µg/L) |
|-----------|-------|---------|-------|-----------------|-----------|-----------|--------------------|
| 8/07/2017 | 17:40 | KR20642 | 206.4 | PacifiCorp | KR17089 | 0.5 | ND |
| 8/07/2017 | 15:50 | KR19874 | 198.7 | PacifiCorp | KR17095 | 0.5 | 2.4 |
| 8/07/2017 | 16:00 | KR19874 | 198.7 | PacifiCorp | KR17096 | 0-8 | 1.3 |
| 8/07/2017 | 15:00 | KR19645 | 196.5 | PacifiCorp | KR17094 | 0.5 | 0.54 |
| 8/07/2017 | 12:00 | KR19019 | 190.2 | PacifiCorp | KR17090 | 0.5 | 14 |
| 8/07/2017 | 12:10 | KR19019 | 190.2 | PacifiCorp | KR17091 | 0-8 | 1.3 |
| 8/07/2017 | 19:35 | KR18973 | 189.7 | PacifiCorp | KR17088 | 0.5 | 0.35 |
| 8/07/2017 | 19:50 | KR18973 | 189.7 | PacifiCorp | KR17101 | 0.5 | 0.63 |
| 8/27/2017 | 13:15 | KR18973 | 189.7 | PacifiCorp | KR17103 | 0.5 | 14 |

^a“ND” value indicates a result less than the laboratory analytical detection limit (0.1 µg/L)

^{c1} indicates the reported concentration for this analyte is below the quantitation limit.

^j indicates the reported result for this analyte should be considered an estimated value.

References

California SWRCB 2016. Draft Statewide Voluntary Guidance on CyanoHABs in Recreational Waters. Available online at:

http://www.mywaterquality.ca.gov/monitoring_council/cyanohab_network/docs/triggers.pdf

Oregon Health Authority. 2016. Oregon Harmful Algal Bloom Surveillance (HABS) Program – Public Health Advisory Guidelines, Harmful Algae Blooms in Freshwater Bodies. 27 pp.

https://public.health.oregon.gov/HealthyEnvironments/Recreation/HarmfulAlgaeBlooms/Pages/resources_for_samplers.aspx

Appendix 1

Cyanobacteria Species and Microcystin Data for 2017 Public Health Samples

| Table A1. Summary of 2017 public health laboratory algal identification and enumeration microcystin results. | | | | | | | | | | | |
|---|-------|---------|-------|-----------------|-----------|-------|---------------------|--------------------|---------------------|---|----------------------|
| Date | Time | Site ID | RM | Sampling Entity | Sample ID | Depth | MSAE ⁽¹⁾ | AFA ⁽²⁾ | DKFA ⁽³⁾ | Other ^{(4),(5), (6), (7), (8), (9), (10), (11), or (12)} | Microcystin (µg/L) |
| 5/30/2017 | 12:19 | UKEP | N/A | ODEQ | UKEP17001 | SG | 0 | 0 | 2,662,890 | 0 | 15 |
| 5/30/2017 | 12:36 | UKHP | N/A | ODEQ | UKHP17001 | SG | 0 | 0 | 44,670 | 0 | ND |
| 5/30/2017 | 12:53 | UKMP | N/A | ODEQ | UKMP17001 | SG | 0 | 0 | 72,611 | 0 | ND |
| 5/30/2017 | 11:32 | KEKP | 234.0 | ODEQ | KEKP17001 | SG | 0 | 0 | 2,075 | 0 | ND |
| 5/30/2017 | 11:14 | BRTC | 225.0 | ODEQ | BRTC17001 | SG | 0 | 0 | 635 | 0 | ND |
| 5/31/2017 | 17:50 | CRMC | 201.5 | PacifiCorp | KR17800 | SG | 0 | 0 | 0 | 0 | ND |
| 5/31/2017 | 17:10 | CRCC | 200.0 | PacifiCorp | KR17801 | SG | 0 | 25 | 0 | 0 | ND |
| 5/31/2017 | 16:35 | IRCC | 192.8 | PacifiCorp | KR17802 | SG | 0 | 0 | 0 | 0 | ND |
| 5/31/2017 | 16:05 | IRJW | 192.4 | PacifiCorp | KR17803 | SG | 0 | 0 | 0 | 0 | ND |
| 5/31/2017 | 18:30 | KRBI | 189.7 | PacifiCorp | KR17804 | SG | 0 | 0 | 0 | 0 | ND |
| 6/15/2017 | 11:06 | UKEP | N/A | ODEQ | UKEP17002 | SG | 0 | 9,364 | 0 | 0 | ND |
| 6/15/2017 | 11:22 | UKHP | N/A | ODEQ | UKHP17002 | SG | 0 | 11,226 | 9,371 | 0 | 0.16 |
| 6/15/2017 | 11:36 | UKMP | N/A | ODEQ | UKMP17002 | SG | 0 | 18,798 | 12,764 | 0 | ND |
| 6/15/2017 | 10:23 | KEKP | 234.0 | ODEQ | KEKP17002 | SG | 4,840 | 141,988 | 946 | 0 | 1.3 |
| 6/15/2017 | 10:09 | BRTC | 225.0 | ODEQ | BRTC17002 | SG | 0 | 26,394 | 0 | 0 | ND |
| 6/13/2017 | 16:45 | CRMC | 201.5 | PacifiCorp | KR17805 | SG | 0 | 0 | 0 | 185 ⁽⁴⁾ | ND |
| 6/13/2017 | 15:10 | CRCC | 200.0 | PacifiCorp | KR17806 | SG | 0 | 117 | 201 | 0 | ND |
| 6/13/2017 | 12:20 | IRCC | 192.8 | PacifiCorp | KR17807 | SG | 0 | 150 | 24 | 0 | ND |
| 6/13/2017 | 12:00 | IRJW | 192.4 | PacifiCorp | KR17808 | SG | 0 | 135 | 0 | 0 | ND |
| 6/13/2017 | 17:50 | KRBI | 189.7 | PacifiCorp | KR17809 | SG | 0 | 0 | 0 | 0 | ND |
| 6/25/2017 | 13:35 | CRMC | 201.5 | PacifiCorp | KR17810 | SG | 0 | 0 | 0 | 0 | 0.18 |
| 6/25/2017 | 12:20 | CRCC | 200.0 | PacifiCorp | KR17811 | SG | 16,161 | 11,300 | 0 | 0 | 6.7 |
| 6/25/2017 | 11:40 | IRCC | 192.8 | PacifiCorp | KR17812 | SG | 0 | 0 | 0 | 255 ⁽⁶⁾ , 44 ⁽¹²⁾ | ND |
| 6/25/2017 | 11:15 | IRJW | 192.4 | PacifiCorp | KR17813 | SG | 0 | 0 | 0 | 490 ⁽⁶⁾ | ND |
| 6/25/2017 | 14:35 | KRBI | 189.7 | PacifiCorp | KR17814 | SG | 0 | 0 | 0 | 0 | ND |
| 6/27/2017 | 11:22 | UKEP | N/A | ODEQ | UKEP17003 | SG | 2,966 | 137,243 | 0 | 0 | 1.2 |
| 6/27/2017 | 11:38 | UKHP | N/A | ODEQ | UKHP17003 | SG | 0 | 2,469,675 | 0 | 31,761 ⁽⁵⁾ | 1.2 |
| 6/27/2017 | 11:59 | UKMP | N/A | ODEQ | UKMP17003 | SG | 0 | 460,204 | 0 | 0 | 0.50 |
| 6/27/2017 | 10:20 | KEKP | 234.0 | ODEQ | KEKP17003 | SG | 0 | 1,458,901 | 0 | 0 | 2.5 |
| 6/27/2017 | 10:01 | BRTC | 225.0 | ODEQ | BRTC17003 | SG | 0 | 9,364 | 0 | 0 | ND |
| 7/10/2017 | 18:30 | CRMC | 201.5 | PacifiCorp | KR17815 | SG | 288 | 1,899 | 0 | 0 | 0.1 ^{C1, J} |
| 7/10/2017 | 15:15 | CRCC | 200.0 | PacifiCorp | KR17816 | SG | 4,252 | 23,919 | 0 | 201 ⁽⁶⁾ | 3 |
| 7/10/2017 | 14:00 | IRCC | 192.8 | PacifiCorp | KR17817 | SG | 582,554 | 10,988 | 0 | 1,998 ⁽¹²⁾ | 47 |
| 7/10/2017 | 13:45 | IRJW | 192.4 | PacifiCorp | KR17818 | SG | 3,644 | 53,118 | 0 | 228 ⁽⁶⁾ | 2.4 |
| 7/10/2017 | 19:55 | KRBI | 189.7 | PacifiCorp | KR17819 | SG | 497 | 23,750 | 0 | 0 | 0.32 |
| 7/20/2017 | 11:04 | UKEP | N/A | ODEQ | UKEP17004 | SG | 0 | 118,923 | 0 | 0 | 0.42 |
| 7/20/2017 | 11:24 | UKHP | N/A | ODEQ | UKHP17004 | SG | 104,103 | 387,589 | 0 | 0 | 12 |
| 7/20/2017 | 11:44 | UKMP | N/A | ODEQ | UKMP17004 | SG | 17,925 | 7,967 | 0 | 0 | 0.57 |
| 7/20/2017 | 10:19 | KEKP | 234.0 | ODEQ | KEKP17004 | SG | 11,633 | 15,257 | 0 | 0 | 6.1 |
| 7/20/2017 | 10:07 | BRTC | 225.0 | ODEQ | BRTC17004 | SG | 1,956 | 0 | 0 | 0 | 0.39 |
| 7/23/2017 | 12:45 | CRMC | 201.5 | PacifiCorp | KR17820 | SG | 15,534 | 381,446 | 0 | 0 | 4.5 |

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Table A1 (cont.)

| Date | Time | Site ID | RM | Sampling Entity | Sample ID | Depth | MSAE ⁽¹⁾ | AFA ⁽²⁾ | DKFA ⁽³⁾ | Other ^{(4),(5), (6), (7), (8), (9), (10), or (11)} | Microcystin (µg/L) |
|-----------|-------|---------|-------|-----------------|-----------|-------|---------------------|--------------------|---------------------|---|-----------------------|
| 7/23/2017 | 11:40 | CRCC | 200.0 | PacifiCorp | KR17821 | SG | 0 | 19,936,041 | 0 | 0 | 550 |
| 7/23/2017 | 11:15 | IRCC | 192.8 | PacifiCorp | KR17822 | SG | 3,667 | 54,270 | 0 | 0 | 1.6 |
| 7/23/2017 | 10:55 | IRJW | 192.4 | PacifiCorp | KR17823 | SG | 5,556 | 377,467 | 0 | 0 | 5.1 |
| 7/23/2017 | 13:30 | KRBI | 189.7 | PacifiCorp | KR17824 | SG | 404 | 33,764 | 0 | 0 | 0.22 |
| 8/07/2017 | 18:15 | CRMC | 201.5 | PacifiCorp | KR17825 | SG | * | * | * | * | 560 |
| 8/07/2017 | 15:30 | CRCC | 200.0 | PacifiCorp | KR17826 | SG | * | * | * | * | 36 |
| 8/07/2017 | 14:30 | IRCC | 192.8 | PacifiCorp | KR17827 | SG | * | * | * | * | 7.9 |
| 8/07/2017 | 14:00 | IRJW | 192.4 | PacifiCorp | KR17828 | SG | * | * | * | * | 19 |
| 8/07/2017 | 19:30 | KRBI | 189.7 | PacifiCorp | KR17829 | SG | * | * | * | * | 0.23 |
| 8/02/2017 | 11:46 | UKEP | N/A | ODEQ | UKEP17005 | SG | 90,200 | 5,267,235 | 0 | 0 | 37 ^{A2, J} |
| 8/02/2017 | 12:08 | UKHP | N/A | ODEQ | UKHP17005 | SG | * | * | * | * | 0.45 ^{A2, J} |
| 8/02/2017 | 12:39 | UKMP | N/A | ODEQ | UKMP17005 | SG | 0 | 632,052 | 0 | 0 | 1.1 ^{A2, J} |
| 8/02/2017 | 10:55 | KEKP | 234.0 | ODEQ | KEKP17005 | SG | 0 | 0 | 332 | 0 | 0.9 ^{A2, J} |
| 8/02/2017 | 10:36 | BRTC | 225.0 | ODEQ | BRTC17005 | SG | 0 | 0 | 0 | 0 | 0.19 ^{A2, J} |
| 8/27/2017 | 12:40 | CRMC | 201.5 | PacifiCorp | KR17830 | SG | * | * | * | * | 3,000 |
| 8/27/2017 | 11:40 | CRCC | 200.0 | PacifiCorp | KR17831 | SG | * | * | * | * | 380,000 |
| 8/27/2017 | 11:10 | IRCC | 192.8 | PacifiCorp | KR17832 | SG | * | * | * | * | 240 |
| 8/27/2017 | 10:30 | IRJW | 192.4 | PacifiCorp | KR17833 | SG | * | * | * | * | 450 |
| 8/27/2017 | 13:25 | KRBI | 189.7 | PacifiCorp | KR17834 | SG | * | * | * | * | 18 |

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

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

³DKFA = *Dolichospermum flos-aquae* (cells/mL)

Other = Cells/mL of either ⁴*Planktothrix (Oscillatoria)* sp., ⁵*Gloeotrichia echinulata*, ⁶*Dolichospermum* sp., ⁷*Lyngbya* sp.,

⁸*Dolichospermum circinalis*, ⁹*Dolichospermum planctonica*, ¹⁰*Planktothrix (Oscillatoria) limosa*, ¹¹*Pseudanabaena* spp., or

¹²*Limnothrix* sp.

"ND" value indicates a result less than the laboratory analytical detection limit (0.1 µg/L)

"0" value indicates non-detect by analytical laboratory

*** value indicates no result available

^{C1} indicates the reported concentration for this analyte is below the quantitation limit.

^J indicates the reported result for this analyte should be considered an estimated value.

Appendix 2

Microcystin Data for 2017 Baseline Samples

| Table A2-1. Summary of 2017 baseline laboratory microcystin results for samples collected in Oregon. | | | | | | | |
|---|-------|---------|-------|-----------------|-------------|-----------|-----------------------|
| Date | Time | Site ID | RM | Sampling Entity | Sample ID | Depth (m) | Microcystin (µg/L) |
| 5/09/2017 | 10:00 | KR246.0 | 246.0 | BOR | 2017KHSA-22 | 0.5 | ND |
| 5/09/2017 | 07:45 | KBK | 231.8 | BOR | 2017KHSA-23 | 0.5 | ND |
| 5/15/2017 | 9:40 | KR22460 | 224.6 | PacifiCorp | KR17033 | 0.5 | ND |
| 5/15/2017 | 8:59 | KR21950 | 219.5 | PacifiCorp | KR17034 | 0.5 | ND |
| 6/06/2017 | 09:45 | KR246.0 | 246.0 | BOR | 2017KHSA-32 | 0.5 | ND |
| 6/06/2017 | 07:50 | KBK | 231.8 | BOR | 2017KHSA-33 | 0.5 | ND |
| 6/12/2017 | 13:50 | KR22460 | 224.6 | PacifiCorp | KR17050 | 0.5 | ND |
| 6/12/2017 | 13:15 | KR21950 | 219.5 | PacifiCorp | KR17051 | 0.5 | ND |
| 7/11/2017 | 7:00 | KR254.4 | 254.4 | BOR | 2017KHSA-40 | 0.5 | 0.52 |
| 7/11/2017 | 9:50 | KR246.0 | 246.0 | BOR | 2017KHSA-43 | 0.5 | 0.68 |
| 7/11/2017 | 8:55 | KBK | 231.8 | BOR | 2017KHSA-44 | 0.5 | 0.36 |
| 7/25/2017 | 8:45 | KR254.4 | 254.4 | BOR | 2017KHSA-46 | 0.5 | 0.50 |
| 7/11/2017 | 7:55 | KR22460 | 224.6 | PacifiCorp | KR17068 | 0.5 | ND |
| 7/11/2017 | 8:45 | KR21950 | 219.5 | PacifiCorp | KR17069 | 0.5 | ND |
| 8/08/2017 | 8:15 | KR254.4 | 254.4 | BOR | 2017KHSA-51 | 0.5 | 0.29 |
| 8/08/2017 | 9:55 | KR246.0 | 246.0 | BOR | 2017KHSA-54 | 0.5 | 0.26 |
| 8/08/2017 | 7:20 | KBK | 231.8 | BOR | 2017KHSA-55 | 0.5 | 0.14 ^{C1, J} |
| 8/08/2017 | 8:50 | KR22460 | 224.6 | PacifiCorp | KR17086 | 0.5 | ND |
| 8/08/2017 | 8:00 | KR21950 | 219.5 | PacifiCorp | KR17087 | 0.5 | ND |

"ND" value indicates a result less than the laboratory analytical detection limit (0.1 µg/L)

^{C1} indicates the reported concentration for this analyte is below the quantitation limit.

^J indicates the reported result for this analyte should be considered an estimated value.

| Table A2-2. Summary of 2017 baseline laboratory microcystin results for samples collected in California. | | | | | | | |
|---|-------|---------|-------|-----------------|-----------|-----------|-----------------------|
| Date | Time | Site ID | RM | Sampling Entity | Sample ID | Depth (m) | Microcystin (µg/L) |
| 5/16/2017 | 16:20 | KR20642 | 206.4 | PacifiCorp | KR17036 | 0.5 | ND |
| 5/16/2017 | 14:30 | KR19874 | 198.7 | PacifiCorp | KR17042 | 0.5 | ND |
| 5/16/2017 | 14:45 | KR19874 | 198.7 | PacifiCorp | KR17043 | 0-8 | ND |
| 5/16/2017 | 13:40 | KR19645 | 196.5 | PacifiCorp | KR17041 | 0.5 | ND |
| 5/16/2017 | 10:55 | KR19019 | 190.2 | PacifiCorp | KR17037 | 0.5 | ND |
| 5/16/2017 | 10:45 | KR19019 | 190.2 | PacifiCorp | KR17038 | 0-8 | ND |
| 5/16/2017 | 17:15 | KR18973 | 189.7 | PacifiCorp | KR17035 | 0.5 | ND |
| 5/16/2017 | 17:25 | KR18973 | 189.7 | PacifiCorp | KR17048 | 0.5 | ND |
| 6/13//2017 | 16:10 | KR20642 | 206.4 | PacifiCorp | KR17053 | 0.5 | ND |
| 6/13//2017 | 13:55 | KR19874 | 198.7 | PacifiCorp | KR17059 | 0.5 | ND |
| 6/13//2017 | 14:10 | KR19874 | 198.7 | PacifiCorp | KR17060 | 0-8 | ND |
| 6/13//2017 | 12:50 | KR19645 | 196.5 | PacifiCorp | KR17058 | 0.5 | ND |
| 6/13//2017 | 9:30 | KR19019 | 190.2 | PacifiCorp | KR17054 | 0.5 | ND |
| 6/13//2017 | 9:45 | KR19019 | 190.2 | PacifiCorp | KR17055 | 0-8 | ND |
| 7/10/2017 | 17:15 | KR20642 | 206.4 | PacifiCorp | KR17071 | 0.5 | ND |
| 7/10/2017 | 15:40 | KR19874 | 198.7 | PacifiCorp | KR17077 | 0.5 | ND |
| 7/10/2017 | 15:50 | KR19874 | 198.7 | PacifiCorp | KR17078 | 0-8 | 0.13 |
| 7/10/2017 | 14:45 | KR19645 | 196.5 | PacifiCorp | KR17076 | 0.5 | 0.1 ^{C1, J} |
| 7/10/2017 | 11:45 | KR19019 | 190.2 | PacifiCorp | KR17072 | 0.5 | 1.6 ^{C1, J} |
| 7/10/2017 | 12:15 | KR19019 | 190.2 | PacifiCorp | KR17073 | 0-8 | 0.15 |
| 7/10/2017 | 19:30 | KR18973 | 189.7 | PacifiCorp | KR17070 | 0.5 | 0.22 |
| 7/10/2017 | 19:30 | KR18973 | 189.7 | PacifiCorp | KR17083 | 0.5 | 0.32 |
| 7/23/2017 | 13:15 | KR18973 | 189.7 | PacifiCorp | KR17085 | 0.5 | 0.12 ^{C1, J} |
| 8/07/2017 | 17:40 | KR20642 | 206.4 | PacifiCorp | KR17089 | 0.5 | ND |
| 8/07/2017 | 15:50 | KR19874 | 198.7 | PacifiCorp | KR17095 | 0.5 | 2.4 |
| 8/07/2017 | 16:00 | KR19874 | 198.7 | PacifiCorp | KR17096 | 0-8 | 1.3 |
| 8/07/2017 | 15:00 | KR19645 | 196.5 | PacifiCorp | KR17094 | 0.5 | 0.54 |
| 8/07/2017 | 12:00 | KR19019 | 190.2 | PacifiCorp | KR17090 | 0.5 | 14 |
| 8/07/2017 | 12:10 | KR19019 | 190.2 | PacifiCorp | KR17091 | 0-8 | 1.3 |
| 8/07/2017 | 19:35 | KR18973 | 189.7 | PacifiCorp | KR17088 | 0.5 | 0.35 |
| 8/07/2017 | 19:50 | KR18973 | 189.7 | PacifiCorp | KR17101 | 0.5 | 0.63 |
| 8/27/2017 | 13:15 | KR18973 | 189.7 | PacifiCorp | KR17103 | 0.5 | 14 |

"ND" value indicates a result less than the laboratory analytical detection limit

^{C1} indicates the reported concentration for this analyte is below the quantitation limit.

^J indicates the reported result for this analyte should be considered an estimated value.

Appendix 3

Phytoplankton Sample Analysis

Klamath
Sample: Basin
Sample Site: KEKP17005
Sample Depth:
Sample Date: 2-Aug-17 1055

Total Density (#/mL): 11
Total Biovolume (um³/mL): 22,218
Trophic State Index: 22.7

| Species | Density #/mL | Density Percent | Biovolume um ³ /mL | Biovolume Percent |
|-----------------------------|-----------------|--------------------|----------------------------------|----------------------|
| 1 Dolichospermum flos-aquae | 11 | 100.0 | 22,218 | 100.0 |

Dolichospermum flos-aquae cells/mL = 332

Note: Toxic Algae Only

Phytoplankton Sample Analysis

Sample: Klamath Basin
 Sample Site: UKMP17005
 Sample Depth:
 Sample Date: 2-Aug-17 1239

Total Density (#/mL): 30,098
 Total Biovolume (um³/mL): 39,819,293
 Trophic State Index: 76.4

| Species | Density #/mL | Density Percent | Biovolume um ³ /mL | Biovolume Percent |
|----------------------------|--------------|-----------------|-------------------------------|-------------------|
| 1 Aphanizomenon flos-aquae | 30,098 | 100.0 | 39,819,293 | 100.0 |

Aphanizomenon flos-aquae cells/mL = 632,052

Note: Toxic Algae Only

Phytoplankton Sample Analysis

Sample: Klamath Basin
Sample Site: UKEP17005
Sample Depth:
Sample Date: 2-Aug-17 1146

Total Density (#/mL): 242,760
Total Biovolume (um³/mL): 332,557,378
Trophic State Index: 91.7

| Species | Density #/mL | Density Percent | Biovolume um ³ /mL | Biovolume Percent |
|----------------------------|--------------|-----------------|-------------------------------|-------------------|
| 1 Aphanizomenon flos-aquae | 239,420 | 98.6 | 331,835,778 | 99.8 |
| 2 Microcystis aeruginosa | 3,341 | 1.4 | 721,600 | 0.2 |

Aphanizomenon flos-aquae cells/mL = 5,267,235

Microcystis aeruginosa cells/mL = 90,200

Note: Toxic Algae Only

Phytoplankton Sample Analysis

Sample: Klamath Basin
Sample Site: BRTC17005
Sample Depth:
Sample Date: 2-Aug-17 1036

Total Density (#/mL): <4
Total Biovolume (um³/mL):
Trophic State Index:

| Species | Density #/mL | Density Percent | Biovolume um³/mL | Biovolume Percent |
|--------------------------|-------------------------|----------------------------|--|------------------------------|
| - | - | - | - | - |
| 1 No Toxic Algae Present | <4 | | | |

Note: Toxic Algae Only