

Kemp Lake: Water Quality Objectives Attainment (2016-2017)



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EXECUTIVE SUMMARY

Water Quality Objectives (WQO) were approved for Kemp Lake in 2012 (Obee and Phippen, 2012) based on data collected between 2006 and 2009. WQO attainment monitoring occurred in May and August 2016 and in February (spring overturn) 2017. These data, and changes that may affect water quality within the watershed, are presented within this report.

The data showed there were exceedances for all WQO parameters for which there were sufficient data to compare to WQOs. Exceedances occurred for water temperature, dissolved oxygen (DO), turbidity, true colour, total organic carbon (TOC), total phosphorus, and chlorophyll *a*. Though Kemp Lake has no objective for *Escherichia coli* (*E.coli*), this parameter also exceeded provincial Water Quality Guidelines. The exceedances generally occurred during summer low flow periods which suggest the lake is still experiencing internal loading and is impacted by surrounding land uses.

Kemp Lake Waterworks District (KLWD) has been approved to join the Capital Regional District (CRD) water supply and is constructing the necessary infrastructure (i.e. water main and pump house). The Kemp Lake Water Source Replacement Project is set to be completed in 2019 (Kemp Lake Waterworks District, 2019).

Recommendations include:

- continue WQO attainment monitoring over the next 3-5 years, ensuring recommended parameters and sampling frequency and timing are followed.
- continue to provide adequate treatment of Kemp Lake water intended for drinking water use.
- continue education around the importance of maintaining septic systems and minimizing fertilizer use for residence surrounding Kemp Lake as suggested in the 2012 WQO report by Obee and Phippen

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1. INTRODUCTION

As part of the Province of British Columbia, Ministry of Environment and Climate Change Strategy's (ENV) mandate to manage water bodies, water quality assessments and Water Quality Objectives (WQO) have been created for a number of lakes, rivers and marine surface waters. These reports provide a list of objectives to protect water quality that are tailored to the specific water body for which they have been created, taking into account natural local water quality, water uses, water movement, and waste discharges. While the WQOs currently have no legal standing, they can direct resource managers aiming to protect the water body in question and are used as a standard against which to measure the water quality of that water body. Once objectives have been developed, periodic attainment monitoring (approximately every three to five years) is undertaken to determine whether they are being met.

Kemp Lake is located in the southern portion of the Kemp Lake watershed (area of 620 ha) (Figure 1), which is about 3km northwest from the community of Sooke on Vancouver Island, BC. Kemp Lake is a designated community watershed supplying drinking water to the residents within the District of Kemp Lake. WQOs for Kemp Lake were approved in 2012 based on data collected between February and November 2006-2009. This report summarizes attainment monitoring data collected in 2016-2017 from the Kemp Lake Deep Station (1130096) and 2016 data from the Kemp Lake at Intake Site (E306494). The data are summarized in Appendix 1.

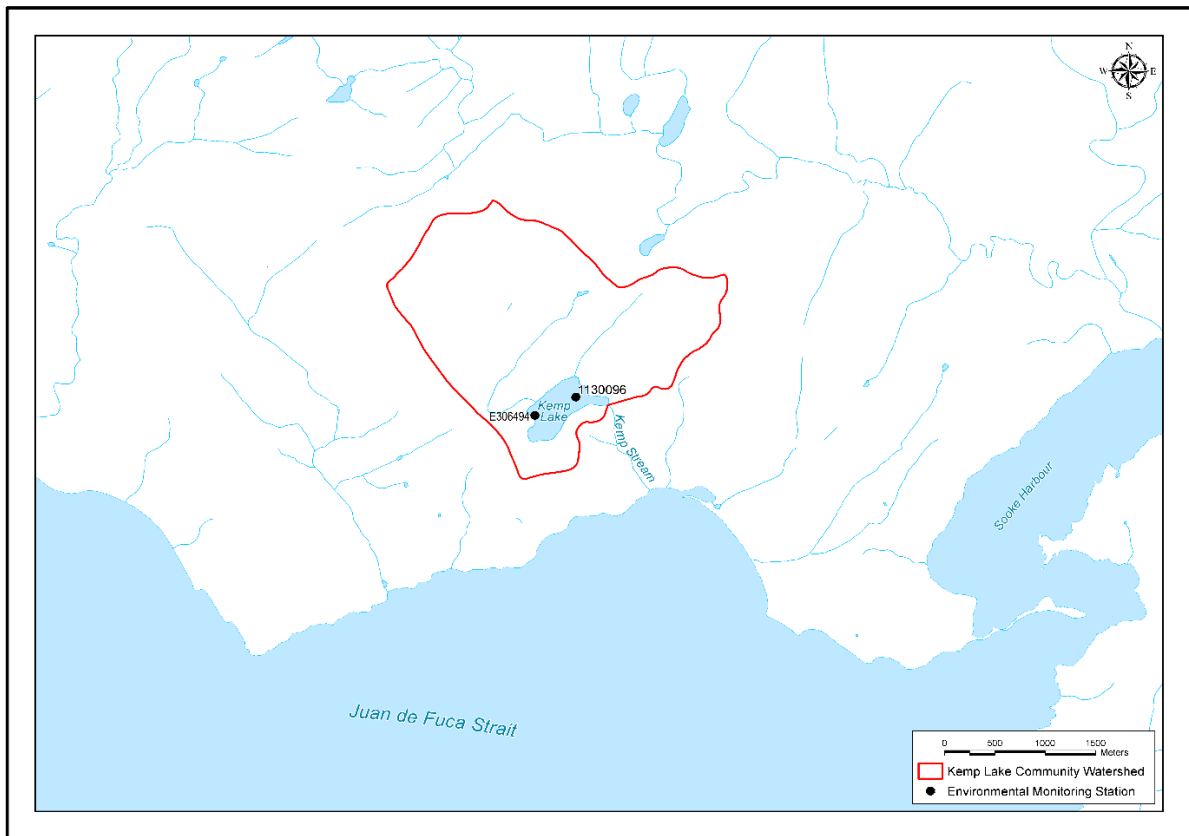


Figure 1 Water quality attainment sampling sites within the Kemp Lake Watershed.

2. CHANGES IN THE WATERSHED SINCE OBJECTIVES DEVELOPMENT

There have not been any significant changes affecting water quality within the Kemp Lake Watershed since the WQO were developed in 2012 (Boquist, 2019 *pers.comm*). However, the Kemp Lake Water District (KLWD) has added a pump house and water main along the West Coast Road (completion June 2019) to enable switching from Kemp Lake as a water supply and joining the Capital Regional District (CRD) water supply (Kemp Lake Waterworks District, 2019). Some residences will still be utilizing the Kemp Lake water supply as there are three licenses for domestic use and one for irrigation.

3. SAMPLING AND ANALYTICAL METHODS

Water samples were collected from Kemp Lake following the 2012 WQO report recommendations (Obee and Phippen, 2012). At the Kemp Lake Deep Station (1130096) samples were collected in May and in August 2016 and February 2017. At the Kemp Lake at Intake Site (E306494) sample site, five weekly samples in 30 days were collected during summer low flow (Aug-Sept) and fall flush (Oct-Nov) in 2016. Phytoplankton and zooplankton sampling occurred in August 2016 and February 2017. Note that some recommended frequency and timing of sampling from the 2012 WQO report were not met, including October sampling at the Deep Station (1130096) (Table 1).

Samples were collected by ENV and District of Sooke employees according to the Resource Inventory Standards Committee (RISC) protocols (BC MOE, 2013). Samples were collected using the discrete grab method. Sterilized plastic or glass sampling bottles, as required by the lab, were used to collect surface water samples by hand, while a Van Dorn bottle was used to collect water column samples which were then transferred to sampling bottles for lab analysis. A Hydrolab Surveyor 4 was used to conduct depth profiles at the Kemp Lake Deep Station (1130096) for parameters including dissolved oxygen (DO), water temperature, oxidation-reduction potential (ORP), pH and conductivity. A 20cm diameter Secchi disc was also used to measure water clarity at the deep station. Chlorophyll *a*, microbiological and water chemistry parameter analyses were conducted by ALS Environmental in Burnaby, B.C, and plankton taxonomy was conducted by Fraser Environmental Services in Surrey, B.C.

Table 1. Recommended schedule for attainment water quality monitoring in Kemp Lake and 2016-2017 attainment monitoring schedule deviations.

Frequency and timing	Characteristic to be measured	2016-17 Deviation from recommended monitoring
Deep station site (3 depths per site) – quarterly sampling (March, May, August, October)	pH, specific conductivity, turbidity, colour, TOC, DOC, nitrogen species, total phosphorus total and dissolved metals including iron and hardness (spring overturn only), <i>chlorophyll a</i> , DO, temp profiles, secchi disk	Samples were not consistently taken at 3 depths per site and there were no samples taken in October
Intake Site - 5-in-30 sampling in summer and fall	Turbidity, TOC, total and dissolved metals including iron, hardness, <i>E.coli</i>	Total and dissolved metals including iron, hardness were only sampled on one occasion (August 30, 2016). Samples not taken at recommended 4m depth.
Deep Station Site- twice per year (spring overturn and summer)	Phytoplankton and zooplankton	Only conducted in summer 2016 and spring overturn 2017

4. OBJECTIVES

A list of the WQO for Kemp Lake, along with a summary of the exceedances observed from the attainment monitoring, are presented in Table 2. Objectives were not consistently met for any parameters. Attainment data are summarized in Appendix 1. Only parameters of concern are discussed.

Table 2. Summary of water quality objective attainment for Kemp Lake.

Variable	Objective Value	Objective met? (yes/no)
Water temperature	≤ 15°C summer maximum hypolimnetic temperature (> 5m depth)	No
Dissolved oxygen	≥ 5 mg/L > 2 m above lake bottom ≥ 2 mg/L ≤ 2 m above lake bottom (May-August)	No
Secchi depth	≥ 4 m annual average	Insufficient data
Turbidity	≤ 2 NTU maximum < 1 NTU 95% of the time	No
True Colour	≤ 20 TCU maximum	No
Total organic carbon	≤ 6 mg/L maximum	No
Total phosphorus	≤ 10 µg/L maximum during spring overturn	No
Chlorophyll α	1.5 µg/L to 2.5 µg/L (May-August)	No

4.1 Temperature

All sampling done in 2016 from May through August met the WQO, with temperatures below 15°C in the hypolimnion, except once. In August at a depth of 6m, the temperature of the water in the hypolimnion was 16.5°C. This exceeds the drinking water guideline (15°C) but is within the optimal range for fish (17°C). During the summer months temperatures are relatively warmer at all depths but visible thermal stratification is seen at around 5-6m. During spring turnover in February 2017, the water was well mixed, and temperatures were homogeneous at all depths (Figure 2).

4.2 Dissolved Oxygen

There are two objectives for DO concentrations in Kemp Lake. Objective one is DO concentrations measured at greater than 2 m above the lake bottom should be above 5 mg/L at all times. In February 2017 the objective range requirement was met at all depths as the lake was well mixed. The results in May 2016 show the lake was starting to stratify at 7m, with DO levels not meeting the WQO (1.61mg/L- 3.78 mg/L). In August 2016 the DO was below 5mg/L ranging from 0.74mg/L- 3.78mg/L at the lower depths (6m-9m) and did not meet the WQO (Figure 3). Objective two is that DO concentrations in the bottom 2 m of the lake, measured at the deepest point, should be > 2 mg/L during the summer months (May to August). The samples collected at 9m depth from May to August 2016 were 1.61mg/L, 0.74mg/L, respectively, and thus did not meet the WQO.

4.3 Water Clarity- Secchi Depth

The water clarity Secchi depth objective is a mean annual Secchi depth of greater than 4 m based on a minimum of four seasonal measurements. There was only three secchi depths measured in 2016-2017, instead of four seasonal measurements, so no direct comparison to the WQO could be made for this attainment monitoring period. The May and August 2016 secchi values were 3.85m and 4.2m and the February 2017 secchi value was 3.33m (Figure 4).

4.4 Water Clarity - Turbidity

The Kemp Lake turbidity objective is that turbidity should not exceed a maximum of 2.0 NTU at any time (1 NTU above ambient levels) and that turbidity at the intake be < 1 NTU 95% of the time. For the Kemp Lake Deep Water Station (1130096) all the results met the objective, except in August 2016 when the 9m depth had a concentration of 6.15 NTU (Figure 4). As the other turbidity values collected in May 2016 and February 2017 at the lower depths were found to be drastically lower (1.67NTU and 1.34NTU), the spike at the lower sample depth in August could be due to a disturbance of bottom sediment during sampling but may also have been a result of algal die-off settling to the bottom of the water column. At the Kemp Lake at Intake Site (E306494) concentrations ranged from 0.65-1.6 NTU with over 50% of the concentrations greater than 1 NTU, which is not within the objective range requirement (Figure 5). However, samples at the intake were not taken at the recommended depth of 4m (Table 3) and cannot be directly compared to the WQO.

4.5 True colour

The Kemp Lake water quality objective for maximum true colour is ≤ 20 TCU. At the Kemp Lake Deep Station (1130096), two of the three sampling events (occurring in May 2016 (28.5 TCU) and February 2017 (24.3 TCU)) exceeded the objective. August 2016 results (18.7 TCU) met the objective.

4.6 Total Organic Carbon

At the Kemp Lake Deep Station (1130096) one sampling event (August 2016) exceeded the objective of ≤ 6 mg/L maximum with a value of 6.49mg/L at a depth of 9m. The other two sampling events, May 2016 and February 2017, met the WOO, ranging from 4.87mg/L to 5.32mg/L (Figure 6). The highest values of TOC were seen at the lower sampling depths. At the Kemp Lake at Intake Site (E306494) all values were below the objectives except for three samples collected at the lower sampling depths. The exceedances were seen on August 15 (6.41mg/L), November 3 (6.35mg/L) and December 9 (6.72mg/L) (Figure 7). All sampling events exceeded the provincial drinking water guidelines for TOC of 4 mg/L, which was set to protect against disinfection by-products.

4.7 Nutrients - Total Phosphorus

The Kemp Lake water quality objective for total phosphorus is a maximum spring overturn concentration of $\leq 10\mu\text{g/L}$ (with collection taking place before the lake stratifies in April). Total phosphorus samples were collected in February at depths of 0m and 10m, with concentrations of $9.20\mu\text{g/L}$ and $10.7\mu\text{g/L}$. The sample collected at 10m exceeded the total phosphorus objective. Figure 8 illustrates averages from all sampling events with the February (spring turnover) event highlighted in green.

4.8 Biological Analyses- Chlorophyll *a*

The water quality objective for chlorophyll *a* in Kemp Lake is a summer (May through August) concentration between $1.5\mu\text{g/L}$ and $2.5\mu\text{g/L}$. Chlorophyll *a* concentrations were measured in 2016 in May and August (ranging from 1.82 - $17.9\mu\text{g/L}$) and again in February 2017 ($2.22\mu\text{g/L}$) at the Deep Station (1130096). Only the May 2016 sample at 0m ($17.9\mu\text{g/L}$) exceeded the WQO for chlorophyll *a*.

4.9 Escherichia coli

There are no WQOs for *E.coli* in Kemp Lake; however, Obee and Phippen's 2012 report recommended *E.coli* be included in future sampling. During 2016 summer low flow and fall flush, five weekly samples in 30 days were conducted for *E.coli* at the Kemp Lake at Intake Site (E306494) (Table 3). The geometric mean for *E.coli* was 1.1 CFU/100mL during summer low flow and 3.9 CFU/100mL during fall flush (Table 4). Fall flush values coincided with increased precipitation events during October- November. *E.coli* results do not exceed the provincial water quality guidelines of ≤ 10 *E.coli* per 100mL for both 5 in 30 sampling events (British Columbia, 2017). The highest *E.coli* result was on October 27, 2016, with a concentration of 15 CFU/100mL; possibly a result of high precipitation.

KLWD samples water from the distribution system on a weekly basis for bacteriological parameters including *E.coli* under the direction of Vancouver Island Health Authority (VIHA) (KLWD, 2019). The KLWD data (available online) had all levels of *E.coli* as L1 (less than 1, no detectable bacteria), with the exception of November 30, 2016 which was < 1 (greater than 1, detectable bacteria present) (VIHA, 2019). These data indicate that the water treatment system appears to be meeting drinking water requirements.

4.10 Phytoplankton

There is no WQO regarding phytoplankton for Kemp Lake. However, Obee and Phippen (2012) recommend samples be taken twice a year (spring overturn and summer) at the Deep Station (1130096). Phytoplankton samples were collected at the Deep Station (1130096) in August 2016 and

February 2017. In the August 2016 sampling the phytoplankton community was dominated by blue-green algae (*Lyngbya limnetica*), diatoms (*Melosira italica*) and brown algae (*Dinobryon sertularia*). In the February 2017 sampling the dominant communities were diatoms (*Melosira italica* and *Asterionella formosa*) and Cryptomonads (*Chroomonas acuta*). Table 5 summarizes the dominant phytoplankton species. The dominant phytoplankton communities seen in the 2016-2017 attainment monitoring data are similar to the communities seen in the 2012 WQO report, which is still consistent with mesotrophic conditions (Obee and Phippen, 2012).

4.11 Zooplankton

There is no WQO regarding zooplankton for Kemp Lake, just the recommendation made by Obee and Phippen (2012) to conduct sampling twice a year (spring overturn and summer) at the Deep Station (1130096). Zooplankton samples were taken in August 2016 and February 2017 at the Deep Station (1130096). In August 2016 there was a higher concentration (14,371 total organisms/sample) compared to February 2017, which had less than half the concentration (6,320 total organisms/sample) of zooplankton. For both sampling events the dominant zooplankton were rotifers (*Keratella cochlearis*, *Polyarthra sp.*, *Keratella quadrata* and *Kellicottia longispina*). Table 6 summarizes the dominant zooplankton species. These concentrations are similar to what was measured in the 2006-2009 data (Obee and Phippen, 2012).

5. CONCLUSIONS AND RECOMMENDATIONS

The general water quality of Kemp Lake remains similar to what was seen in the 2012 WQO report which was classified as quite good by Obee and Phippen. The 2016-2017 data collected shows the WQO parameters all had exceedances during the sampling period; thus these parameters are still a concern and should be monitored. The *E.coli* data gathered at the Kemp Lake at Intake Site (E306494) illustrated the need for purveyors to continue to provide adequate treatment of Kemp Lake water intended for drinking water use. More *E.coli* data are needed to determine if an objective needs to be created for Kemp Lake.

It is recommended that attainment monitoring continue every 3-5 years. Sampling at the Kemp Lake at Intake Site (E306494) for general water chemistry and bacteriological parameters should be continued as per sampling recommendations in the 2012 WQO report by Obee and Phippen. To enable comparison to all WQOs in place for Kemp Lake, it is recommended that effort be made to obtain the recommended sampling frequency and timing for parameters for which insufficient or no data were collected.

It is also recommended that applicable government agencies continue landowner education and outreach around the importance of septic system maintenance and prudent fertilizer use as suggested in the 2012 WQO report by Obee and Phippen.

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APPENDIX 1: WATER QUALITY MONITORING RESULTS

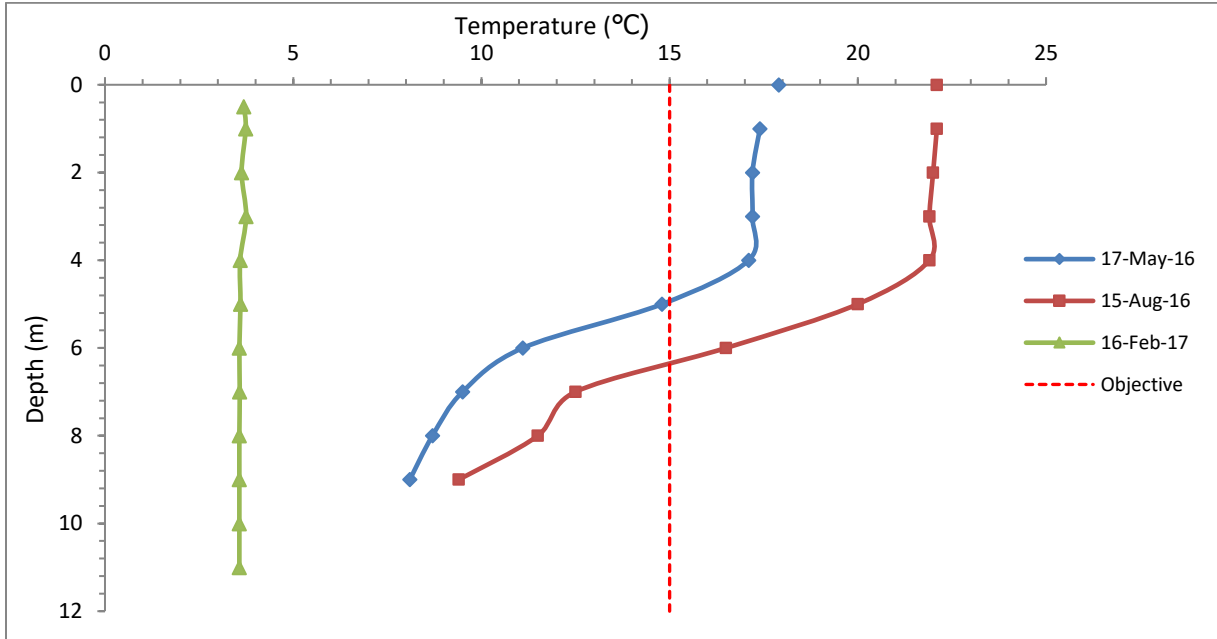


Figure 2. Temperature profile for Kemp Lake Deep Station (1130096) 2016-2017.

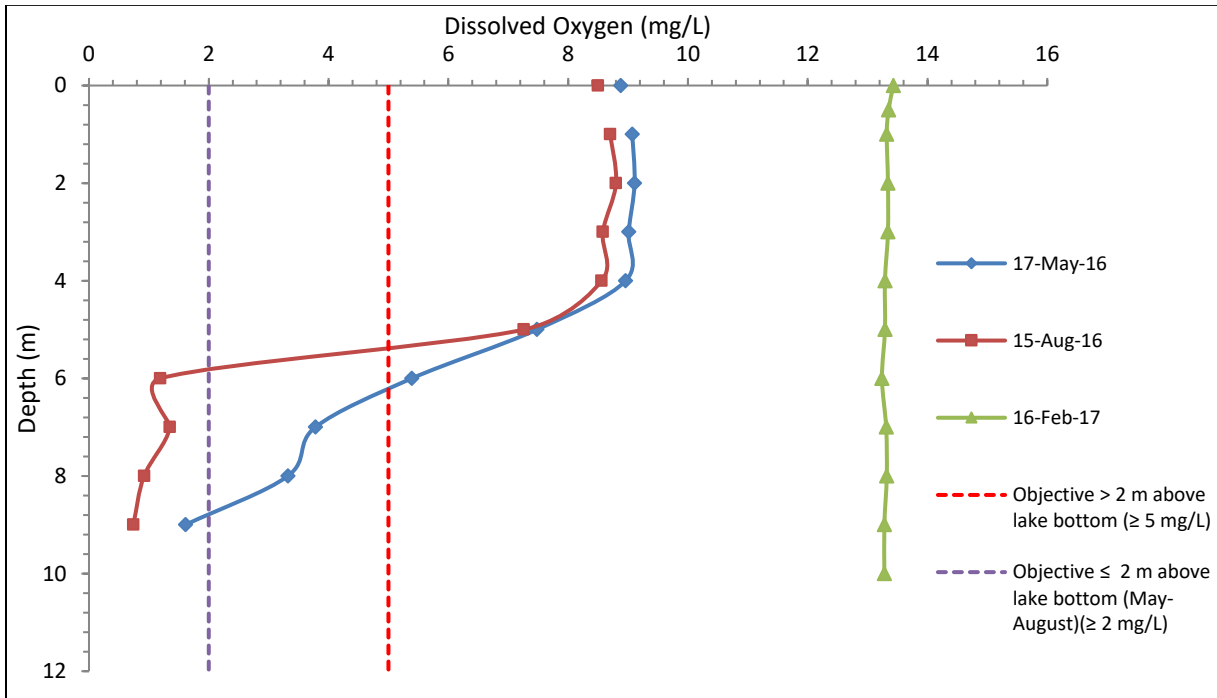


Figure 3. Dissolved oxygen profile for Kemp Lake Deep Station (1130096) 2016-2017.

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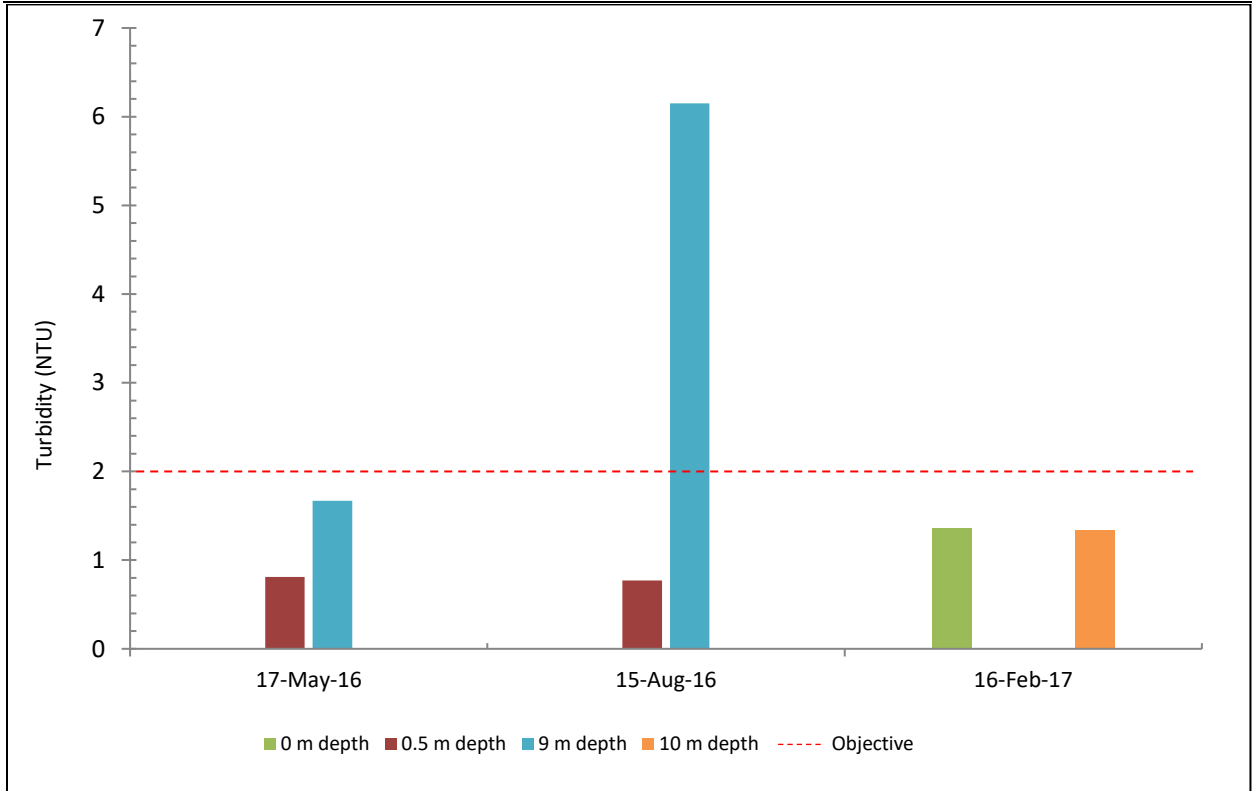


Figure 4. Turbidity at Kemp Lake Deep Station (1130096) from 2016-2017.

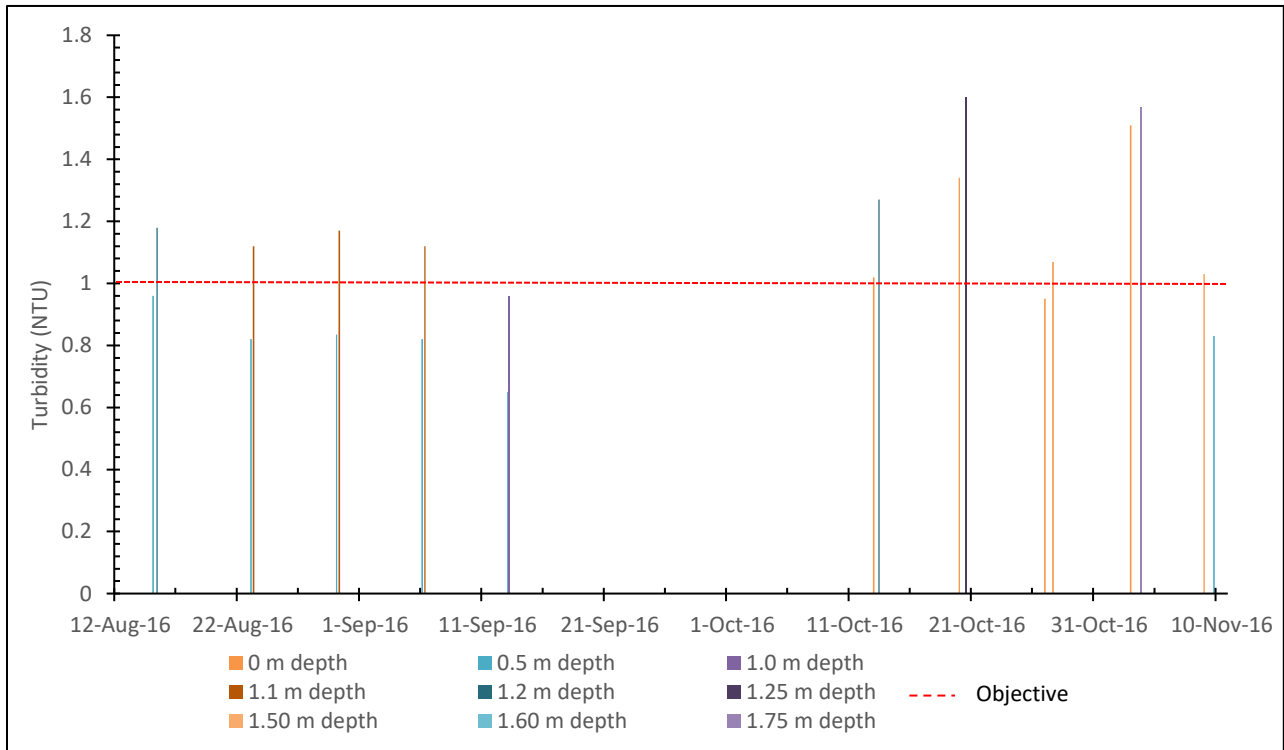


Figure 5. Turbidity at Kemp Lake at Intake Site (E306494) in 2016.

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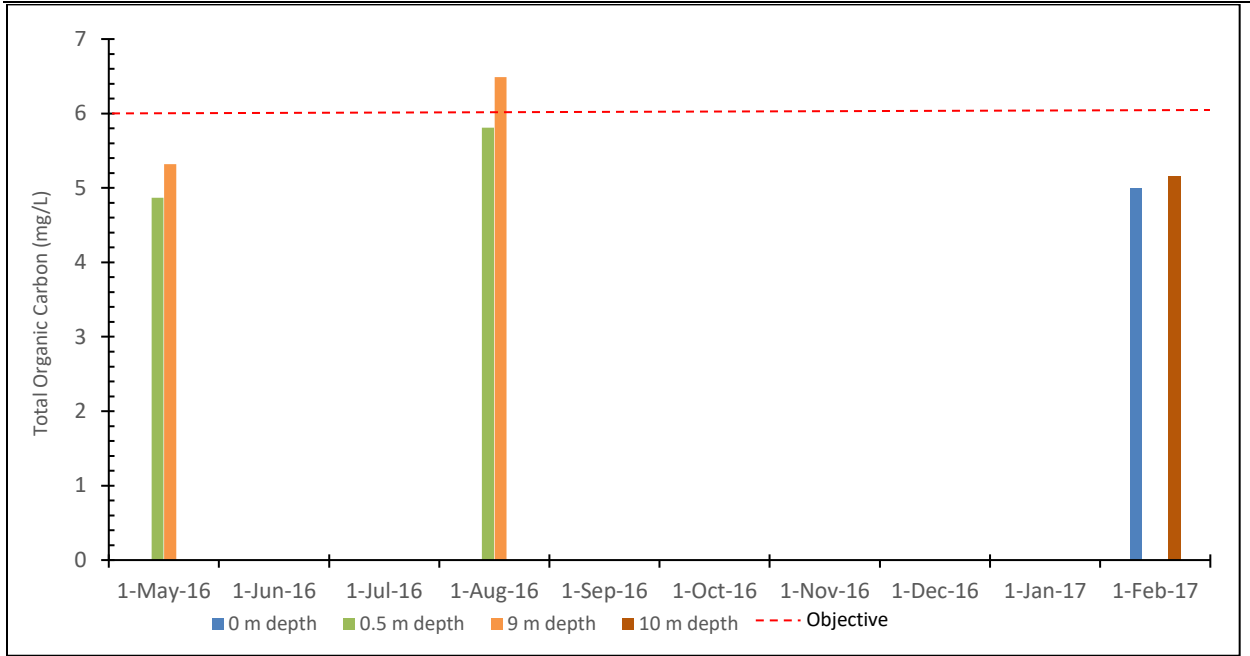


Figure 6. Total organic carbon at Kemp Lake Deep Station (1130096) from 2016-2017.

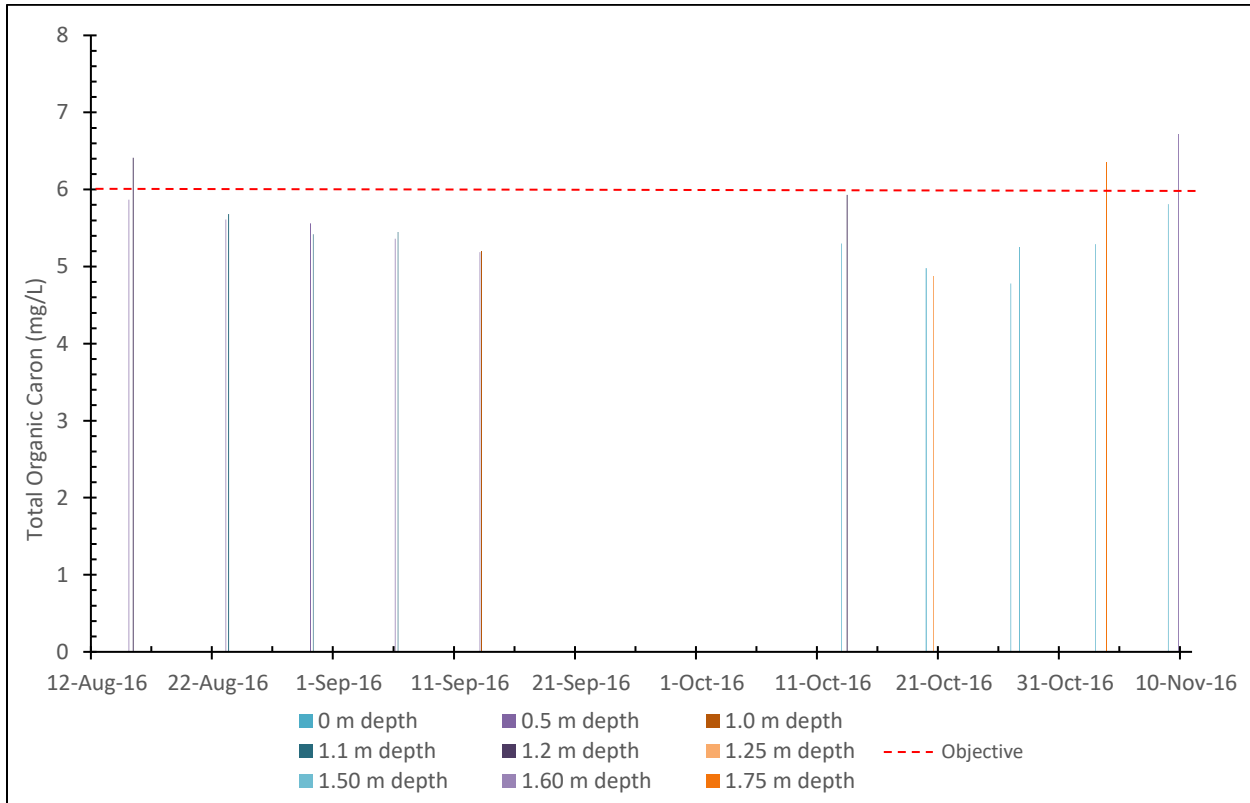


Figure 7. Total organic carbon at Kemp Lake Intake Site (E306494) from 2016-2017.

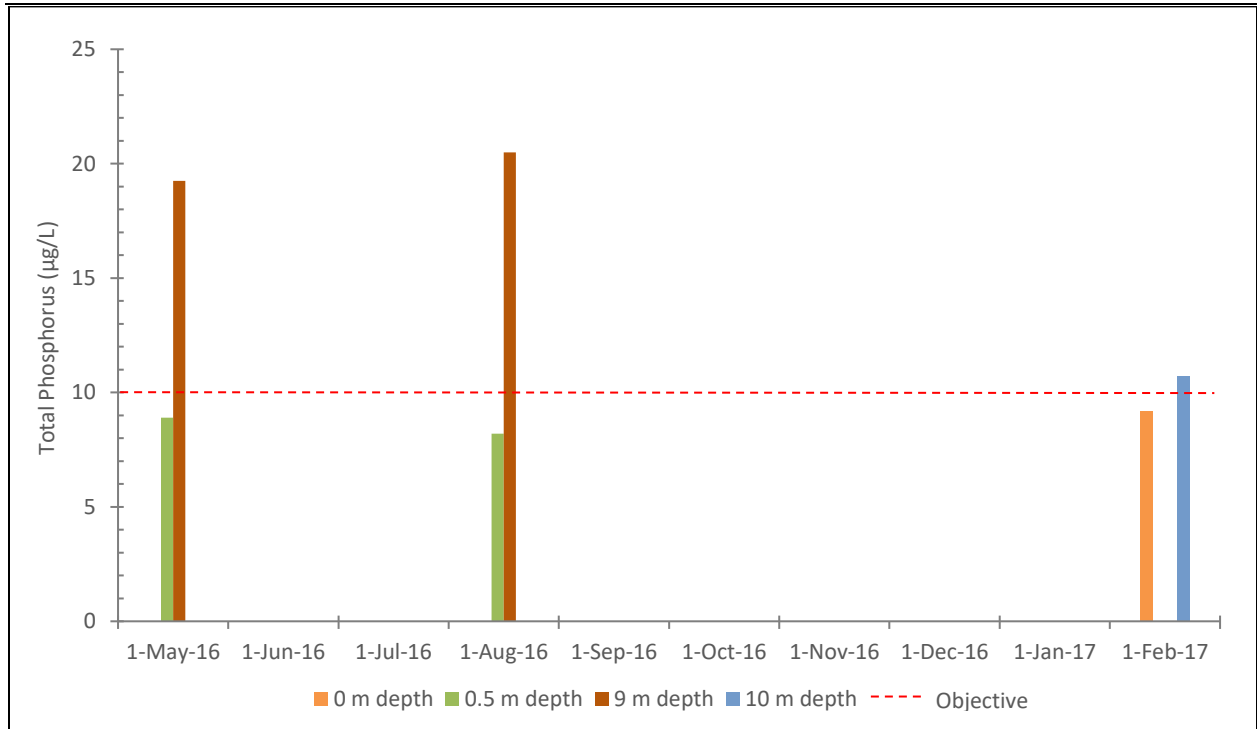


Figure 8. Total phosphorus concentration in Kemp Lake Deep Station (1130096) for all sampling events.

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Table 3. Summary of data collected at Site E306494, Kemp Lake at Intake Site in 2016.

Date (year-month-day)	Depth (m)	E. coli (CFU/100mL)	Temperature (°C)	Turbidity (NTU)	Total Organic Carbon (mg/L)
2016-08-15	0		23.2		
2016-08-15	0.5	<1		0.96	5.87
2016-08-15	1		22.3		
2016-08-15	1.2	1		1.18	6.41
2016-08-15	1.2	2			
2016-08-23	0		21.3		
2016-08-23	0.5	<1		0.82	5.61
2016-08-23	1.0		21.5		
2016-08-23	1.1	1		1.12	5.55
2016-08-23	1.1				5.81
2016-08-30	0		20.5		
2016-08-30	0.5	1		0.80	5.56
2016-08-30	0.5			0.87	
2016-08-30	1.0		21		
2016-08-30	1.1	<1		1.17	5.42
2016-09-06	0		19.4		
2016-09-06	0.5	1		0.82	5.36
2016-09-06	1.0		19.2		
2016-09-06	1.1	<1		1.12	5.45
Date (year-month-day)	Depth (m)	E. coli (CFU/100mL)	Temperature (°C)	Turbidity (NTU)	Total Organic Carbon (mg/L)
2016-09-06	1.1	2			
2016-09-13	0		18.5		
2016-09-13	0.5			0.65	5.0
2016-09-13	0.5	<1			5.37
2016-09-13	1.0	<1	19	0.96	5.2
2016-10-13	0	1	14.5	1.02	5.3
2016-10-13	1		14.2		
2016-10-13	1.2	<1		1.27	5.93
2016-10-13	1.2	<1			
2016-10-20	0	4	12	1.34	4.98
2016-10-20	1		12.9		
2016-10-20	1.25	5		1.60	4.98
2016-10-20	1.25				4.76
2016-10-27	0		12.2	0.92	4.78
2016-10-27	0	9		0.98	
2016-10-27	1.5	15	12.1	1.07	5.25
2016-11-03	0	8	11.3	1.51	5.29
2016-11-03	1.75	8	11.4	1.57	6.35
2016-11-03	1.75	7			
2016-11-09	0				5.85
2016-11-09	0	3	12	1.03	5.77
2016-11-09	1		11.8		
2016-11-09	1.6	3		0.83	6.72

Table 4. Statistical summary of *E. coli* measurements at Kemp Lake at Intake Site (E306494) in 2016.

	Minimum	Maximum	Count	5 weekly samples in 30 days geometric mean August 15- September 13	5 weekly samples in 30 days geometric mean October 13- November 9
Kemp Lake at Intake	<1	15	24	1.1	3.9

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Table 5. Summary of all phytoplankton species collected from Kemp Lake Deep Station (1130096) in 2016-2017 (all units in cells/mL) (Dominate species >10% bolded).

	August 15, 2016		February 16, 2017	
	Number	%	Number	%
Order : Centrales				
<i>Cyclotella cf. bodanica</i>	11.2	0.59		
<i>Cyclotella cf. glomerata</i>	16.8	0.88		
<i>Melosira cf. italica</i>	369.6	19.38	86.8	11.36
<i>Melosira sp.</i>	<2.8	<0.15		
Order : Chlorococcales				
<i>Botryococcus braunii</i>	33.6	1.76		
<i>Crucigenia crucifera</i>	22.4	1.17		
<i>Crucigenia quadrata</i>	78.4	4.11	<2.8	<0.37
<i>Crucigenia tetrapedia</i>	67.2	3.52		
<i>Elakathrix gelatinosa</i>	11.2	0.59	<2.8	<0.37
<i>Nephrocytium sp. ?</i>	<2.8	<0.15		
<i>Oocystis cf. lacustris</i>	16.8	0.88	<2.8	<0.37
<i>Oocystis sp.</i>	<2.8	<0.15	<2.8	<0.37
<i>Pediastrum tetras</i>	22.4	1.17		
<i>Pediastrum sp.</i>	<2.8	<0.15		
<i>Quadrigula closterioides</i>	11.2	0.59		
<i>Scenedesmus cf. denticulatus</i>	11.2	0.59		
<i>Selenastrum minutum</i>	2.8	0.15		
<i>Sphaerocystis Schroeteri</i>	<2.8	<0.15	<2.8	<0.37
<i>Tetraedron minimum</i>	<2.8	<0.15	2.8	0.37
Order : Chroococcales				
<i>Agmenellum tenuissima</i>	<2.8	<0.15		
<i>Anacystis cf. elachista</i>	<2.8	<0.15		
<i>Anacystis cf. limneticus</i>	<2.8	<0.15		
Order : Cryptomonadales				
<i>Chroomonas acuta</i>	<2.8	<0.15	319.2	41.76
<i>Cryptomonas ovata / erosa</i>	<2.8	<0.15	8.4	1.10
<i>Cryptomonas sp.</i>	<2.8	<0.15	<2.8	<0.37
Order : Dinokontae				
<i>Ceratium hirundinella</i>	<2.8	<0.15		
<i>Peridinium cf. inconspicuum</i>	<2.8	<0.15		
Order : Euglenales				
<i>Euglena sp.</i>	<2.8	<0.15	<2.8	<0.37
<i>Trachelomonas sp.</i>	<2.8	<0.15		
Order : Nostocales*				
<i>Anabaena sp.</i>	<2.8	<0.15		
Order : Ochromonadales				
<i>Dinobryon divergens</i>	28.0	1.47	<2.8	<0.37
<i>Dinobryon cf. sertularia</i>	182.0	9.54	50.4	6.59
<i>Dinobryon spp.</i>	8.4	0.44		
<i>Mallomonas cf. akrokomos</i>			2.8	0.37
<i>Ochromonas sp. ?</i>			<2.8	<0.37
<i>Synura sp. ?</i>			<2.8	<0.37

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Order : Oedogoniales				
<i>Oedogonium sp. ?</i>	<2.8	<0.15		
Order : Oscillatoriales*				
<i>Lyngbya cf. limnetica</i>	980.0	59.40		
<i>Oscillatoria sp.</i>			<2.8	<0.37
<i>Oscillatoria sp. ? (<2μ)</i>			<2.8	<0.37
Order : Pennales				
<i>Achnanthes minutissima</i>	<2.8	<0.15	2.8	0.37
<i>Amphiprora = Entomoneis</i>			<2.8	<0.37
<i>Asterionella formosa</i>	<2.8	<0.15	271.6	35.53
<i>Cymbella cf. minuta</i>			<2.8	<0.37
<i>Cymbella sp.</i>	<2.8	<0.15	<2.8	<0.37
<i>Eunotia cf. pectinalis</i>			2.8	0.37
<i>Eunotia sp.</i>			<2.8	<0.37
<i>Fragilaria crotonensis</i>			16.8	2.20
<i>Frustulia rhomboides</i>			<2.8	<0.37
<i>Gomphonema olivaceum</i>			<2.8	<0.37
<i>Gomphonema sp.</i>			<2.8	<0.37
<i>Meridion circulare</i>			<2.8	<0.37
<i>Navicula cf. radiosa</i>	<2.8	<0.15		
<i>Navicula spp.</i>	<2.8	<0.15	<2.8	<0.37
<i>Pinnularia sp.</i>			<2.8	<0.37
<i>Surirella sp.</i>	<2.8	<0.15	<2.8	<0.37
<i>Synedra ulna</i>			<2.8	<0.37
<i>Synedra sp.</i>			<2.8	<0.37
<i>Tabellaria fenestrata</i>			<2.8	<0.37
UID Pennales			<2.8	<0.37
Order : Rhizochrysidales				
<i>Diceras phaseolus</i>	<2.8	<0.15		
Order : Ulotrichales				
<i>Geminella sp.</i>	33.6	1.76		
Order : Zygnematales				
<i>Cosmarium sp.</i>	<2.8	<0.15	<2.8	<0.37
<i>Spondylosium planum</i>	<2.8	<0.15		
UID colonial algae	<2.8	<0.15		
UID branched filamentous algae			<2.8	<0.37
UID filamentous algae			<2.8	<0.37
UID unicellular algae			<2.8	<0.37
Total	1906.8		764.4	

UID= Unidentified due to lack of size and/or missing morphological characters

*Phytoplankton from the orders Nostocales and Oscillatoriales are cyanophytes

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Table 6. Summary of all zooplankton species collected from Kemp Lake Deep Station (1130096) in 2016-2017 (all units in cell/mL) (Dominate species >10% bolded).

	August 15, 2016		February 16, 2017	
	Number	%	Number	%
Order: Cyclopoida				
<i>Diacyclops thomasi</i>				
Adult	36	0.25		
UID Cyclopoida				
Copepodid	57	0.40	40	0.63
Order: Calanoida				
Family: Diaptomidae				
<i>Hesperodiaptomus novemdecimus</i>				
Adult	145	1.0		
<i>Skistodiaptomus oregonensis</i>				
Adult			127	2.0
UID Calanoida				
Copepodid	36	0.25	15	0.24
UID Calanoida/ Cyclopoida	845	5.88	253	4.0
Nauplii				
Order Cladocera				
<i>Bosmina longirostris / longispina</i>	93	0.65	40	0.63
Adult				
<i>Ceriodaphnia reticulata</i>	362	2.52		
Adult				
<i>Daphnia ambigua</i>	16	0.11		
Adult				
<i>Daphnia pulicaria</i>			160	2.53
Adult				
<i>Daphnia thorata</i>			30	0.47
Adult				
<i>Daphnia sp.</i>	40	0.28	25	0.40
Juvenile				
<i>Diaphanosoma brachyurum</i>	443	3.01		
Adult				
<i>Holopedium gibberum</i>	926	6.44		
Adult				
Phylum: Rotifera				
<i>Asplanchna sp.</i>	966	6.93	30	0.47%
<i>Kellicottia longispina</i>	4589	31.93	760	12.03
<i>Keratella cochlearis</i>	2777	19.32	2760	43.67
<i>Keratella quadrata</i>	161	1.12	760	12.03
<i>Polyarthra sp.</i>	2214	15.40	1160	18.35
<i>Testudinella sp.</i>	362	2.51	80	1.27
<i>Trichocerca sp</i>	242	1.68		
UID Rotifera			80	1.27
Order Diptera (Benthic)				
Chaoborus sp.	61	0.41		
Larvae				
Total	14371		6320	

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Table 7. Summary of water quality analyses conducted on samples from Site 1130096, Kemp Lake at Deep Station from 2016-2017.

Parameter	Minimum	Maximum	Average	Std Dev	Count
Ammonia Dissolved (mg/L)	<0.005	0.0306	0.0109	0.0098	6
Carbon Dissolved Organic (mg/L)	4.94	5.97	5.37	0.45	6
Carbon Total Organic (mg/L)	4.87	6.49	5.44	0.61	6
Chlorophyll A (mg/L)	0.0018	0.018	0.0063	0.0078	4
Color True (Col.unit)	11	32.7	23.83	6.49	7
Diss Oxy (mg/L)	0.74	13.43	8.78	4.43	32
Secchi depth (m)	3.33	4.2	3.77	0.615	2
Hardness (Dissolved) (mg/L)	21.8	22.4	22.1	0.42	2
Hardness Total (T) (mg/L)	23.44	23.56	23.50	0.081	2
Mn-D (mg/L)	0.00808	0.0083	0.0082	0.00017	2
Nitrate (NO ₃) Dissolved (mg/L)	0.003	0.383	0.127	0.161	9
Nitrate + Nitrite Diss. (mg/L)	<0.004	0.3846	0.158	0.173	7
Nitrogen - Nitrite Diss. (mg/L)	<0.001	0.0022	0.0013	0.0046	7
Nitrogen Total (mg/L)	0.312	0.59	0.455	0.12	6
ORP (mV)	-105.4	256	94.64	139.35	32
pH (pH units)	6.12	7.52	6.99	0.34	32
P--T (mg/L)	0.0082	0.0228	0.0146	0.0059	8
Specific Conductance (µS/cm)	36	75.1	68.56	3.67	32
Temp (C)	3.57	22.1	11.32	7.20	32
Turbidity (NTU)	0.65	6.15	1.275	0.99	6
Metals	Minimum	Maximum	Average	Std Dev	Count
Ag-D (µg/L)	<0.005	<0.005	<0.005	0	2
Ag-T (µg/L)	<0.005	<0.005	<0.005	0	2
Al-D (mg/L)	0.0789	0.0802	0.080	0.00092	2
Al-T (mg/L)	0.125	0.127	0.126	0.0014	2
As-D (µg/L)	0.077	0.089	0.080	0.00354	2
As-T (µg/L)	0.089	0.089	0.089	0	2
Ba-D (µg/L)	0.954	1.95	1.42	0.514	2
Ba-T (µg/L)	1.12	2.17	1.65	0.541	2
B--D (mg/L)	0.0092	0.0095	0.0094	0.000212	2
Be-D (µg/L)	<0.01	<0.01	<0.01	0	2
Be-T (µg/L)	<0.01	<0.01	<0.01	0	2
Bi-D (µg/L)	<0.005	<0.005	<0.005	0	2
Bi-T (µg/L)	<0.005	<0.005	<0.005	0	2
B--T (mg/L)	0.0079	0.0082	0.0081	0.000212	2
Ca-D (mg/L)	4.96	5.16	5.06	0.1414	2
Ca-T (mg/L)	5.41	5.43	5.42	0.01414	2
Cd-D (µg/L)	<0.005	<0.005	<0.005	0	2
Cd-T (µg/L)	<0.005	<0.005	<0.005	0	2
Co-D (µg/L)	0.0645	0.066	0.0653	0.00106	2
Co-T (µg/L)	0.085	0.088	0.0865	0.00205	2
Cr-D (µg/L)	0.27	0.30	0.285	0.0212	2
Cr-T (µg/L)	0.32	0.33	0.325	0.0071	2
Cu-D (µg/L)	1.39	1.51	1.45	0.085	2
Cu-T (µg/L)	1.62	1.94	1.78	0.23	2
Fe-D (mg/L)	0.12	0.121	0.1205	0.00071	2
Fe-T (mg/L)	0.166	0.173	0.1695	0.00495	2
K--D (mg/L)	0.405	0.41	0.4075	0.00354	2

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K--T (mg/L)	0.414	0.428	0.421	0.0099	2
Metals	Minimum	Maximum	Average	Std Dev	Count
Li-D (µg/L)	<0.5	<0.5	<0.5	0	2
Li-T (µg/L)	<0.5	<0.5	<0.5	0	2
Mg-D (mg/L)	2.29	2.30	2.295	0.071	2
Mg-T (mg/L)	2.40	2.44	2.42	0.0283	2
Mn-D (mg/L)	0.00808	0.00832	0.0082	0.0017	2
Mn-T (mg/L)	0.0109	0.0112	0.01105	0.000212	2
Mo-D (mg/L)	<0.0005	<0.0005	<0.0005	0	2
Mo-T (mg/L)	<0.0005	<0.0005	<0.0005	0	2
Na-D (mg/L)	5.16	5.24	5.20	0.057	2
Na-T (mg/L)	5.67	5.88	5.775	0.148	2
Ni-D (µg/L)	0.298	0.316	0.307	0.0127	2
Ni-T (µg/L)	0.352	0.391	0.372	0.0276	2
Pb-D (µg/L)	0.0385	0.0439	0.0412	0.00382	2
Pb-T (µg/L)	0.0553	0.137	0.09615	0.05778	2
Sb-D (µg/L)	<0.02	<0.02	<0.02	0	2
Sb-T (µg/L)	<0.02	<0.02	<0.02	0	2
Se-D (µg/L)	0.046	0.049	0.0475	0.0021	2
Se-T (µg/L)	0.047	0.048	0.0475	0.000707	2
Si-D (mg/L)	4.53	4.55	4.54	0.0141	2
Si-T (mg/L)	4.91	4.92	4.915	0.00707	2
Sn-D (µg/L)	<0.01	<0.01	<0.01	0	2
Sn-T (µg/L)	<0.01	<0.01	<0.01	0	2
Sr-D (mg/L)	0.0129	0.0130	0.01295	0.07071	2
Sr-T (mg/L)	0.0129	0.0130	0.01295	0.07071	2
Tl-D (µg/L)	0.0043	0.0064	0.00535	0.001485	2
Tl-T (µg/L)	0.0035	0.0037	0.0036	0.0001414	2
U--D (µg/L)	0.0031	0.0035	0.0033	0.000283	2
U--T (µg/L)	0.0036	0.0037	0.00365	0.00007071	2
V--D (µg/L)	0.46	0.48	0.47	0.01414	2
V--T (µg/L)	0.62	0.64	0.63	0.01414	2
Zn-D (µg/L)	2.46	2.53	2.495	0.0495	2
Zn-T (µg/L)	1.66	4.91	3.285	2.298	2

Table 8. Summary of water quality analyses conducted on samples from Site 1130096, Kemp Lake at Deep Station in 2016-2017.

	Minimum	Maximum	Average	Std Dev	Count
Diss Oxy (mg/L)	0.74	13.43	8.78	4.43	32
ORP (mV)	-105.4	256	94.64	139.35	32
pH (pH units)	6.12	7.52	6.99	0.339	32
Specific Conductance (µs/cm)	65	75.1	68.56	3.67	32
Temp (°C)	3.57	23.2	13.33	6.7	32