Enos Lake Water Quality Monitoring Program

2021 Annual Report

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Executive Summary

From February to November 2021, the British Columbia Conservation Foundation (BCCF) conducted water quality sampling in Enos Lake based on a monitoring schedule and sampling procedures outlined in the *Enos Lake Protection and Monitoring Program* (ELPMP).

Data collection was completed with volunteer assistance from the *Friends of Enos Lake*, a dedicated local stewardship group interested in the conservation and protection of the lake and its ecosystem.

Results were sent to a professional limnologist for analysis and review. Sample results indicated that chlorophyll-*a* was within the target, with no significant increase above baseline levels on dates of sample collection. One quarter of the total phosphorous samples (3/12) surpassed the target value (≤12 µg/L) in February, May, and Augustof 2021; however, the annual average was below target. Dissolved oxygen results met the target for the epilimnion (≥5 mg/L) in all months, but did not meet the target for the hypolimnion (≥2 mg/L) in May or August 2021 (and likely into early fall). This occurred from 2017 – 2020 as well, and is thought to be a natural condition of Enos Lake; however, the severity of oxygen depletion in the hypolimnion has increased since 2017 and, concerningly, was noted to extend halfway up into the thermocline in August of 2021. The progression of anoxia beyond the hypolimnion should be closely monitored going forward.

A webpage for Enos Lake data and reports was established in 2021 in partnership with the Mid-Vancouver Island Habitat Enhancement Society, per recommendations of the 2020 final report. This public webpage can be found at https://www.mvihes.bc.ca/current-initiatives/enos-lake.

2021 marks the final year of "base" annual monitoring as per the ELPMP. In 2022, the ELPMP recommends adhering to the 5-year monitoring and water quality protection plan through an expanded monitoring protocol to include additional assessment of metals/hardness, PAHs in lake sediment, and *E. coli*. This sampling is intended to examine 5-year trends, review the monitoring program, and provide feedback for ongoing sustainable watershed management.

Additional suggestions for data accuracy include implementing a QA/QC program to increase confidence in field data collection methods and lab analysis results (e.g., duplicate and field blank samples, duplicate YSI readings on ascent & descent of probes), and additional Secchi readings during the summer, when the lake is stratified (March – November) with at least one or two additional winter readings (December – March).

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Background

An annual water quality monitoring program for Enos Lake was established in 2017 by the British Columbia Conservation Foundation (BCCF), per the management recommendations of the *Enos Lake Protection and Monitoring Plan* (ELPMP) (PGL 2016).

This report summarizes the monitoring of select chemical and physical water quality parameters to evaluate seasonal water quality and productivity status of Enos Lake in 2021, with comparison to established water quality targets. This report also includes suggestions for reporting as outlined in the ELPMP, including:

- A summary of work performed, including dates, individuals, weather conditions, methods, QA/QC protocols, and any challenges encountered during the work.
- A presentation of the water quality results compared against targets in the ELPMP.
- A summary of preventative actions taken with respect to aquatic invasive species in the past year (e.g. signage, educational materials for residents or visitors, etc.).
- Any anecdotal observations related to Enos Lake ecology, including but not limited to aquatic invasive species.
- An interpretation of the results of the program for the past year, conducted by an experienced, qualified limnologist provided in report form, including but not limited to input provided for stormwater management practices or new phases of construction (included as an appendix).
- Recommendations for augmentation to the program, if relevant.
- Laboratory certificates and raw data for the year, as appendices.

1.0 Introduction

Enos Lake is a small, relatively productive lake located on Vancouver Island's Nanoose peninsula (Fig. 1). The lake is approximately 18 ha and surrounded by nearby ponds and wetlands, supporting a wide diversity of birds and aquatic life. The lake is approximately 12 metres at its deepest point, and drains into Enos Creek via a weir established at its north outlet since 1956 (PGL 2016).

Enos Lake is most well-known for the presence of a unique benthic and limnetic stickleback species-pair, protected under the federal Species at Risk Act (SARA). The pair were designated as Threatened in 1988, then re-classified and split into two species separately listed as Endangered in 2002 and renewed in 2012 (Environment Canada 2011). Recent research has suggested the species pair is collapsing due to habitat changes caused by crayfish and/or changes in lake productivity (Taylor et al. 2006; Taylor & Piercey 2018).

Enos Lake undergoes thermal stratification in the summer months, resulting in a warm surface water layer (epilimnion); this layer is separated from the cooler, deeper water (hypolimnion) by a narrow zone of rapid temperature change (thermocline). Solar radiation and wind movement at the water's surface work together to warm the uppermost layer, while the water at depth receives very little sunlight and remains cool and dark. Density differences prevent these two layers from mixing during the summer months.

From fall through early spring, as air temperatures drop and the amount of solar radiation decreases, the warm surface waters gradually cool and densify. Denser water settles down into the hypolimnion and initiates mixing throughout the entire water column, a process known as fall turnover.

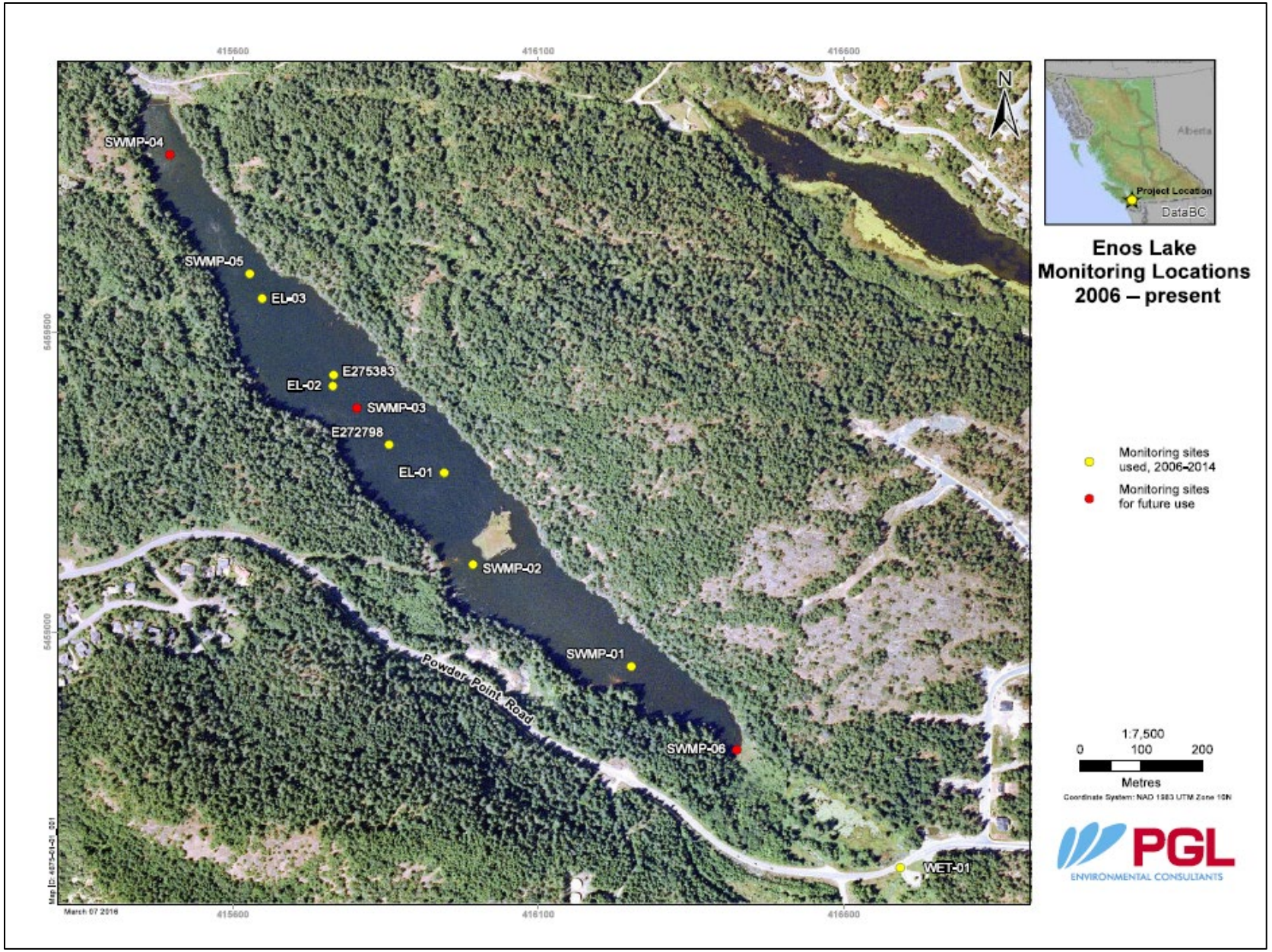

Figure 1: Enos Lake sampling locations (PGL 2016).

2.0 Methods

2.1 Scope of Work

BCCF was contracted to conduct water quality sampling as described in the ELPMP (Table 1) in 2021. Sampling occurred quarterly and field crews consisted of a BCCF biologist with an additional volunteer or staff member. Extra safety precautions had to be taken due to COVID-19, including social distancing, equipment sanitization, and use of face coverings in indoor spaces. Water samples were collected from site SWMP-03 (Fig. 1), located at the deepest part of the lake. The site was accessed by boat with a small electric motor.

Table 1: Proposed ELPMP Monitoring Schedule for 2021 (PGL 2016).

	2021											
Parameter	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Dissolved Oxygen		F			F			F			F	
Temperature		F			F			F			F	
Redox potential		F			F			F			F	
pH		F			F			F			F	
Secchi Depth		F			F			F			F	
Chlorophyl *a*		L			L			L			L	
Phosphorhus		L			L			L			L	
E Coli												
Metals												
Hardness												
PAH												
Legend	***L = Water sample from three depths at SWMP-03***											
	F = 1m in situ profiles from SWMP-03											
	E = Five samples in 30 days, from SWMP-03 and any two shoreline locations.											
	M = Five samples in 30 days, from SWMP-03											
	P = Surface sediment from SWMP-03, SWMP-06 and SWMP-04											

2.2 Data Collection

FIELD EQUIPMENT

The following equipment was utilized for field sampling:

- YSI Professional Plus QUATTRO handheld multi-parameter water quality sonde with probes for Galvanic Dissolved Oxygen, Temperature/Conductivity, pH, and ORP
- Calibration solutions for YSI probes
- 1 L Van Dorn water sampler
- Sample bottles, supplied by ALS Laboratories (Burnaby, BC)
- Chain of Custody (COC) forms, supplied by ALS
- Cooler with ice
- Secchi disk
- Field notebook
- Safety kit (waders, gloves, Personal Flotation Devices (PFDs))
- 10-ft Zodiac with an electric outboard motor

IN SITU FIELD PARAMETERS

In situ water quality parameters were collected once per quarter, beginning in February at site SWMP-03. The YSI handheld sonde was calibrated by a BCCF technician immediately prior to each sampling date and calibration records kept for reference. Results were recorded at 1 m intervals throughout the water column, down to 10-12 m (total site depth). An occasional reading was taken every 0.5m in the thermocline during cases of a steep temperature transition. Parameters included:

- Temperature (°C)
- Dissolved oxygen (mg/L and %)
- pH
- Conductivity (µS/cm)
- Redox potential (mV)

Weather and surface observations were noted on each sampling date. A water clarity measurement was recorded once per quarter using a Secchi disk, between the hours of 10am – 4pm; sunglasses were removed and observations made on the shady side of the boat. The *Friends of Enos Lake* (FoEL) undertook ten additional dates of Secchi monitoring between February – August of 2021, using a non-motorized watercraft for site access.

LABORATORY SAMPLES

Grab samples were collected at 1, 5, and 9.5 or 10 m depths at site SWMP-03 using a 1 L Van Dorn sampler. Samples were collected for chlorophyll-*a* (unfiltered), orthophosphate (raw water) and total phosphorous (preserved H_2SO_4) analyses.

The Van Dorn was rinsed with surface water before each sampling event, and allowed to remain at depth (5 and 9.5 m) for 10 seconds before retrieving samples to ensure mixing within the sampling tube. Sample bottles were pre-labelled and handled to prevent contamination of the interior cap or bottle.

Water sampling procedures followed guidelines provided by ALS, in addition to guidelines outlined in the *Ambient Freshwater and Effluent Sampling Manual* (BC Ministry of Water, Land and Air Protection 2003) and those provided in the ELPMP (PGL 2016). Water samples were transferred to the bottles provided from ALS and packed in a cooler with ice and completed COC form. Samples were immediately shipped to the ALS lab in Burnaby for analysis.

INVASIVE SPECIES

Incidental monitoring for invasive species occurred concurrently with water sampling, through visual observation and assessment of emergent/shallow submerged vegetation seen while travelling to the sample site, and any plant matter on the boat anchor.

HISTORICAL AIR TEMPERATURE AND PRECIPITATION

Data was retrieved from Environment Canada's historical weather database for the Qualicum Beach Airport weather station (Meteorological Service of Canada - Climate ID 1026562), for the period of January 1, 2016 to December 12, 2021. The weather station is located approximately 20 km from the Nanoose peninsula. Data was summarized by daily maximum, mean, and minimum values.

2.3 Analysis

An accredited facility for conducting water quality testing, ALS Laboratories (Burnaby, BC) performed all lab analyses including Quality Assurance/Quality Control (QA/QC) for assessment methods. Results were received by BCCF within one to three weeks of sample submission (Appendix 1).

Data were compiled using MS Excel and summarized using descriptive analyses. All results were sent to professional limnologist John Deniseger for further review and comparison to water quality guidelines and data previously collected for Enos Lake. Deniseger's analysis is summarized in "*Enos Lake Protection and Monitoring Program: Review of 2021 Water Quality Data*" (Appendix 2).

3.0 Results

Water quality targets as listed in the ELPMP are summarized in Table 2. Each parameter is discussed in detail in Deniseger (2021) (Appendix 2).

Table 2: Summary of Water Quality Monitoring Targets for data collected in 2021 (PGL 2016).

Parameter (units)		Water Quality Target
***In situ* parameters**	Secchi depth (m)	None - supporting context only
	Dissolved Oxygen (mg/L)	≥5 mg/L epilimnion ≥2 mg/L hypolimnion
	Conductivity (µS/cm)	None - supporting context only
	Temperature (°C)	None - supporting context only
	pH	None - supporting context only
	Redox (mV)	None - supporting context only
Lab result	Total phosphorous	≤12 µg/L
	Chlorophyll-a	Avoid any increase [1]

[1] Chlorophyll-*a* baseline data for Enos Lake (2009-2013) ranges from 0.17 to 19.8 µg/L; values are typically in the range of 4-5 µg/L (PGL 2016).

3.1 Air temperature and precipitation

Mean daily air temperature and precipitation data is summarized in Figure 2. A comparison of the mean monthly air temperature and precipitation for the summer period (June – September) is provided in Table 3.

Mean monthly air temperature in June of 2021 (17.8 °C) was approximately 3 degrees warmer than in June of 2020 (14.9 °C; Table 3). Maximum daily air temperature (28.4 °C on June 28, 2021) was just under 5 degrees warmer than the previous recorded maximum (23.7 °C on June 18, 2018) (Fig. 2). This indicates it was a very hot June compared to past years.

Relative to the 5-year (2016-2020) mean monthly average, precipitation in 2021 was 124% (June), 3% (July), 40% (August), and 200% (September) (Table 3). This indicates it was a dry mid-summer and wet early fall relative to past years.

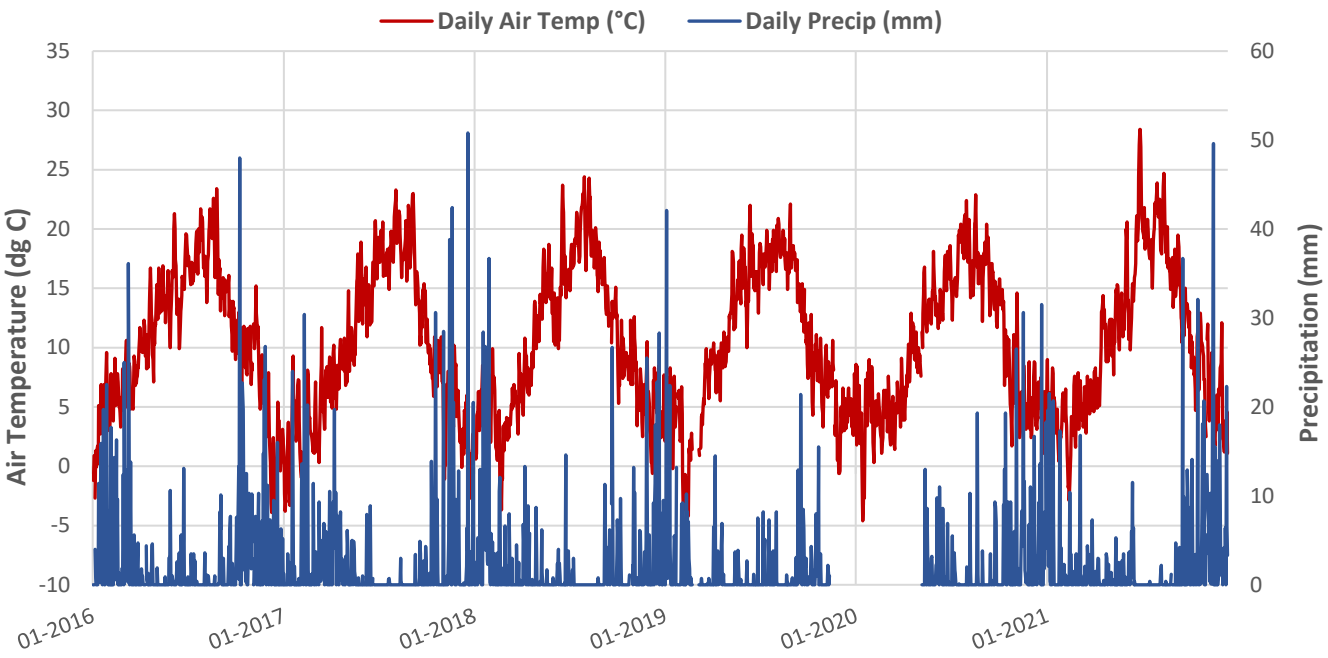

Figure 2: Mean daily air temperature and precipitation for the Qualicum Beach Airport, 2016-2021 (Environment Canada 2021).

Table 3: Mean monthly air temperature and precipitation for the Qualicum Beach Airport, Jun-Sep 2016-2021 (Environment Canada 2021).

xx	Warmest mean monthly air temperature (since 2016)

Mean monthly precip < 0.5 mm	Mean monthly precip 0.5 ≤ 1.0 mm	Mean monthly precip > 1.0 mm

JUNE						
	2016	**2017**	**2018**	**2019**	**2020**	**2021**
Air temp (°C)	15.8	15.3	15.2	16.1	14.9	17.8
Precipitation (mm)	1.2	0.6	1.2	0.4	1.8	1.3

JULY						
	2016	**2017**	**2018**	**2019**	**2020**	**2021**
Air temp (°C)	17.9	18.0	19.3	17.8	17.6	19.8
Precipitation (mm)	0.5	0.0	0.2	0.9	0.5	0.0

AUGUST						
	2016	**2017**	**2018**	**2019**	**2020**	**2021**
Air temp (°C)	18.7	19.2	18.8	18.4	17.1	18.9
Precipitation (mm)	0.5	0.1	0.0	0.3	1.2	0.2

SEPTEMBER						
	2016	**2017**	**2018**	**2019**	**2020**	**2021**
Air temp (°C)	13.6	15.5	14.0	14.6	15.9	14.4
Precipitation (mm)	1.5	0.7	3.0	2.5	1.0	3.5

3.2 In situ Field Parameters

A summary of *in situ* field parameters is provided in Tables 4 and 5. Parameters of interest are discussed here, while each parameter is discussed in detail in Deniseger (2021) (Appendix 2).

WATER CLARITY

Water clarity dropped to a minimum of 0.8 m in February before rebounding >3.0 m into May-June. A slight decrease occurred in early July (2.6 m), before increasing again to a maximum of 4.0 m in mid-August. After the second peak in mid-August, clarity gradually decreased into November (Table 4).

TEMPERATURE

Water temperature varied widely with the season and the lake's thermal stratification. The lake was relatively isothermal in February and November, but exhibited strong thermal stratification in May and August. The maximum recorded water temperature was 21.5 °C, at 0.5–2 m below the surface on August 23 (Table 5).

DISSOLVED OXYGEN

The water quality target (>5 mg/L for the epilimnion) was met throughout the year, however the water qulity target for the hypolimnion (>2 mg/L) was not met during May or August sampling. Severely anoxic conditions had developed below the thermocline or, in the case of the August lake profile, were creeping up into the mid-point of the thermocline (Table 5). By November, DO values had returned to acceptable levels.

Table 4: Secchi Depth Summary from Enos Lake 2021 Water Quality Monitoring.

Date	Time	Site	Secchi (m)	Collected by
Feb 7, 2021	13:00	SWMP-03	2.0	PL
Feb 7, 2021	13:00	SWMP-03	1.6	PL
Feb 23, 2021	10:45	SWMP-03	0.8	TR
May 18, 2021	11:45	SWMP-03	3.3	TR
May 30, 2021	N/a	SWMP-03	3.4	PL
June 20, 2021	11:00	SWMP-03	3.8	PL
July 3, 2021	12:45	SWMP-03	2.6	PL
July 28, 2021	13:38	SWMP-03	3.0	PL
August 3, 2021	11:35	SWMP-03	3.3	PL
August 10, 2021	13:51	SWMP-03	3.5	PL
August 15, 2021	14:45	SWMP-03	4.0	PL
August 23, 2021	10:15	SWMP-03	3.9	TR
August 29, 2021	14:30	SWMP-03	3.7	PL
November 15, 2021	10:15	SWMP-03	1.7	TR

Table 5: Summary of *in situ* Results from Enos Lake 2021 Water Quality Monitoring.

1st Quarter Sampling	Crew: TR, TN	Site: SWMP-03	Weather: Windy, choppy, <10 °C			
	Date: Feb 23, 2021	Time: 10:40	Staff gauge: 1.06m			Secchi: 0.82 m
	Depth (m)	Temp. (°C)	D.O. (mg/L)	D.O. (%)	pH	Sp.Con. (µS/cm)	Redox (mV)
Isothermal	0.5	3.9	12.73	96.5	7.08	118.1	188.3
	1	3.7	12.51	94.8	7.00	117.9	199.2
	2	3.8	12.32	93.5	6.86	117.8	212.9
	3	3.8	12.31	93.4	6.81	117.9	224.0
	4	3.8	12.20	92.7	6.81	117.9	232.4
	5	3.8	12.29	93.3	6.81	117.9	236.4
	6	3.8	12.33	93.9	6.84	117.8	242.6
	7	3.8	11.93	90.3	6.86	117.9	246.2
	8	3.8	12.00	91.0	6.88	117.9	249.6
	9	3.8	11.79	89.6	6.90	117.9	252.1
	10	3.8	11.63	88.3	6.94	117.9	255.9
	10	3.8	11.69	88.7	6.94	118.3	257.8
2nd Quarter Sampling	Crew: TR, ER	Site: SWMP-03	Weather: Overcast, light breeze, ~ 18 °C			
	Date: May 18, 2021	Time: 11:40	Staff gauge: 0.90m			Secchi: 3.3 m
	Depth (m)	Temp. (°C)	D.O. (mg/L)	D.O. (%)	pH	Sp.Con. (µS/cm)	Redox (mV)
Epi	0.5	17.9	8.32	87.8	7.28	117.7	187.0
	1	17.9	8.54	90.0	7.41	117.7	186.5
	2	17.7	7.64	80.2	7.42	117.6	186.9
Thermocline	3	17.1	8.08	83.7	7.19	117.1	190.2
	3.5	14.8	9.52	94.5	7.32	114.9	181.4
	4	12.3	10.39	97.2	7.31	112.8	198.3
	5	10.6	9.17	82.1	7.08	112.5	191.7
	6	9.3	8.98	78.2	6.88	112.5	200.2
	7	8.3	7.30	62.2	6.74	113.0	205.2
Hyp	8	7.8	5.50	46.3	6.56	114.2	208.3
	9	7.5	2.83	23.6	6.47	117.5	210.5
	10	7.4	1.08*	9.0	6.4	120.7	212.0
	11	7.3	0.57*	4.8	6.36	121	211.5
3rd Quarter Sampling	Crew: TR, TN	Site: SWMP-03	Weather: Sunny, clear, calm, ~ 20 °C			
	Date: Aug 23, 2021	Time: 10:00	Staff gauge: 0.38m			Secchi: 3.9 m
	Depth (m)	Temp. (°C)	D.O. (mg/L)	D.O. (%)	pH	Sp.Con. (µS/cm)	Redox (mV)
Epi	0.5	21.5	7.41	86.1	7.86	137.2	181.8
	1	21.5	7.44	84.8	7.92	137.2	179.6
	2	21.5	7.29	81.20	7.91	137.2	179.4
	3	21.4	7.24	81.90	7.91	137.3	178
Thermocline	4	20.7	7.05	78.6	7.8	134.8	179.9
	4.5	19.3	6.55	70.8	7.51	126.0	183.9
	5	15.6	4.56	45.6	7.12	121.4	188.3
	6	11.8	0.21*	2.1	6.33	122.5	207.5
	7	9.6	0.11*	1.0	6.33	124.2	208.1
	8	8.6	0.07*	0.6	6.3	131.9	183
Hyp	9	8.1	0.05*	0.5	6.26	144.9	52.6
	10	8	0.05*	0.4	6.25	149.4	-64.6
	11	7.9	0.05*	0.4	6.29	151.7	-138.8
4th Quarter Sampling	Crew: TR, AA	Site: SWMP-03	Weather: Overcast, calm ~ 6 °C			
	Date: Nov 16, 2021	Time: 10:15	Staff gauge: 1.22m			Secchi: 1.7 m
	Depth (m)	Temp. (°C)	D.O. (mg/L)	D.O. (%)	pH	Sp.Con. (µS/cm)	Redox (mV)
Isothermal	0.5	8.1	9.85	84.0	6.73	122.5	222.3
	1	8.1	9.94	83.8	6.79	122.6	220
	2	8	9.65	81.4	6.83	122.5	217.1
	3	8	9.48	80.4	6.85	122.7	215.6
	4	8	9.54	80.4	6.88	122.7	213.4
	5	8	10.03	84.8	6.92	122.7	210.4
	6	8	9.83	83.6	6.95	122.7	208.4
	7	8	9.89	83.5	6.97	122.8	206.4
	8	8	9.58	81.0	6.98	122.8	205.2
	9	8	9.65	80.8	6.99	122.4	204.3
	10	8	9.22	78.2	6.99	122.1	203.5
	11	7.9	9.74	82.0	7.00	121.7	201.8
	12	8	6.02	54.9	6.47	146.3	67.0

* = Dissolved Oxygen (mg/L)) values below the water quality targets of 5 mg/L in the epilimnion or 2 mg/L in the hypolimnion (per the ELPMP; PGL 2016).

3.3 Laboratory Samples

A summary of laboratory sample results is provided in Table 6. Each parameter is discussed in detail in Deniseger (2021) (Appendix 2).

PHOSPHOROUS

In 2021, the mean annual Total P was below the water quality target of 12 µg/L (Table 2), at 10.7 µg/L (*SD* = 4.3).

This target threshold was exceeded by individual samples on three occasions from February – August of 2021 (Table 6).

In 2019, the mean annual across all samples was also well below target at 7.3 µg/L (*SD* = 5.0). In 2020, 2018 and 2017, the averages were at or above the target at 12.0 µg /L (*SD* = 2.5), 16.6 µg/L (*SD* = 10.6), and 20.4 µg/L (*SD* = 11.1), respectively.

Orthophosphate was relatively undetectable in 2021, with values below the laboratory Reported Detection Limit (RDL) of 1 µg/L for almost all samples, except one result of 1.1 µg/L on February 23 at 1m depth.

CHLOROPHYLL-A

In 2021, chlorophyll-*a* values were well below the upper limit of 19.8 µg/L as specified in the ELPMP (Table 2). The maximum chlorophyll-*a* concentration was 9.7 µg/L, collected on August 23 at 9.5 m depth.

The mean annual chlorophyll-*a* across all depths and dates in 2021 was 6.9 µg/L (*SD* = 2.5). This is the second lowest mean annual result, just slightly higher than the year 2019 (*M* = 4.5 µg/L, *SD* =2.2) but well below the years 2020 (*M* = 9.21 µg/L, *SD* = 4.97), 2018 (*M* = 10.22 µg/L, *SD* = 3.65) and 2017 (*M* = 10.55 µg/L, *SD* = 6.52).

3.4 Invasive Species

No invasive species were noted during field sampling in 2021.

Table 6: Summary of Laboratory Results from Enos Lake 2021 Water Quality Monitoring.

			Date	Feb 23, 2021			May 18, 2021			Aug 23, 2021			Nov 16, 2021		
			Site	SWMP-03			SWMP-03			SWMP-03			SWMP-03		
	Units	**RDL [1]**		**1 m**	**5 m**	**10 m**	**1 m**	**5 m**	**9.5 m**	**1 m**	**5 m**	**9.5 m**	**1 m**	**5 m**	**10 m**
Chlorophyll-*a*	µg/L	0.50		7.38	6.92	8.89	1.95	3.87	6.99	3.69	7.2	9.7	9.66	9.45	6.83
Anions															
Orthophosphate-Dissolved (as P)	mg/L	0.001		0.0011	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nutrients															
Total Phosphorus (P)	mg/L	0.002		**0.0139 [2]**	0.0116	0.0093	0.0063	0.0094	**0.0157 [2]**	0.0042	0.0076	**0.0192 [2]**	0.0120	0.0069	0.0120

[1] RDL = Reportable Detection Limit

[2] Total phosphorous (Total P) values exceeding the water quality target of ≤12 µg/L

4.0 Discussion

The primary intent of the Enos Lake monitoring program is to better understand the lake's productivity trends (PGL 2016; Deniseger 2019) and to build a consistent, long-term database to assess the overall health of Enos Lake with respect to ongoing development, land use, and increasing population within the watershed (Deniseger 2020; Nordin 2017; PGL 2016). The general management objective for Enos Lake is to maintain pre-development water quality and to avoid eutrophication (PGL 2016).

Watershed disturbances such as logging, road building, development, and climate change impacts all have potential to shift the lake's trophic status through increased stormwater runoff, nutrient loading, rising air and water temperatures, and seasonal variability in precipitation. Therefore, it is important to take surrounding land use and seasonal climate patterns into account when interpreting the water quality trends of Enos Lake.

4.1 Air temperature and precipitation

A strong “heat dome” event in early summer 2021 influenced weather patterns for the east coast of Vancouver Island (Deniseger 2021; Environment Canada 2021).

Hourly air temperatures in June frequently peaked at 35-40 °C for several consecutive days. There was little to no precipitation recorded between mid-June and early September (Fig. 2), characterizing the summer of 2021 as being hot and dry.

This was followed by relatively early fall rains beginning in mid-September, and a significant storm pattern, widely reported as an “atmospheric river”, causing significant precipitation in the month of November.

This type of early season hot/dry and late season warm/wet weather pattern is predicted to occur more frequently as the impacts of climate change unfold over time. Long-term trends of warming air and water temperatures will cause summer stratification to begin earlier and extend later in the year (Deniseger 2021).

4.2 In situ Field Parameters

WATER CLARITY

Secchi depth is a relatively simple measure of clarity, which can provide insight into lake health and productivity (Deniseger 2021). The Secchi readings collected in 2021 followed a similar trend as in 2020, indicating an early spring phytoplankton bloom occurred in late February.

The advantage of additional Secchi depth observations collected by FoEL throughout the year is it allows for a broader understanding of Enos Lake's ecological dynamics. Monthly Secchi readings should continue, as it is a relatively inexpensive and simple way to gain additional insight into blooms or sediment loading.

TEMPERATURE

Enos Lake usually begins to thermally stratisfy as early as March – April, and undergoes fall turnover between October – November (Nordin 2017 and Deniseger 2018).

In 2021 and 2020, isothermal mixing was noted in February while a strong stratification was observed in May, suggesting adherence to this typical spring pattern. Stratification continued through late summer, contributing to the strongly anoxic conditions observed below 5m depth in August (Deniseger 2021).

Water temperature influences several other chemical and physical water quality parameters, and influences a lake's susceptibility to watershed activities and disturbance. It has a significant and pronounced effect on stratification and mixing (Deniseger 2021).

DISSOLVED OXYGEN

DO concentration targets for the hypolimnion (≥2 mg/L) were not met in May or August of 2021. Per Deniseger (2021), "a very steep, compressed thermocline was observed in August, particularly between 4.5 and 6 meters […] This strong thermocline is continuous at least from mid-spring through early fall, effectively isolating the deeper waters of the lake."

Mid-summer anoxia recorded in 2021 was at its most extreme since the start of monitoring, with an average DO in the hypolimnion of 0.05 mg/L that extended well up into the thermocline. This is compared to DO concentrations (in the hypolimnion only) of 0.05 mg/L, 0.09 mg/L, 0.25 mg/L and 1.27 mg/L in 2020, 2019, 2018 and 2017, respectively (BCCF 2020; BCCF 2019; BCCF 2018; BCCF 2017).

A strong thermocline, paired with biological decomposition of organic matter at the lake bottom, results in severe oxygen depletion within the hypolimnion. Enos Lake is frequently subjected to low oxygen (hypoxic) conditions in the hypolimnion during the summer (≤1 mg/L) which is likely a naturally existing condition of the lake ecosystem (MESL 2014; PGL 2016). However, the hot and dry summer weather pattern in 2021 compressed and steepened the thermocline in Enos Lake to a degree not seen in previous monitoring years.

These conditions are capable of producing a late summer fish die-off due to oxygen depletion (Deniseger 2021). A trend of worsening hypoxia at depth should be closely monitored in summer to ensure the oxygen depletion does not extend too far up into the thermocline, restricting the habitable range for aquatic life. If the hypolimnion volume increases and dwarfs the epilimnion, it could cause total die-offs for fish in the event of late summer mixing or fall turnover, bringing the entire lake below suitable oxygen levels for aquatic life (Deniseger 2021).

4.3 Laboratory Samples

PHOSPHOROUS

In lakes, phosphorus is an important nutrient and key indicator of productivity; excessive phosphorus can result in blooms and subsequent low dissolved oxygen levels, impacting water quality and fish health (Deniseger 2021). Mean annual Total P results suggest the productivity of Enos Lake in 2021 remained below the target threshold of 12 µg/L. The highest individual Total P concentrations were measured in

May (15.7 µg /L) and August (19.2 µg /L), reflecting prolonged oxygen deficit in the hypolimnion and internal loading of phosphorus from lake sediments (Deniseger 2021).

CHLOROPHYLL-A

The concentration of chlorophyll-*a*, a major photosynthetic pigment of algae, is an indicator of the amount of algae in water and is another parameter used to assess biological productivity of Enos Lake. A target for Enos Lake outlined in the ELPMP was to avoid any increase in chlorophyll-*a* over time from the baseline values ranging from 0.17 – 19.8 µg/L (Table 2). Based on the data gathered over the last 5 years, this target has thus far been met.

General trophic status classification using Total P and chlorophyll-*a* is summarized in Table 6 below, per comments in Deniseger (2021).

Table 7: Summary of trophic status classification based on chlorophyll-*a* and total phosphorous.

Total phosphorous	<10 µg/L [1]	Oligotrophic
	10 - 30 µg/L [1]	Mesotrophic
	>30 µg/L [1]	Eutrophic
Chlorophyll-*a*	<2 µg/L	Oligotrophic
	2 - 7 µg/L	Mesotrophic
	>7 µg/L	Eutrophic

[1] In lakes with longer residence times (>1 year), the Total P assessment is based on concentrations at spring overturn, prior to the establishment of a thermocline. In lakes with shorter residence times (<1 year), it is based on an annual mean.

Using the assessment methods in Table 7 for Total P, Enos Lake would be considered mesotrophic (or moderately productive) in 2021, 2020, 2018 and 2017, but oligotrophic (low productivity) in 2019. Using the assessment of mean chlorophyll-*a* concentration, Enos Lake would be considered mesotrophic in 2021 and 2019, whereas 2020, 2018 and 2017 were indicative of a eutrophic (high productivity) lake.

This year-to-year variability highlights the importance of building a longer term dataset which can help illustrate trends over time. All results are discussed in further detail in Deniseger (2021) (Appendix 2).

As lakes become more eutrophic, there is a higher risk of algae blooms which can lead to lower oxygen levels and impaired water quality. Once lakes become eutrophic, it is very difficult to reverse the process; prevention of eutrophication is a far more effective tool in protecting lake water quality (Deniseger 2021).

Preventative measures include avoiding additional nutrient loading caused by land disturbance and runoff, which can achieved through preservation of native vegetation and wide riparian buffers, avoidance of pavement or large lawnscapes in favour of permeable pavements or forested landscapes, sediment mitigation measures during construction, and a stormwater management plan to capture and treat runoff (WDNR 2006).

4.4 Invasive Species

A BCCF biologist trained in aquatic invasive plant ID attended all sampling dates and made incidental observations of aquatic and terrestrial plants, per recommendations in the ELPMP (PGL 2016). No aquatic invasive species were noted again in 2021. A draft of invasive species awareness signage was further refined in partnership with the FoEL and the BC Invasive Species Council, and submitted in 2021 for review and feedback.

5.0 Recommendations

- Ongoing monitoring and water quality protection efforts will help prevent Enos Lake from undergoing significant detrimental change in productivity. Future monitoring should, at minimum, follow the suggested schedule and guidelines as laid out in the ELPMP (PGL 2016).

- Of specific concern in 2021, a trend of intensifying hypoxia at depth and extending into the thermocline prompts paying close attention to lake stratification intensity in the coming years.

- 2021 again showed the value of additional Secchi measurements. This should continue, as volunteer capacity allows, during the summer when the lake is stratified (March – November) and at least one or two additional winter readings (December – March).

- A 5-year expanded monitoring protocol is recommended for 2022, including monitoring for metals/hardness, PAHs in lake sediment, and *E. coli* per the ELPMP (Appendix 3). The purpose of this expanded monitoring is to examine trends, review the monitoring program, and provide feedback for ongoing sustainable watershed management.

- Additional suggestions for data accuracy include implementing a QA/QC program to increase confidence in field data collection methods and lab analysis results (e.g., duplicate and field blank samples, duplicate YSI readings on ascent & descent of probes).

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Appendix 1

Laboratory results

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **VA21A3306**	Page	: 1 of 2
Client	: **The British Columbia Conservation Foundation**	Laboratory	: Vancouver - Environmental
Contact	: Thea Rodgers	Account Manager	: Sneha Sansare
Address	: 7217 Lantzville Road Suite 1 Lantzville BC Canada V0R 2H0	Address	: 8081 Lougheed Highway Burnaby BC Canada V5A 1W9
Telephone	: 250-390-2525	Telephone	: +1 604 253 4188
Project	: Enos Lake - 1301073	Date Samples Received	: 24-Feb-2021 08:20
PO	: ----	Date Analysis Commenced	: 24-Feb-2021
C-O-C number	: 20-905695	Issue Date	: 02-Mar-2021 13:00
Sampler	: TN/TR/PST		
Site	: ----		
Quote number	: Q78255 - Standing offer		
No. of samples received	: 3		
No. of samples analysed	: 3		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QC Interpretive report to assist with Quality Review and Sample Receipt Notification (SRN).

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is conducted in accordance with US FDA 21 CFR Part 11.

Signatories	*Position*	*Laboratory Department*
Lindsay Gung	Supervisor - Water Chemistry	Inorganics, Burnaby, British Columbia
Tracy Harley	Supervisor - Water Quality Instrumentation	Inorganics, Burnaby, British Columbia

General Comments

The analytical methods used by ALS are developed using internationally recognized reference methods (where available), such as those published by US EPA, APHA Standard Methods, ASTM, ISO, Environment Canada, BC MOE, and Ontario MOE. Refer to the ALS Quality Control Interpretive report (QCI) for applicable references and methodology summaries. Reference methods may incorporate modifications to improve performance.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Please refer to Quality Control Interpretive report (QCI) for information regarding Holding Time compliance.

Key : CAS Number: Chemical Abstracts Services number is a unique identifier assigned to discrete substances
LOR: Limit of Reporting (detection limit).

Unit	*Description*
µg/L	micrograms per litre
mg/L	milligrams per litre

<: less than.

>: greater than.

Surrogate: An analyte that is similar in behavior to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED on SRN or QCI Report, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical results in reports identified as "Preliminary Report" are considered authorized for use.

Analytical Results

Sub-Matrix: **Water** (Matrix: **Water**)				*Client sample ID*	**SWMP 03 (1m)**	**SWMP 03 (5m)**	**SWMP 03 (10m)**	**----**	**----**
				Client sampling date / time	23-Feb-2021 11:20	23-Feb-2021 11:25	23-Feb-2021 11:30	----	----
Analyte	*CAS Number*	*Method*	*LOR*	*Unit*	**VA21A3306-001**	**VA21A3306-002**	**VA21A3306-003**	**--------**	**--------**
					Result	Result	Result	----	----
Anions and Nutrients									
phosphate, ortho-, dissolved (as P)	14265-44-2	E378-U	0.0010	mg/L	0.0011	<0.0010	<0.0010	----	----
phosphorus, total	7723-14-0	E372-U	0.0020	mg/L	0.0139	0.0116	0.0093	----	----
Plant Pigments									
chlorophyll a	479-61-8	E870	0.010	µg/L	7.38	6.92	8.89	----	----

Please refer to the General Comments section for an explanation of any qualifiers detected.

QUALITY CONTROL INTERPRETIVE REPORT

Work Order	: **VA21A3306**	Page	: 1 of 6
Client	: **The British Columbia Conservation Foundation**	Laboratory	: Vancouver - Environmental
Contact	: Thea Rodgers	Account Manager	: Sneha Sansare
Address	: 7217 Lantzville Road Suite 1 Lantzville BC Canada V0R 2H0	Address	: 8081 Lougheed Highway Burnaby, British Columbia Canada V5A 1W9
Telephone	: 250-390-2525	Telephone	: +1 604 253 4188
Project	: Enos Lake - 1301073	Date Samples Received	: 24-Feb-2021 08:20
PO	: ----	Issue Date	: 02-Mar-2021 12:58
C-O-C number	: 20-905695		
Sampler	: TN/TR/PST		
Site	: ----		
Quote number	: Q78255 - Standing offer		
No. of samples received	: 3		
No. of samples analysed	: 3		

This report is automatically generated by the ALS LIMS (Laboratory Information Management System) through evaluation of Quality Control (QC) results and other QA parameters associated with this submission, and is intended to facilitate rapid data validation by auditors or reviewers. The report highlights any exceptions and outliers to ALS Data Quality Objectives, provides holding time details and exceptions, summarizes QC sample frequencies, and lists applicable methodology references and summaries.

Key

Anonymous: Refers to samples which are not part of this work order, but which formed part of the QC process lot.
CAS Number: Chemical Abstracts Services number is a unique identifier assigned to discrete substances.
DQO: Data Quality Objective.
LOR: Limit of Reporting (detection limit).
RPD: Relative Percent Difference.

Summary of Outliers

Outliers : Quality Control Samples

- No Method Blank value outliers occur.
- No Duplicate outliers occur.
- No Laboratory Control Sample (LCS) outliers occur
- No Matrix Spike outliers occur.
- No Test sample Surrogate recovery outliers exist.

Outliers: Reference Material (RM) Samples

- No Reference Material (RM) Sample outliers occur.

Outliers : Analysis Holding Time Compliance (Breaches)

- No Analysis Holding Time Outliers exist.

Outliers : Frequency of Quality Control Samples

- No Quality Control Sample Frequency Outliers occur.

Analysis Holding Time Compliance

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times, which are selected to meet known provincial and /or federal requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by organizations such as CCME, US EPA, APHA Standard Methods, ASTM, or Environment Canada (where available). Dates and holding times reported below represent the first dates of extraction or analysis. If subsequent tests or dilutions exceeded holding times, qualifiers are added (refer to COA).

If samples are identified below as having been analyzed or extracted outside of recommended holding times, measurement uncertainties may be increased, and this should be taken into consideration when interpreting results.

Where actual sampling date is not provided on the chain of custody, the date of receipt with time at 15:00 is used for calculation purposes.

Where only the sample date without time is provided on the chain of custody, the sampling date at 15:00 is used for calculation purposes.

Matrix: **Water**

Evaluation: × = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group / Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times Rec	Holding Times Actual	Eval	Analysis Date	Holding Times Rec	Holding Times Actual	Eval
Anions and Nutrients : Dissolved Orthophosphate by Colourimetry (Ultra Trace Level)										
HDPE SWMP 03 (10m)	E378-U	23-Feb-2021	----	----	----		24-Feb-2021	3 days	1 days	✓
Anions and Nutrients : Dissolved Orthophosphate by Colourimetry (Ultra Trace Level)										
HDPE SWMP 03 (1m)	E378-U	23-Feb-2021	----	----	----		24-Feb-2021	3 days	1 days	✓
Anions and Nutrients : Dissolved Orthophosphate by Colourimetry (Ultra Trace Level)										
HDPE SWMP 03 (5m)	E378-U	23-Feb-2021	----	----	----		24-Feb-2021	3 days	1 days	✓
Anions and Nutrients : Total Phosphorus by Colourimetry (Ultra Trace)										
Amber glass total (sulfuric acid) SWMP 03 (10m)	E372-U	23-Feb-2021	25-Feb-2021	28 days	2 days	✓	26-Feb-2021	25 days	0 days	✓
Anions and Nutrients : Total Phosphorus by Colourimetry (Ultra Trace)										
Amber glass total (sulfuric acid) SWMP 03 (1m)	E372-U	23-Feb-2021	25-Feb-2021	28 days	2 days	✓	26-Feb-2021	25 days	0 days	✓
Anions and Nutrients : Total Phosphorus by Colourimetry (Ultra Trace)										
Amber glass total (sulfuric acid) SWMP 03 (5m)	E372-U	23-Feb-2021	25-Feb-2021	28 days	2 days	✓	26-Feb-2021	25 days	0 days	✓
Plant Pigments : Chlorophyll-a by Fluorometry										
Opaque HDPE SWMP 03 (10m)	E870	23-Feb-2021	25-Feb-2021	2 days	1 days	✓	28-Feb-2021	28 days	3 days	✓

Matrix: **Water**

Evaluation: × = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group / Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times Rec	Holding Times Actual	Eval	Analysis Date	Holding Times Rec	Holding Times Actual	Eval
Plant Pigments : Chlorophyll-a by Fluorometry										
Opaque HDPE										
SWMP 03 (1m)	E870	23-Feb-2021	25-Feb-2021	2 days	1 days	✓	28-Feb-2021	28 days	3 days	✓
Plant Pigments : Chlorophyll-a by Fluorometry										
Opaque HDPE										
SWMP 03 (5m)	E870	23-Feb-2021	25-Feb-2021	2 days	1 days	✓	28-Feb-2021	28 days	3 days	✓

Legend & Qualifier Definitions

Rec. HT: ALS recommended hold time (see units).

Quality Control Parameter Frequency Compliance

The following report summarizes the frequency of laboratory QC samples analyzed within the analytical batches (QC lots) in which the submitted samples were processed. The actual frequency should be greater than or equal to the expected frequency.

Matrix: **Water**

Evaluation: × = *QC frequency outside specification*; ✓ = *QC frequency within specification.*

Quality Control Sample Type			Count		Frequency (%)		
Analytical Methods	*Method*	*QC Lot #*	*QC*	*Regular*	*Actual*	*Expected*	*Evaluation*
Laboratory Duplicates (DUP)							
Dissolved Orthophosphate by Colourimetry (Ultra Trace Level)	E378-U	154978	1	14	7.1	5.0	✓
Total Phosphorus by Colourimetry (Ultra Trace)	E372-U	155261	1	13	7.6	5.0	✓
Laboratory Control Samples (LCS)							
Chlorophyll-a by Fluorometry	E870	155235	1	11	9.0	5.0	✓
Dissolved Orthophosphate by Colourimetry (Ultra Trace Level)	E378-U	154978	1	14	7.1	5.0	✓
Total Phosphorus by Colourimetry (Ultra Trace)	E372-U	155261	1	13	7.6	5.0	✓
Method Blanks (MB)							
Chlorophyll-a by Fluorometry	E870	155235	1	11	9.0	5.0	✓
Dissolved Orthophosphate by Colourimetry (Ultra Trace Level)	E378-U	154978	1	14	7.1	5.0	✓
Total Phosphorus by Colourimetry (Ultra Trace)	E372-U	155261	1	13	7.6	5.0	✓
Matrix Spikes (MS)							
Dissolved Orthophosphate by Colourimetry (Ultra Trace Level)	E378-U	154978	1	14	7.1	5.0	✓
Total Phosphorus by Colourimetry (Ultra Trace)	E372-U	155261	1	13	7.6	5.0	✓

Methodology References and Summaries

The analytical methods used by ALS are developed using internationally recognized reference methods (where available), such as those published by US EPA, APHA Standard Methods, ASTM, ISO, Environment Canada, BC MOE, and Ontario MOE. Reference methods may incorporate modifications to improve performance (indicated by "mod").

Analytical Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
Total Phosphorus by Colourimetry (Ultra Trace)	E372-U Vancouver - Environmental	Water	APHA 4500-P E (mod).	Total Phosphorus is determined colourimetrically using a discrete analyzer after heated persulfate digestion of the sample.
Dissolved Orthophosphate by Colourimetry (Ultra Trace Level)	E378-U Vancouver - Environmental	Water	APHA 4500-P E (mod)	Dissolved Orthophosphate is determined colourimetrically on a water sample that has been lab or field filtered through a 0.45 micron membrane filter. Field filtration is recommended to ensure test results represent conditions at time of sampling.
Chlorophyll-a by Fluorometry	E870 Vancouver - Environmental	Water	EPA 445.0 (mod)	Chlorophyll a is determined by a 90 % acetone extraction followed with analysis by fluorometry using the non-acidification procedure. This method is not subject to interferences from chlorophyll b. Sample volume provided by client.

Preparation Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
Digestion for Total Phosphorus in water	EP372 Vancouver - Environmental	Water	APHA 4500-P E (mod).	Samples are heated with a persulfate digestion reagent.
Chlorophyll-a Extraction	EP870 Vancouver - Environmental	Water	EPA 445.0 (mod)	Chlorophyll a is determined by a 90 % acetone extraction followed with analysis by fluorometry using the non-acidification procedure. This method is not subject to interferences from chlorophyll b. Sample volume provided by client.

QUALITY CONTROL REPORT

Work Order	: **VA21A3306**	Page	: 1 of 3
Client	: The British Columbia Conservation Foundation	Laboratory	: Vancouver - Environmental
Contact	: Thea Rodgers	Account Manager	: Sneha Sansare
Address	: 7217 Lantzville Road Suite 1 Lantzville BC Canada V0R 2H0	Address	: 8081 Lougheed Highway Burnaby, British Columbia Canada V5A 1W9
Telephone	: 250-390-2525	Telephone	: +1 604 253 4188
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PO	: ----	Date Analysis Commenced	: 24-Feb-2021
C-O-C number	: 20-905695	Issue Date	: 02-Mar-2021 12:58
Sampler	: TN/TR/PST		
Site	: ----		
Quote number	: Q78255 - Standing offer		
No. of samples received	: 3		
No. of samples analysed	: 3		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits
- Reference Material (RM) Report; Recovery and Acceptance Limits
- Method Blank (MB) Report; Recovery and Acceptance Limits
- Laboratory Control Sample (LCS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is conducted in accordance with US FDA 21 CFR Part 11.

Signatories	*Position*	*Laboratory Department*
Lindsay Gung	Supervisor - Water Chemistry	Inorganics, Burnaby, British Columbia
Tracy Harley	Supervisor - Water Quality Instrumentation	Inorganics, Burnaby, British Columbia

General Comments

The ALS Quality Control (QC) report is optionally provided to ALS clients upon request. ALS test methods include comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against predetermined Data Quality Objectives (DQOs) to provide confidence in the accuracy of associated test results. This report contains detailed results for all QC results applicable to this sample submission. Please refer to the ALS Quality Control Interpretation report (QCI) for applicable method references and methodology summaries.

Key :

Anonymous = Refers to samples which are not part of this work order, but which formed part of the QC process lot.
CAS Number = Chemical Abstracts Services number is a unique identifier assigned to discrete substances.
DQO = Data Quality Objective.
LOR = Limit of Reporting (detection limit).
RPD = Relative Percentage Difference
# = Indicates a QC result that did not meet the ALS DQO.

Laboratory Duplicate (DUP) Report

A Laboratory Duplicate (DUP) is a randomly selected intralaboratory replicate sample. Laboratory Duplicates provide information regarding method precision and sample heterogeneity. ALS DQOs for Laboratory Duplicates are expressed as test-specific limits for Relative Percent Difference (RPD), or as an absolute difference limit of 2 times the LOR for low concentration duplicates within ~ 4-10 times the LOR (cut-off is test specific).

Sub-Matrix: **Water**

					Laboratory Duplicate (DUP) Report						
Laboratory sample ID	*Client sample ID*	*Analyte*	*CAS Number*	*Method*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD(%) or Difference*	*Duplicate Limits*	*Qualifier*
Anions and Nutrients (QC Lot: 154978)											
VA21A3276-001	Anonymous	phosphate, ortho-, dissolved (as P)	14265-44-2	E378-U	0.0010	mg/L	0.0081	0.0084	0.0003	Diff <2x LOR	----
Anions and Nutrients (QC Lot: 155261)											
FJ2100079-001	Anonymous	phosphorus, total	7723-14-0	E372-U	0.0020	mg/L	0.0028	0.0021	0.0007	Diff <2x LOR	----

Method Blank (MB) Report

A Method Blank is an analyte-free matrix that undergoes sample processing identical to that carried out for test samples. Method Blank results are used to monitor and control for potential contamination from the laboratory environment and reagents. For most tests, the DQO for Method Blanks is for the result to be < LOR.

Sub-Matrix: **Water**

Analyte	*CAS Number*	*Method*	*LOR*	*Unit*	*Result*	*Qualifier*
Anions and Nutrients (QCLot: 154978)						
phosphate, ortho-, dissolved (as P)	14265-44-2	E378-U	0.001	mg/L	<0.0010	----
Anions and Nutrients (QCLot: 155261)						
phosphorus, total	7723-14-0	E372-U	0.002	mg/L	<0.0020	----
Plant Pigments (QCLot: 155235)						
chlorophyll a	479-61-8	E870	0.01	µg/L	<0.010	----

Laboratory Control Sample (LCS) Report

A Laboratory Control Sample (LCS) is an analyte-free matrix that has been fortified (spiked) with test analytes at known concentration and processed in an identical manner to test samples. LCS results are expressed as percent recovery, and are used to monitor and control test method accuracy and precision, independent of test sample matrix.

Sub-Matrix: **Water**

					Laboratory Control Sample (LCS) Report				
					Spike	Recovery (%)	Recovery Limits (%)		
Analyte	CAS Number	Method	LOR	Unit	Concentration	LCS	Low	High	Qualifier
Anions and Nutrients (QCLot: 154978)									
phosphate, ortho-, dissolved (as P)	14265-44-2	E378-U	0.001	mg/L	0.03 mg/L	95.4	80.0	120	----
Anions and Nutrients (QCLot: 155261)									
phosphorus, total	7723-14-0	E372-U	0.002	mg/L	0.05 mg/L	101	80.0	120	----
Plant Pigments (QCLot: 155235)									
chlorophyll a	479-61-8	E870	0.01	µg/L	5 µg/L	110	80.0	120	----

Matrix Spike (MS) Report

A Matrix Spike (MS) is a randomly selected intra-laboratory replicate sample that has been fortified (spiked) with test analytes at known concentration, and processed in an identical manner to test samples. Matrix Spikes provide information regarding analyte recovery and potential matrix effects. MS DQO exceedances due to sample matrix may sometimes be unavoidable; in such cases, test results for the associated sample (or similar samples) may be subject to bias. ND – Recovery not determined, background level >= 1x spike level.

Sub-Matrix: **Water**

					Matrix Spike (MS) Report					
					Spike		Recovery (%)	Recovery Limits (%)		
Laboratory sample ID	Client sample ID	Analyte	CAS Number	Method	Concentration	Target	MS	Low	High	Qualifier
Anions and Nutrients (QCLot: 154978)										
VA21A3276-002	Anonymous	phosphate, ortho-, dissolved (as P)	14265-44-2	E378-U	0.0286 mg/L	0.03 mg/L	95.4	70.0	130	----
Anions and Nutrients (QCLot: 155261)										
VA21A3306-001	SWMP 03 (1m)	phosphorus, total	7723-14-0	E372-U	0.0485 mg/L	0.05 mg/L	97.0	70.0	130	----

Chain of Custody (COC) / Analytical Request Form

COC Number: 20 - 905695

Canada Toll Free: 1 800 668 9878

Page 1 of 1

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Report To	Contact and company name below will appear on the final report
Company:	BC Conservation Foundation
Contact:	Thea Rodgers
Phone:	250-419-3805
	Company address below will appear on the final report
Street:	#1-7217 Lantzville, BC
City/Province:	
Postal Code:	V0R 2H0
Invoice To	Same as Report To ☒ YES ☐ NO
	Copy of Invoice with Report ☒ YES ☐ NO
Company:	
Contact:	

Reports / Recipients

Select Report Format: ☒ PDF ☐ EXCEL ☐ EDD (DIGITAL)

Merge QC/QCI Reports with COA ☐ YES ☐ NO ☐ N/A

☐ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☒ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax: trodgers@bccf.com

Email 2:

Email 3:

Invoice Recipients

Select Invoice Distribution: ☒ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax: trodgers@bccf.com

Email 2: llimerick@bccf.com

Turnaround Time (TAT) Requested

☒ Routine [R] if received by 3pm M-F - no surcharges apply

☐ 4 day [P4] if received by 3pm M-F - 20% rush surcharge minimum

☐ 3 day [P3] if received by 3pm M-F - 25% rush surcharge minimum

☐ 2 day [P2] if received by 3pm M-F - 50% rush surcharge minimum

☐ 1 day [E] if received by 3pm M-F - 100% rush surcharge minimum

☐ Same day [E2] if received by 10am M-S - 200% rush surcharge. Additional fees may apply to rush requests on weekends, statutory holidays and non-routine tests

AFFIX ALS BARCODE LABEL HERE (ALS use only)

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm am/pm

For all tests with rush TATs requested, please contact your AM to confirm availability.

Project Information

ALS Account # / Quote #: Q78255

Job #: Enos Lake - 1301073

PO / AFE:

LSD:

ALS Lab Work Order # (ALS use only): 3306

Oil and Gas Required Fields (client use)

AFE/Cost Center: PO#:

Major/Minor Code: Routing Code:

Requisitioner:

Location:

ALS Contact: Sneha S. Sampler: TN / TR

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (ALS use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time PST (hh:mm)	Sample Type	NUMBER OF CONTAINERS	Chlorophyll-a (UNFILTERED)	Total Phosph. (P)	Orthophosphate	SAMPLES ON HOLD	EXTENDED STORAGE REQUIRED	SUSPECTED HAZARD (see notes)
	SWMP 03 (1m)	23 Feb	11:20	Water	3		P				
	SWMP 03 (5m)	"	11:25	"	3		P				
	SWMP 03 (10m)	"	11:30	"	3		P				

Environmental Division Vancouver

Work Order Reference VA21A3306

Telephone : +1 604 253 4188

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System? ☐ YES ☒ NO

Are samples for human consumption/ use? ☐ YES ☒ NO

Notes / Specify Limits for result evaluation by selecting from drop-down below (Excel COC only)

Chlorophyll-a needs to be lab filtered w/i 48 hours → please process asap if possible.

SAMPLE RECEIPT DETAILS (ALS use only)

Cooling Method: ☐ NONE ☐ ICE ☒ ICE PACKS ☐ FROZEN ☐ COOLING INITIATED

Submission Comments identified on Sample Receipt Notification: ☐ YES ☐ NO

Cooler Custody Seals Intact: ☐ YES ☐ N/A Sample Custody Seals Intact: ☐ YES ☐ N/A

INITIAL COOLER TEMPERATURES °C				FINAL COOLER TEMPERATURES °C			
				3			

SHIPMENT RELEASE (client use)

Released by:	Date:	Time:
TR	Feb. 23	1400

INITIAL SHIPMENT RECEPTION (ALS use only)

Received by:	Date:	Time:

FINAL SHIPMENT RECEPTION (ALS use only)

Received by:	Date:	Time:
JC	FEB 24 2021	820am

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

AUG 2020 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **VA21A9627**	Page	: 1 of 2
Client	: **The British Columbia Conservation Foundation**	Laboratory	: Vancouver - Environmental
Contact	: Thea Rodgers	Account Manager	: Sneha Sansare
Address	: 105 - 1885 Boxwood Rd Nanaimo BC Canada V9S 5X9	Address	: 8081 Lougheed Highway Burnaby BC Canada V5A 1W9
Telephone	: 250-390-2525	Telephone	: +1 604 253 4188
Project	: ----	Date Samples Received	: 19-May-2021 08:15
PO	: Enos Lake -- 1302015	Date Analysis Commenced	: 20-May-2021
C-O-C number	: ----	Issue Date	: 27-May-2021 15:38
Sampler	: TR		
Site	: ----		
Quote number	: Q78255 - Standing offer		
No. of samples received	: 3		
No. of samples analysed	: 3		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QC Interpretive report to assist with Quality Review and Sample Receipt Notification (SRN).

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is conducted in accordance with US FDA 21 CFR Part 11.

Signatories	*Position*	*Laboratory Department*
Lindsay Gung	Supervisor - Water Chemistry	Inorganics, Burnaby, British Columbia

General Comments

The analytical methods used by ALS are developed using internationally recognized reference methods (where available), such as those published by US EPA, APHA Standard Methods, ASTM, ISO, Environment Canada, BC MOE, and Ontario MOE. Refer to the ALS Quality Control Interpretive report (QCI) for applicable references and methodology summaries. Reference methods may incorporate modifications to improve performance.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Please refer to Quality Control Interpretive report (QCI) for information regarding Holding Time compliance.

Key : CAS Number: Chemical Abstracts Services number is a unique identifier assigned to discrete substances
LOR: Limit of Reporting (detection limit).

Unit	*Description*
µg/L	micrograms per litre
mg/L	milligrams per litre

<: less than.

>: greater than.

Surrogate: An analyte that is similar in behavior to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED on SRN or QCI Report, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical Results

Sub-Matrix: **Water**
(Matrix: **Water**)

Analyte	*CAS Number*	*Method*	*LOR*	*Unit*	*Client sample ID*	**SWMP 03 (1m)**	**SWMP 03 (5m)**	**SWMP 03 (9.5m)**	**----**	**----**
					Client sampling date / time	18-May-2021 11:30	18-May-2021 11:35	18-May-2021 11:40	----	----
						VA21A9627-001	**VA21A9627-002**	**VA21A9627-003**	**--------**	**--------**
						Result	Result	Result	----	----
Anions and Nutrients										
phosphate, ortho-, dissolved (as P)	14265-44-2	E378-U	0.0010	mg/L		<0.0010	<0.0010	<0.0010	----	----
phosphorus, total	7723-14-0	E372-U	0.0020	mg/L		0.0063	0.0094	0.0157	----	----
Plant Pigments										
chlorophyll a	479-61-8	E870	0.010	µg/L		1.95	3.87	6.99	----	----

Please refer to the General Comments section for an explanation of any qualifiers detected.

QUALITY CONTROL INTERPRETIVE REPORT

Work Order	: **VA21A9627**	Page	: 1 of 5
Client	: **The British Columbia Conservation Foundation**	Laboratory	: Vancouver - Environmental
Contact	: Thea Rodgers	Account Manager	: Sneha Sansare
Address	: 105 - 1885 Boxwood Rd Nanaimo BC Canada V9S 5X9	Address	: 8081 Lougheed Highway Burnaby, British Columbia Canada V5A 1W9
Telephone	: 250-390-2525	Telephone	: +1 604 253 4188
Project	: ----	Date Samples Received	: 19-May-2021 08:15
PO	: Enos Lake -- 1302015	Issue Date	: 27-May-2021 15:38
C-O-C number	: ----		
Sampler	: TR		
Site	: ----		
Quote number	: Q78255 - Standing offer		
No. of samples received	: 3		
No. of samples analysed	: 3		

This report is automatically generated by the ALS LIMS (Laboratory Information Management System) through evaluation of Quality Control (QC) results and other QA parameters associated with this submission, and is intended to facilitate rapid data validation by auditors or reviewers. The report highlights any exceptions and outliers to ALS Data Quality Objectives, provides holding time details and exceptions, summarizes QC sample frequencies, and lists applicable methodology references and summaries.

Key

Anonymous: Refers to samples which are not part of this work order, but which formed part of the QC process lot.
CAS Number: Chemical Abstracts Services number is a unique identifier assigned to discrete substances.
DQO: Data Quality Objective.
LOR: Limit of Reporting (detection limit).
RPD: Relative Percent Difference.

Summary of Outliers

Outliers : Quality Control Samples

- No Method Blank value outliers occur.
- No Duplicate outliers occur.
- No Laboratory Control Sample (LCS) outliers occur
- No Matrix Spike outliers occur.
- No Test sample Surrogate recovery outliers exist.

Outliers: Reference Material (RM) Samples

- No Reference Material (RM) Sample outliers occur.

Outliers : Analysis Holding Time Compliance (Breaches)

- Analysis Holding Time Outliers exist - please see following pages for full details.

Outliers : Frequency of Quality Control Samples

- No Quality Control Sample Frequency Outliers occur.

Analysis Holding Time Compliance

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times, which are selected to meet known provincial and /or federal requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by organizations such as CCME, US EPA, APHA Standard Methods, ASTM, or Environment Canada (where available). Dates and holding times reported below represent the first dates of extraction or analysis. If subsequent tests or dilutions exceeded holding times, qualifiers are added (refer to COA).

If samples are identified below as having been analyzed or extracted outside of recommended holding times, measurement uncertainties may be increased, and this should be taken into consideration when interpreting results.

Where actual sampling date is not provided on the chain of custody, the date of receipt with time at 00:00 is used for calculation purposes.

Where only the sample date without time is provided on the chain of custody, the sampling date at 00:00 is used for calculation purposes.

Matrix: **Water**

Evaluation: × = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group / Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times Rec	Holding Times Actual	Eval	Analysis Date	Holding Times Rec	Holding Times Actual	Eval
Anions and Nutrients : Dissolved Orthophosphate by Colourimetry (Ultra Trace Level)										
HDPE SWMP 03 (5m)	E378-U	18-May-2021	----	----	----		27-May-2021	3 days	10 days	× EHT
Anions and Nutrients : Dissolved Orthophosphate by Colourimetry (Ultra Trace Level)										
HDPE SWMP 03 (1m)	E378-U	18-May-2021	----	----	----		26-May-2021	3 days	9 days	× EHT
Anions and Nutrients : Dissolved Orthophosphate by Colourimetry (Ultra Trace Level)										
HDPE SWMP 03 (9.5m)	E378-U	18-May-2021	----	----	----		26-May-2021	3 days	9 days	× EHT
Anions and Nutrients : Total Phosphorus by Colourimetry (Ultra Trace)										
Amber glass total (sulfuric acid) SWMP 03 (1m)	E372-U	18-May-2021	26-May-2021	----	8 days	✓	26-May-2021	28 days	1 days	✓
Anions and Nutrients : Total Phosphorus by Colourimetry (Ultra Trace)										
Amber glass total (sulfuric acid) SWMP 03 (5m)	E372-U	18-May-2021	26-May-2021	----	8 days	✓	26-May-2021	28 days	1 days	✓
Anions and Nutrients : Total Phosphorus by Colourimetry (Ultra Trace)										
Amber glass total (sulfuric acid) SWMP 03 (9.5m)	E372-U	18-May-2021	26-May-2021	----	8 days	✓	26-May-2021	28 days	1 days	✓
Plant Pigments : Chlorophyll-a by Fluorometry										
Opaque HDPE SWMP 03 (1m)	E870	18-May-2021	20-May-2021	2 days	2 days	✓	23-May-2021	672 hrs	4 days	✓

Matrix: **Water**

Evaluation: × = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group / Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times Rec	Holding Times Actual	Eval	Analysis Date	Holding Times Rec	Holding Times Actual	Eval
Plant Pigments : Chlorophyll-a by Fluorometry										
Opaque HDPE SWMP 03 (5m)	E870	18-May-2021	20-May-2021	2 days	2 days	✓	23-May-2021	679 hrs	4 days	✓
Plant Pigments : Chlorophyll-a by Fluorometry										
Opaque HDPE SWMP 03 (9.5m)	E870	18-May-2021	20-May-2021	2 days	2 days	✓	23-May-2021	679 hrs	4 days	✓

Legend & Qualifier Definitions

EHT: Exceeded ALS recommended hold time prior to analysis.

Rec. HT: ALS recommended hold time (see units).

Quality Control Parameter Frequency Compliance

The following report summarizes the frequency of laboratory QC samples analyzed within the analytical batches (QC lots) in which the submitted samples were processed. The actual frequency should be greater than or equal to the expected frequency.

Matrix: **Water**

Evaluation: × = *QC frequency outside specification*; ✓ = *QC frequency within specification.*

Quality Control Sample Type			Count		Frequency (%)		
Analytical Methods	*Method*	*QC Lot #*	*QC*	*Regular*	*Actual*	*Expected*	*Evaluation*
Laboratory Duplicates (DUP)							
Dissolved Orthophosphate by Colourimetry (Ultra Trace Level)	E378-U	205429	2	9	22.2	5.0	✓
Total Phosphorus by Colourimetry (Ultra Trace)	E372-U	205458	1	8	12.5	5.0	✓
Laboratory Control Samples (LCS)							
Chlorophyll-a by Fluorometry	E870	201750	1	14	7.1	5.0	✓
Dissolved Orthophosphate by Colourimetry (Ultra Trace Level)	E378-U	205429	2	9	22.2	5.0	✓
Total Phosphorus by Colourimetry (Ultra Trace)	E372-U	205458	1	8	12.5	5.0	✓
Method Blanks (MB)							
Chlorophyll-a by Fluorometry	E870	201750	1	14	7.1	5.0	✓
Dissolved Orthophosphate by Colourimetry (Ultra Trace Level)	E378-U	205429	2	9	22.2	5.0	✓
Total Phosphorus by Colourimetry (Ultra Trace)	E372-U	205458	1	8	12.5	5.0	✓
Matrix Spikes (MS)							
Dissolved Orthophosphate by Colourimetry (Ultra Trace Level)	E378-U	205429	1	9	11.1	5.0	✓
Total Phosphorus by Colourimetry (Ultra Trace)	E372-U	205458	1	8	12.5	5.0	✓

Methodology References and Summaries

The analytical methods used by ALS are developed using internationally recognized reference methods (where available), such as those published by US EPA, APHA Standard Methods, ASTM, ISO, Environment Canada, BC MOE, and Ontario MOE. Reference methods may incorporate modifications to improve performance (indicated by "mod").

Analytical Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
Total Phosphorus by Colourimetry (Ultra Trace)	E372-U Vancouver - Environmental	Water	APHA 4500-P E (mod).	Total Phosphorus is determined colourimetrically using a discrete analyzer after heated persulfate digestion of the sample.
Dissolved Orthophosphate by Colourimetry (Ultra Trace Level)	E378-U Vancouver - Environmental	Water	APHA 4500-P E (mod)	Dissolved Orthophosphate is determined colourimetrically on a water sample that has been lab or field filtered through a 0.45 micron membrane filter. Field filtration is recommended to ensure test results represent conditions at time of sampling.
Chlorophyll-a by Fluorometry	E870 Vancouver - Environmental	Water	EPA 445.0 (mod)	Chlorophyll a is determined by solvent extraction followed with analysis by fluorometry using the non-acidification procedure. This method is not subject to interferences from chlorophyll b. Sample volume provided by client.

Preparation Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
Digestion for Total Phosphorus in water	EP372 Vancouver - Environmental	Water	APHA 4500-P E (mod).	Samples are heated with a persulfate digestion reagent.
Chlorophyll-a Extraction	EP870 Vancouver - Environmental	Water	EPA 445.0 (mod)	Chlorophyll-a solvent extraction.

ALS Environmental

QUALITY CONTROL REPORT

Work Order	: **VA21A9627**	Page	: 1 of 4
Client	: The British Columbia Conservation Foundation	Laboratory	: Vancouver - Environmental
Contact	: Thea Rodgers	Account Manager	: Sneha Sansare
Address	: 105 - 1885 Boxwood Rd Nanaimo BC Canada V9S 5X9	Address	: 8081 Lougheed Highway Burnaby, British Columbia Canada V5A 1W9
Telephone	: 250-390-2525	Telephone	: +1 604 253 4188
Project	: ----	Date Samples Received	: 19-May-2021 08:15
PO	: Enos Lake -- 1302015	Date Analysis Commenced	: 20-May-2021
C-O-C number	: ----	Issue Date	: 27-May-2021 15:38
Sampler	: TR		
Site	: ----		
Quote number	: Q78255 - Standing offer		
No. of samples received	: 3		
No. of samples analysed	: 3		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits
- Reference Material (RM) Report; Recovery and Acceptance Limits
- Method Blank (MB) Report; Recovery and Acceptance Limits
- Laboratory Control Sample (LCS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is conducted in accordance with US FDA 21 CFR Part 11.

Signatories	*Position*	*Laboratory Department*
Lindsay Gung	Supervisor - Water Chemistry	Inorganics, Burnaby, British Columbia

General Comments

The ALS Quality Control (QC) report is optionally provided to ALS clients upon request. ALS test methods include comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against predetermined Data Quality Objectives (DQOs) to provide confidence in the accuracy of associated test results. This report contains detailed results for all QC results applicable to this sample submission. Please refer to the ALS Quality Control Interpretation report (QCI) for applicable method references and methodology summaries.

Key :

Anonymous = Refers to samples which are not part of this work order, but which formed part of the QC process lot.
CAS Number = Chemical Abstracts Services number is a unique identifier assigned to discrete substances.
DQO = Data Quality Objective.
LOR = Limit of Reporting (detection limit).
RPD = Relative Percentage Difference
# = Indicates a QC result that did not meet the ALS DQO.

Laboratory Duplicate (DUP) Report

A Laboratory Duplicate (DUP) is a randomly selected intralaboratory replicate sample. Laboratory Duplicates provide information regarding method precision and sample heterogeneity. ALS DQOs for Laboratory Duplicates are expressed as test-specific limits for Relative Percent Difference (RPD), or as an absolute difference limit of 2 times the LOR for low concentration duplicates within ~ 4-10 times the LOR (cut-off is test specific).

Sub-Matrix: **Water**

					Laboratory Duplicate (DUP) Report						
Laboratory sample ID	*Client sample ID*	*Analyte*	*CAS Number*	*Method*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD(%) or Difference*	*Duplicate Limits*	*Qualifier*
Anions and Nutrients (QC Lot: 205429)											
VA21A9618-001	Anonymous	phosphate, ortho-, dissolved (as P)	14265-44-2	E378-U	0.0010	mg/L	<0.0010	<0.0010	0	Diff <2x LOR	----
Anions and Nutrients (QC Lot: 205458)											
FJ2100275-002	Anonymous	phosphorus, total	7723-14-0	E372-U	0.0020	mg/L	<0.0020	<0.0020	0	Diff <2x LOR	----
Anions and Nutrients (QC Lot: 206449)											
VA21A9627-002	SWMP 03 (5m)	phosphate, ortho-, dissolved (as P)	14265-44-2	E378-U	0.0010	mg/L	<0.0010	<0.0010	0	Diff <2x LOR	----

Method Blank (MB) Report

A Method Blank is an analyte-free matrix that undergoes sample processing identical to that carried out for test samples. Method Blank results are used to monitor and control for potential contamination from the laboratory environment and reagents. For most tests, the DQO for Method Blanks is for the result to be < LOR.

Sub-Matrix: **Water**

Analyte	CAS Number	Method	LOR	Unit	Result	Qualifier
Anions and Nutrients (QCLot: 205429)						
phosphate, ortho-, dissolved (as P)	14265-44-2	E378-U	0.001	mg/L	<0.0010	----
Anions and Nutrients (QCLot: 205458)						
phosphorus, total	7723-14-0	E372-U	0.002	mg/L	<0.0020	----
Anions and Nutrients (QCLot: 206449)						
phosphate, ortho-, dissolved (as P)	14265-44-2	E378-U	0.001	mg/L	<0.0010	----
Plant Pigments (QCLot: 201750)						
chlorophyll a	479-61-8	E870	0.01	µg/L	<0.010	----

Laboratory Control Sample (LCS) Report

A Laboratory Control Sample (LCS) is an analyte-free matrix that has been fortified (spiked) with test analytes at known concentration and processed in an identical manner to test samples. LCS results are expressed as percent recovery, and are used to monitor and control test method accuracy and precision, independent of test sample matrix.

Sub-Matrix: **Water**

					Laboratory Control Sample (LCS) Report				
					Spike	Recovery (%)	Recovery Limits (%)		
Analyte	CAS Number	Method	LOR	Unit	Concentration	LCS	Low	High	Qualifier
Anions and Nutrients (QCLot: 205429)									
phosphate, ortho-, dissolved (as P)	14265-44-2	E378-U	0.001	mg/L	0.03 mg/L	103	80.0	120	----
Anions and Nutrients (QCLot: 205458)									
phosphorus, total	7723-14-0	E372-U	0.002	mg/L	0.05 mg/L	95.9	80.0	120	----
Anions and Nutrients (QCLot: 206449)									
phosphate, ortho-, dissolved (as P)	14265-44-2	E378-U	0.001	mg/L	0.03 mg/L	104	80.0	120	----
Plant Pigments (QCLot: 201750)									
chlorophyll a	479-61-8	E870	0.01	µg/L	5 µg/L	109	80.0	120	----

Matrix Spike (MS) Report

A Matrix Spike (MS) is a randomly selected intra-laboratory replicate sample that has been fortified (spiked) with test analytes at known concentration, and processed in an identical manner to test samples. Matrix Spikes provide information regarding analyte recovery and potential matrix effects. MS DQO exceedances due to sample matrix may sometimes be unavoidable; in such cases, test results for the associated sample (or similar samples) may be subject to bias. ND – Recovery not determined, background level >= 1x spike level.

Sub-Matrix: **Water**

					Matrix Spike (MS) Report					
					Spike		Recovery (%)	Recovery Limits (%)		
Laboratory sample ID	Client sample ID	Analyte	CAS Number	Method	Concentration	Target	MS	Low	High	Qualifier
Anions and Nutrients (QCLot: 205429)										
VA21A9627-001	SWMP 03 (1m)	phosphate, ortho-, dissolved (as P)	14265-44-2	E378-U	0.0323 mg/L	0.03 mg/L	108	70.0	130	----
Anions and Nutrients (QCLot: 205458)										
KS2101507-001	Anonymous	phosphorus, total	7723-14-0	E372-U	4.89 mg/L	5 mg/L	97.8	70.0	130	----

Chain of Custody (COC) / Analytical Request Form

ALS Environmental

www.alsglobal.com

Canada Toll Free: 1 800 668 9878

Affix ALS barcode label here (lab use only)

COC Number: 17 -

Page 1 of 1

Report To	Contact and company name below will appear on the final report
Company:	BC Conservation Foundation
Contact:	Thea Rodgers
Phone:	250-390-2525 ext 104
	Company address below will appear on the final report
Street:	#105-1885 Boxwood Road
City/Province:	Nanaimo, BC
Postal Code:	V9S 5X9
Invoice To	Same as Report To ☑ YES ☐ NO
	Copy of Invoice with Report ☑ YES ☐ NO
Company:	
Contact:	

Report Format / Distribution

Select Report Format: ☑ PDF ☑ EXCEL ☐ EDD (DIGITAL)
Quality Control (QC) Report with Report ☑ YES ☐ NO
☐ Compare Results to Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax: trodgers@bccf.com
Email 2:
Email 3:

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax: trodgers@bccf.com
Email 2: llimerick@bccf.com

Select Service Level Below - Contact your AM to confirm all E&P TATs (surcharges may apply)

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4-20%] ☐ | 3 day [P3-25%] ☐ | 2 day [P2-50%] ☐

EMERGENCY: 1 Business day [E1 - 100%] ☐ | Same Day, Weekend or Statutory holiday [E2 -200% (Laboratory opening fees may apply)] ☐

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #: Q78255
Job #:
PO / AFE: Enos Lake -- 1302015
LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center: | PO#:
Major/Minor Code: | Routing Code:
Requisitioner:
Location:

ALS Lab Work Order # (lab use only): 9627

ALS Contact: Rojina G. | Sampler: TR

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Chlorophyll a (UNFILTERED)	Total Phosphorous (P)	Orthophosphate	SAMPLES ON HOLD	Sample is hazardous (please provide further detail)	NUMBER OF CONTAINERS
	SWMP 03 (1m)	18-05-21	1130	Water	R	R	R			3
	SWMP 03 (5m)	18-05-21	1135	Water	R	R	R			3
	SWMP 03 (9.5m)	18-05-21	1140	Water	R	R	R			3

Environmental Division
Vancouver
Work Order Reference
VA21A9627

Telephone : +1 604 253 4188

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System? ☐ YES ☐ NO
Are samples for human consumption/ use? ☐ YES ☐ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

Chl-a is unfiltered; please filter ASAP

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ | SIF Observations: Yes ☐ No ☐
Ice Packs ☑ Ice Cubes ☐ | Custody seal intact: Yes ☐ No ☐
Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C	FINAL COOLER TEMPERATURES °C
	5

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: TR	Date: May 18 2021	Time: 1400	Received by:	Date:	Time:	Received by: MB	Date: May 19	Time: 8:15AM

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

SEPT 2017 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **VA21B7912**	Page	: 1 of 2
Client	: **The British Columbia Conservation Foundation**	Laboratory	: Vancouver - Environmental
Contact	: Thea Rodgers	Account Manager	: Sneha Sansare
Address	: 105 - 1885 Boxwood Rd Nanaimo BC Canada V9S 5X9	Address	: 8081 Lougheed Highway Burnaby BC Canada V5A 1W9
Telephone	: 250-390-2525	Telephone	: +1 604 253 4188
Project	: Enos Lake	Date Samples Received	: 24-Aug-2021 09:00
PO	: ----	Date Analysis Commenced	: 25-Aug-2021
C-O-C number	: 20-922255	Issue Date	: 31-Aug-2021 16:48
Sampler	: TN, TR		
Site	: ----		
Quote number	: Q78255 - Standing offer		
No. of samples received	: 3		
No. of samples analysed	: 3		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QC Interpretive report to assist with Quality Review and Sample Receipt Notification (SRN).

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is conducted in accordance with US FDA 21 CFR Part 11.

Signatories	*Position*	*Laboratory Department*
Lindsay Gung	Supervisor - Water Chemistry	Inorganics, Burnaby, British Columbia
Miles Gropen	Department Manager - Inorganics	Inorganics, Burnaby, British Columbia

General Comments

The analytical methods used by ALS are developed using internationally recognized reference methods (where available), such as those published by US EPA, APHA Standard Methods, ASTM, ISO, Environment Canada, BC MOE, and Ontario MOE. Refer to the ALS Quality Control Interpretive report (QCI) for applicable references and methodology summaries. Reference methods may incorporate modifications to improve performance.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Please refer to Quality Control Interpretive report (QCI) for information regarding Holding Time compliance.

Key : CAS Number: Chemical Abstracts Services number is a unique identifier assigned to discrete substances
LOR: Limit of Reporting (detection limit).

Unit	*Description*
µg/L	micrograms per litre
mg/L	milligrams per litre

<: less than.

>: greater than.

Surrogate: An analyte that is similar in behavior to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED on SRN or QCI Report, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical Results

Sub-Matrix: **Water**
(Matrix: **Water**)

Analyte	*CAS Number*	*Method*	*LOR*	*Unit*	*Client sample ID*	**SWMP 03 -1m**	**SWMP 03 -5m**	**SWMP 03 -9.5m**	**----**	**----**
					Client sampling date / time	23-Aug-2021 11:35	23-Aug-2021 11:40	23-Aug-2021 11:45	----	----
						VA21B7912-001	**VA21B7912-002**	**VA21B7912-003**	**--------**	**--------**
						Result	Result	Result	----	----
Anions and Nutrients										
phosphate, ortho-, dissolved (as P)	14265-44-2	E378-U	0.0010	mg/L		<0.0010	<0.0010	<0.0010	----	----
phosphorus, total	7723-14-0	E372-U	0.0020	mg/L		0.0042	0.0076	0.0192	----	----
Plant Pigments										
chlorophyll a	479-61-8	E870	0.010	µg/L		3.69	7.15	9.72	----	----

Please refer to the General Comments section for an explanation of any qualifiers detected.

QUALITY CONTROL INTERPRETIVE REPORT

Work Order	: **VA21B7912**	Page	: 1 of 5
Client	: **The British Columbia Conservation Foundation**	Laboratory	: Vancouver - Environmental
Contact	: Thea Rodgers	Account Manager	: Sneha Sansare
Address	: 105 - 1885 Boxwood Rd Nanaimo BC Canada V9S 5X9	Address	: 8081 Lougheed Highway Burnaby, British Columbia Canada V5A 1W9
Telephone	: 250-390-2525	Telephone	: +1 604 253 4188
Project	: Enos Lake	Date Samples Received	: 24-Aug-2021 09:00
PO	: ----	Issue Date	: 31-Aug-2021 16:48
C-O-C number	: 20-922255		
Sampler	: TN, TR		
Site	: ----		
Quote number	: Q78255 - Standing offer		
No. of samples received	: 3		
No. of samples analysed	: 3		

This report is automatically generated by the ALS LIMS (Laboratory Information Management System) through evaluation of Quality Control (QC) results and other QA parameters associated with this submission, and is intended to facilitate rapid data validation by auditors or reviewers. The report highlights any exceptions and outliers to ALS Data Quality Objectives, provides holding time details and exceptions, summarizes QC sample frequencies, and lists applicable methodology references and summaries.

Key

Anonymous: Refers to samples which are not part of this work order, but which formed part of the QC process lot.
CAS Number: Chemical Abstracts Services number is a unique identifier assigned to discrete substances.
DQO: Data Quality Objective.
LOR: Limit of Reporting (detection limit).
RPD: Relative Percent Difference.

Summary of Outliers

Outliers : Quality Control Samples

- No Method Blank value outliers occur.
- No Duplicate outliers occur.
- No Laboratory Control Sample (LCS) outliers occur
- No Matrix Spike outliers occur.
- No Test sample Surrogate recovery outliers exist.

Outliers: Reference Material (RM) Samples

- No Reference Material (RM) Sample outliers occur.

Outliers : Analysis Holding Time Compliance (Breaches)

- No Analysis Holding Time Outliers exist.

Outliers : Frequency of Quality Control Samples

- No Quality Control Sample Frequency Outliers occur.

Analysis Holding Time Compliance

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times, which are selected to meet known provincial and /or federal requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by organizations such as CCME, US EPA, APHA Standard Methods, ASTM, or Environment Canada (where available). Dates and holding times reported below represent the first dates of extraction or analysis. If subsequent tests or dilutions exceeded holding times, qualifiers are added (refer to COA).

If samples are identified below as having been analyzed or extracted outside of recommended holding times, measurement uncertainties may be increased, and this should be taken into consideration when interpreting results.

Where actual sampling date is not provided on the chain of custody, the date of receipt with time at 00:00 is used for calculation purposes.

Where only the sample date without time is provided on the chain of custody, the sampling date at 00:00 is used for calculation purposes.

Matrix: **Water**

Evaluation: × = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group / Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times Rec	Holding Times Actual	Eval	Analysis Date	Holding Times Rec	Holding Times Actual	Eval
Anions and Nutrients : Dissolved Orthophosphate by Colourimetry (Ultra Trace Level)										
HDPE SWMP 03 -1m	E378-U	23-Aug-2021	----	----	----		25-Aug-2021	3 days	2 days	✓
Anions and Nutrients : Dissolved Orthophosphate by Colourimetry (Ultra Trace Level)										
HDPE SWMP 03 -5m	E378-U	23-Aug-2021	----	----	----		25-Aug-2021	3 days	2 days	✓
Anions and Nutrients : Dissolved Orthophosphate by Colourimetry (Ultra Trace Level)										
HDPE SWMP 03 -9.5m	E378-U	23-Aug-2021	----	----	----		25-Aug-2021	3 days	2 days	✓
Anions and Nutrients : Total Phosphorus by Colourimetry (Ultra Trace)										
Amber glass total (sulfuric acid) SWMP 03 -1m	E372-U	23-Aug-2021	30-Aug-2021	----	----		31-Aug-2021	28 days	8 days	✓
Anions and Nutrients : Total Phosphorus by Colourimetry (Ultra Trace)										
Amber glass total (sulfuric acid) SWMP 03 -5m	E372-U	23-Aug-2021	30-Aug-2021	----	----		31-Aug-2021	28 days	8 days	✓
Anions and Nutrients : Total Phosphorus by Colourimetry (Ultra Trace)										
Amber glass total (sulfuric acid) SWMP 03 -9.5m	E372-U	23-Aug-2021	30-Aug-2021	----	----		31-Aug-2021	28 days	8 days	✓
Plant Pigments : Chlorophyll-a by Fluorometry										
Opaque HDPE SWMP 03 -1m	E870	23-Aug-2021	25-Aug-2021	2 days	2 days	✓	26-Aug-2021	672 hrs	1 days	✓

Matrix: **Water**

Evaluation: × = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group / Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times Rec	Holding Times Actual	Eval	Analysis Date	Holding Times Rec	Holding Times Actual	Eval
Plant Pigments : Chlorophyll-a by Fluorometry										
Opaque HDPE										
SWMP 03 -5m	E870	23-Aug-2021	25-Aug-2021	2 days	2 days	✓	26-Aug-2021	672 hrs	1 days	✓
Plant Pigments : Chlorophyll-a by Fluorometry										
Opaque HDPE										
SWMP 03 -9.5m	E870	23-Aug-2021	25-Aug-2021	2 days	2 days	✓	26-Aug-2021	672 hrs	1 days	✓

Legend & Qualifier Definitions

Rec. HT: ALS recommended hold time (see units).

Quality Control Parameter Frequency Compliance

The following report summarizes the frequency of laboratory QC samples analyzed within the analytical batches (QC lots) in which the submitted samples were processed. The actual frequency should be greater than or equal to the expected frequency.

Matrix: **Water**

Evaluation: × = *QC frequency outside specification*; ✓ = *QC frequency within specification.*

Quality Control Sample Type			Count		Frequency (%)		
Analytical Methods	*Method*	*QC Lot #*	*QC*	*Regular*	*Actual*	*Expected*	*Evaluation*
Laboratory Duplicates (DUP)							
Dissolved Orthophosphate by Colourimetry (Ultra Trace Level)	E378-U	275357	1	5	20.0	5.0	✓
Total Phosphorus by Colourimetry (Ultra Trace)	E372-U	280037	1	3	33.3	5.0	✓
Laboratory Control Samples (LCS)							
Chlorophyll-a by Fluorometry	E870	275431	1	10	10.0	5.0	✓
Dissolved Orthophosphate by Colourimetry (Ultra Trace Level)	E378-U	275357	1	5	20.0	5.0	✓
Total Phosphorus by Colourimetry (Ultra Trace)	E372-U	280037	1	3	33.3	5.0	✓
Method Blanks (MB)							
Chlorophyll-a by Fluorometry	E870	275431	1	10	10.0	5.0	✓
Dissolved Orthophosphate by Colourimetry (Ultra Trace Level)	E378-U	275357	1	5	20.0	5.0	✓
Total Phosphorus by Colourimetry (Ultra Trace)	E372-U	280037	1	3	33.3	5.0	✓
Matrix Spikes (MS)							
Dissolved Orthophosphate by Colourimetry (Ultra Trace Level)	E378-U	275357	1	5	20.0	5.0	✓
Total Phosphorus by Colourimetry (Ultra Trace)	E372-U	280037	1	3	33.3	5.0	✓

Methodology References and Summaries

The analytical methods used by ALS are developed using internationally recognized reference methods (where available), such as those published by US EPA, APHA Standard Methods, ASTM, ISO, Environment Canada, BC MOE, and Ontario MOE. Reference methods may incorporate modifications to improve performance (indicated by "mod").

Analytical Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
Total Phosphorus by Colourimetry (Ultra Trace)	E372-U Vancouver - Environmental	Water	APHA 4500-P E (mod).	Total Phosphorus is determined colourimetrically using a discrete analyzer after heated persulfate digestion of the sample.
Dissolved Orthophosphate by Colourimetry (Ultra Trace Level)	E378-U Vancouver - Environmental	Water	APHA 4500-P E (mod)	Dissolved Orthophosphate is determined colourimetrically on a water sample that has been lab or field filtered through a 0.45 micron membrane filter. Field filtration is recommended to ensure test results represent conditions at time of sampling.
Chlorophyll-a by Fluorometry	E870 Vancouver - Environmental	Water	EPA 445.0 (mod)	Chlorophyll a is determined by solvent extraction followed with analysis by fluorometry using the non-acidification procedure. This method is not subject to interferences from chlorophyll b.

Preparation Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
Digestion for Total Phosphorus in water	EP372 Vancouver - Environmental	Water	APHA 4500-P E (mod).	Samples are heated with a persulfate digestion reagent.
Chlorophyll-a Extraction	EP870 Vancouver - Environmental	Water	EPA 445.0 (mod)	Chlorophyll-a solvent extraction.

QUALITY CONTROL REPORT

Work Order	: **VA21B7912**	Page	: 1 of 3
Client	: The British Columbia Conservation Foundation	Laboratory	: Vancouver - Environmental
Contact	: Thea Rodgers	Account Manager	: Sneha Sansare
Address	: 105 - 1885 Boxwood Rd Nanaimo BC Canada V9S 5X9	Address	: 8081 Lougheed Highway Burnaby, British Columbia Canada V5A 1W9
Telephone	: 250-390-2525	Telephone	: +1 604 253 4188
Project	: Enos Lake	Date Samples Received	: 24-Aug-2021 09:00
PO	: ----	Date Analysis Commenced	: 25-Aug-2021
C-O-C number	: 20-922255	Issue Date	: 31-Aug-2021 16:48
Sampler	: TN, TR		
Site	: ----		
Quote number	: Q78255 - Standing offer		
No. of samples received	: 3		
No. of samples analysed	: 3		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits
- Reference Material (RM) Report; Recovery and Acceptance Limits
- Method Blank (MB) Report; Recovery and Acceptance Limits
- Laboratory Control Sample (LCS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is conducted in accordance with US FDA 21 CFR Part 11.

Signatories	*Position*	*Laboratory Department*
Lindsay Gung	Supervisor - Water Chemistry	Inorganics, Burnaby, British Columbia
Miles Gropen	Department Manager - Inorganics	Inorganics, Burnaby, British Columbia

General Comments

The ALS Quality Control (QC) report is optionally provided to ALS clients upon request. ALS test methods include comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against predetermined Data Quality Objectives (DQOs) to provide confidence in the accuracy of associated test results. This report contains detailed results for all QC results applicable to this sample submission. Please refer to the ALS Quality Control Interpretation report (QCI) for applicable method references and methodology summaries.

Key :

Anonymous = Refers to samples which are not part of this work order, but which formed part of the QC process lot.
CAS Number = Chemical Abstracts Services number is a unique identifier assigned to discrete substances.
DQO = Data Quality Objective.
LOR = Limit of Reporting (detection limit).
RPD = Relative Percentage Difference
# = Indicates a QC result that did not meet the ALS DQO.

Laboratory Duplicate (DUP) Report

A Laboratory Duplicate (DUP) is a randomly selected intralaboratory replicate sample. Laboratory Duplicates provide information regarding method precision and sample heterogeneity. ALS DQOs for Laboratory Duplicates are expressed as test-specific limits for Relative Percent Difference (RPD), or as an absolute difference limit of 2 times the LOR for low concentration duplicates within ~ 4-10 times the LOR (cut-off is test specific).

Sub-Matrix: **Water**

					Laboratory Duplicate (DUP) Report						
Laboratory sample ID	Client sample ID	Analyte	CAS Number	Method	LOR	Unit	Original Result	Duplicate Result	RPD(%) or Difference	Duplicate Limits	Qualifier
Anions and Nutrients (QC Lot: 275357)											
KS2102670-001	Anonymous	phosphate, ortho-, dissolved (as P)	14265-44-2	E378-U	0.0010	mg/L	0.0053	0.0066	0.0013	Diff <2x LOR	----
Anions and Nutrients (QC Lot: 280037)											
VA21B7912-001	SWMP 03 -1m	phosphorus, total	7723-14-0	E372-U	0.0020	mg/L	0.0042	0.0036	0.0006	Diff <2x LOR	----

Method Blank (MB) Report

A Method Blank is an analyte-free matrix that undergoes sample processing identical to that carried out for test samples. Method Blank results are used to monitor and control for potential contamination from the laboratory environment and reagents. For most tests, the DQO for Method Blanks is for the result to be < LOR.

Sub-Matrix: **Water**

Analyte	CAS Number	Method	LOR	Unit	Result	Qualifier
Anions and Nutrients (QCLot: 275357)						
phosphate, ortho-, dissolved (as P)	14265-44-2	E378-U	0.001	mg/L	<0.0010	----
Anions and Nutrients (QCLot: 280037)						
phosphorus, total	7723-14-0	E372-U	0.002	mg/L	<0.0020	----
Plant Pigments (QCLot: 275431)						
chlorophyll a	479-61-8	E870	0.01	µg/L	<0.010	----

Laboratory Control Sample (LCS) Report

A Laboratory Control Sample (LCS) is an analyte-free matrix that has been fortified (spiked) with test analytes at known concentration and processed in an identical manner to test samples. LCS results are expressed as percent recovery, and are used to monitor and control test method accuracy and precision, independent of test sample matrix.

Sub-Matrix: **Water**

					Laboratory Control Sample (LCS) Report				
					Spike	Recovery (%)	Recovery Limits (%)		
Analyte	CAS Number	Method	LOR	Unit	Concentration	LCS	Low	High	Qualifier
Anions and Nutrients (QCLot: 275357)									
phosphate, ortho-, dissolved (as P)	14265-44-2	E378-U	0.001	mg/L	0.03 mg/L	106	80.0	120	----
Anions and Nutrients (QCLot: 280037)									
phosphorus, total	7723-14-0	E372-U	0.002	mg/L	0.05 mg/L	93.5	80.0	120	----
Plant Pigments (QCLot: 275431)									
chlorophyll a	479-61-8	E870	0.01	µg/L	5 µg/L	109	80.0	120	----

Matrix Spike (MS) Report

A Matrix Spike (MS) is a randomly selected intra-laboratory replicate sample that has been fortified (spiked) with test analytes at known concentration, and processed in an identical manner to test samples. Matrix Spikes provide information regarding analyte recovery and potential matrix effects. MS DQO exceedances due to sample matrix may sometimes be unavoidable; in such cases, test results for the associated sample (or similar samples) may be subject to bias. ND – Recovery not determined, background level >= 1x spike level.

Sub-Matrix: **Water**

					Matrix Spike (MS) Report					
					Spike		Recovery (%)	Recovery Limits (%)		
Laboratory sample ID	Client sample ID	Analyte	CAS Number	Method	Concentration	Target	MS	Low	High	Qualifier
Anions and Nutrients (QCLot: 275357)										
VA21B7912-001	SWMP 03 -1m	phosphate, ortho-, dissolved (as P)	14265-44-2	E378-U	0.0350 mg/L	0.03 mg/L	117	70.0	130	----
Anions and Nutrients (QCLot: 280037)										
VA21B7912-002	SWMP 03 -5m	phosphorus, total	7723-14-0	E372-U	0.0471 mg/L	0.05 mg/L	94.3	70.0	130	----

Chain of Custody (COC) / Analytical Request Form

COC Number: 20 - 922255

Page 1 of 1

Canada Toll Free: 1 800 668 9878

www.alsglobal.com

Report To	Contact and company name below will appear on the final report
Company:	BC Conservation Fdn.
Contact:	Thea Rodgers trodgers@bccf.com
Phone:	250-390-2525
Company address below will appear on the final report	
Street:	#105-1885 Boxwood Road.
City/Province:	Nanaimo BC
Postal Code:	V9S 5X9
Invoice To	Same as Report To: YES NO
	Copy of Invoice with Report: YES NO
Company:	
Contact:	Jimerich@bccf.com

Reports / Recipients

Select Report Format: PDF EXCEL EDD (DIGITAL)

Merge QC/QCI Reports with COA: YES NO N/A

Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: EMAIL MAIL FAX

Email 1 or Fax: trodgers@bccf.com

Email 2:

Email 3:

Invoice Recipients

Select Invoice Distribution: EMAIL MAIL FAX

Email 1 or Fax: trodgers@bccf.com

Email 2:

Turnaround Time (TAT) Requested

- Routine [R] if received by 3pm M-F - no surcharges apply
- 4 day [P4] if received by 3pm M-F - 20% rush surcharge minimum
- 3 day [P3] if received by 3pm M-F - 25% rush surcharge minimum
- 2 day [P2] if received by 3pm M-F - 50% rush surcharge minimum
- 1 day [E] if received by 3pm M-F - 100% rush surcharge minimum
- Same day [E2] if received by 10am M-S - 200% rush surcharge. Additional fees may apply to rush requests on weekends, statutory holidays and non-routine tests

AFFIX ALS BARCODE LABEL HERE (ALS use only)

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm am/pm

For all tests with rush TATs requested, please contact your AM to confirm availability.

Project Information		Oil and Gas Required Fields (client use)	
ALS Account # / Quote #:		AFE/Cost Center:	PO#
Job #:	Enos Lake.	Major/Minor Code:	Routing Code:
PO / AFE:		Requisitioner:	
LSD:		Location:	
ALS Lab Work Order # (ALS use only):		ALS Contact: Sneha Sensare	Sampler: TR/TN

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (ALS use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	NUMBER OF CONTAINERS	P	Total P (P)	Orthophosphate	Chlorophyll-a	Is NOT field filtered.	ES ON HOLD	EXTENDED STORAGE REQUIRED	SUSPECTED HAZARD (see notes)
	SWMP 03 - 1m	Aug 23	1135	Water	3	✓	✓	✓	✓				
	SWMP 03 - 5m	"	1140	"	3	✓	✓	✓	✓				
	SWMP 03 - 9.5m	" 2021	1145	"	3	✓	✓	✓	✓				

Environmental Division
Vancouver
Work Order Reference
VA21B7912

Telephone : +1 604 253 4188

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System? YES NO

Are samples for human consumption/ use? YES NO

Notes / Specify Limits for result evaluation by selecting from drop-down below (Excel COC only)

Please filter Chl-a within 48 hrs.

SAMPLE RECEIPT DETAILS (ALS use only)

Cooling Method: NONE ICE ICE PACKS FROZEN COOLING INITIATED

Submission Comments identified on Sample Receipt Notification: YES NO

Cooler Custody Seals Intact: YES N/A Sample Custody Seals Intact: YES N/A

INITIAL COOLER TEMPERATURES °C				FINAL COOLER TEMPERATURES °C			
				9 C			

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (ALS use only)			FINAL SHIPMENT RECEPTION (ALS use only)		
Released by: TR	Date: Aug 23	Time: 1345	Received by:	Date:	Time:	Received by: JG	Date: 24 Aug	Time: 9 AM

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

AUG 2020 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form**.

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **VA21C5663**	Page	: 1 of 2
Client	: **The British Columbia Conservation Foundation**	Laboratory	: Vancouver - Environmental
Contact	: Thea Rodgers	Account Manager	: Sneha Sansare
Address	: 105 - 1885 Boxwood Rd Nanaimo BC Canada V9S 5X9	Address	: 8081 Lougheed Highway Burnaby BC Canada V5A 1W9
Telephone	: 250-390-2525	Telephone	: +1 604 253 4188
Project	: 1302015-Enos Lake 2021	Date Samples Received	: 17-Nov-2021 09:10
PO	: ----	Date Analysis Commenced	: 18-Nov-2021
C-O-C number	: ----	Issue Date	: 26-Nov-2021 13:58
Sampler	: P L, T R		
Site	: ----		
Quote number	: Q78255 - Standing offer		
No. of samples received	: 3		
No. of samples analysed	: 3		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QC Interpretive report to assist with Quality Review and Sample Receipt Notification (SRN).

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is conducted in accordance with US FDA 21 CFR Part 11.

Signatories	*Position*	*Laboratory Department*
Lindsay Gung	Supervisor - Water Chemistry	Inorganics, Burnaby, British Columbia

General Comments

The analytical methods used by ALS are developed using internationally recognized reference methods (where available), such as those published by US EPA, APHA Standard Methods, ASTM, ISO, Environment Canada, BC MOE, and Ontario MOE. Refer to the ALS Quality Control Interpretive report (QCI) for applicable references and methodology summaries. Reference methods may incorporate modifications to improve performance.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Please refer to Quality Control Interpretive report (QCI) for information regarding Holding Time compliance.

Key : CAS Number: Chemical Abstracts Services number is a unique identifier assigned to discrete substances
LOR: Limit of Reporting (detection limit).

Unit	*Description*
µg/L	micrograms per litre
mg/L	milligrams per litre

<: less than.

>: greater than.

Surrogate: An analyte that is similar in behavior to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED on SRN or QCI Report, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical Results

Sub-Matrix: **Water**
(Matrix: **Water**)

Analyte	*CAS Number*	*Method*	*LOR*	*Unit*	*Client sample ID*	**SUMP 03 - 1m**	**SUMP 03 - 5m**	**SUMP 03 - 10m**	**----**	**----**
					Client sampling date / time	16-Nov-2021 10:30	16-Nov-2021 10:45	16-Nov-2021 11:00	----	----
						VA21C5663-001	**VA21C5663-002**	**VA21C5663-003**	**--------**	**--------**
						Result	Result	Result	----	----
Anions and Nutrients										
phosphate, ortho-, dissolved (as P)	14265-44-2	E378-U	0.0010	mg/L		<0.0010	<0.0010	<0.0010	----	----
phosphorus, total	7723-14-0	E372-U	0.0020	mg/L		0.0120	0.0069	0.0120	----	----
Plant Pigments										
chlorophyll a	479-61-8	E870	0.010	µg/L		9.66	9.45	6.83	----	----

Please refer to the General Comments section for an explanation of any qualifiers detected.

QUALITY CONTROL INTERPRETIVE REPORT

Work Order	: **VA21C5663**	Page	: 1 of 5
Client	: **The British Columbia Conservation Foundation**	Laboratory	: Vancouver - Environmental
Contact	: Thea Rodgers	Account Manager	: Sneha Sansare
Address	: 105 - 1885 Boxwood Rd Nanaimo BC Canada V9S 5X9	Address	: 8081 Lougheed Highway Burnaby, British Columbia Canada V5A 1W9
Telephone	: 250-390-2525	Telephone	: +1 604 253 4188
Project	: 1302015-Enos Lake 2021	Date Samples Received	: 17-Nov-2021 09:10
PO	: ----	Issue Date	: 26-Nov-2021 13:58
C-O-C number	: ----		
Sampler	: P L, T R		
Site	: ----		
Quote number	: Q78255 - Standing offer		
No. of samples received	: 3		
No. of samples analysed	: 3		

This report is automatically generated by the ALS LIMS (Laboratory Information Management System) through evaluation of Quality Control (QC) results and other QA parameters associated with this submission, and is intended to facilitate rapid data validation by auditors or reviewers. The report highlights any exceptions and outliers to ALS Data Quality Objectives, provides holding time details and exceptions, summarizes QC sample frequencies, and lists applicable methodology references and summaries.

Key

Anonymous: Refers to samples which are not part of this work order, but which formed part of the QC process lot.
CAS Number: Chemical Abstracts Services number is a unique identifier assigned to discrete substances.
DQO: Data Quality Objective.
LOR: Limit of Reporting (detection limit).
RPD: Relative Percent Difference.

Summary of Outliers

Outliers : Quality Control Samples

- No Method Blank value outliers occur.
- No Duplicate outliers occur.
- No Laboratory Control Sample (LCS) outliers occur
- No Matrix Spike outliers occur.
- No Test sample Surrogate recovery outliers exist.

Outliers: Reference Material (RM) Samples

- No Reference Material (RM) Sample outliers occur.

Outliers : Analysis Holding Time Compliance (Breaches)

- No Analysis Holding Time Outliers exist.

Outliers : Frequency of Quality Control Samples

- No Quality Control Sample Frequency Outliers occur.

Analysis Holding Time Compliance

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times, which are selected to meet known provincial and /or federal requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by organizations such as CCME, US EPA, APHA Standard Methods, ASTM, or Environment Canada (where available). Dates and holding times reported below represent the first dates of extraction or analysis. If subsequent tests or dilutions exceeded holding times, qualifiers are added (refer to COA).

If samples are identified below as having been analyzed or extracted outside of recommended holding times, measurement uncertainties may be increased, and this should be taken into consideration when interpreting results.

Where actual sampling date is not provided on the chain of custody, the date of receipt with time at 00:00 is used for calculation purposes.

Where only the sample date without time is provided on the chain of custody, the sampling date at 00:00 is used for calculation purposes.

Matrix: **Water**

Evaluation: × = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group / Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times Rec	Holding Times Actual	Eval	Analysis Date	Holding Times Rec	Holding Times Actual	Eval
Anions and Nutrients : Dissolved Orthophosphate by Colourimetry (Ultra Trace Level)										
HDPE										
SUMP 03 - 10m	E378-U	16-Nov-2021	----	----	----		18-Nov-2021	3 days	2 days	✓
Anions and Nutrients : Dissolved Orthophosphate by Colourimetry (Ultra Trace Level)										
HDPE										
SUMP 03 - 1m	E378-U	16-Nov-2021	----	----	----		18-Nov-2021	3 days	2 days	✓
Anions and Nutrients : Dissolved Orthophosphate by Colourimetry (Ultra Trace Level)										
HDPE										
SUMP 03 - 5m	E378-U	16-Nov-2021	----	----	----		18-Nov-2021	3 days	2 days	✓
Anions and Nutrients : Total Phosphorus by Colourimetry (Ultra Trace)										
Amber glass total (sulfuric acid)										
SUMP 03 - 10m	E372-U	16-Nov-2021	23-Nov-2021	----	----		24-Nov-2021	28 days	8 days	✓
Anions and Nutrients : Total Phosphorus by Colourimetry (Ultra Trace)										
Amber glass total (sulfuric acid)										
SUMP 03 - 1m	E372-U	16-Nov-2021	23-Nov-2021	----	----		24-Nov-2021	28 days	8 days	✓
Anions and Nutrients : Total Phosphorus by Colourimetry (Ultra Trace)										
Amber glass total (sulfuric acid)										
SUMP 03 - 5m	E372-U	16-Nov-2021	23-Nov-2021	----	----		24-Nov-2021	28 days	8 days	✓
Plant Pigments : Chlorophyll-a by Fluorometry										
Opaque HDPE										
SUMP 03 - 10m	E870	16-Nov-2021	18-Nov-2021	2 days	2 days	✓	26-Nov-2021	672 hrs	8 days	✓

Matrix: **Water**

Evaluation: × = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group / Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times Rec	Holding Times Actual	Eval	Analysis Date	Holding Times Rec	Holding Times Actual	Eval
Plant Pigments : Chlorophyll-a by Fluorometry										
Opaque HDPE SUMP 03 - 1m	E870	16-Nov-2021	18-Nov-2021	2 days	2 days	✓	26-Nov-2021	672 hrs	8 days	✓
Plant Pigments : Chlorophyll-a by Fluorometry										
Opaque HDPE SUMP 03 - 5m	E870	16-Nov-2021	18-Nov-2021	2 days	2 days	✓	26-Nov-2021	672 hrs	8 days	✓

Legend & Qualifier Definitions

Rec. HT: ALS recommended hold time (see units).

Quality Control Parameter Frequency Compliance

The following report summarizes the frequency of laboratory QC samples analyzed within the analytical batches (QC lots) in which the submitted samples were processed. The actual frequency should be greater than or equal to the expected frequency.

Matrix: **Water**

Evaluation: × = *QC frequency outside specification*; ✓ = *QC frequency within specification.*

Quality Control Sample Type			Count		Frequency (%)		
Analytical Methods	*Method*	*QC Lot #*	*QC*	*Regular*	*Actual*	*Expected*	*Evaluation*
Laboratory Duplicates (DUP)							
Dissolved Orthophosphate by Colourimetry (Ultra Trace Level)	E378-U	347431	1	9	11.1	5.0	✓
Total Phosphorus by Colourimetry (Ultra Trace)	E372-U	351015	1	4	25.0	5.0	✓
Laboratory Control Samples (LCS)							
Chlorophyll-a by Fluorometry	E870	347339	1	3	33.3	5.0	✓
Dissolved Orthophosphate by Colourimetry (Ultra Trace Level)	E378-U	347431	1	9	11.1	5.0	✓
Total Phosphorus by Colourimetry (Ultra Trace)	E372-U	351015	1	4	25.0	5.0	✓
Method Blanks (MB)							
Chlorophyll-a by Fluorometry	E870	347339	1	3	33.3	5.0	✓
Dissolved Orthophosphate by Colourimetry (Ultra Trace Level)	E378-U	347431	1	9	11.1	5.0	✓
Total Phosphorus by Colourimetry (Ultra Trace)	E372-U	351015	1	4	25.0	5.0	✓
Matrix Spikes (MS)							
Dissolved Orthophosphate by Colourimetry (Ultra Trace Level)	E378-U	347431	1	9	11.1	5.0	✓
Total Phosphorus by Colourimetry (Ultra Trace)	E372-U	351015	1	4	25.0	5.0	✓

Methodology References and Summaries

The analytical methods used by ALS are developed using internationally recognized reference methods (where available), such as those published by US EPA, APHA Standard Methods, ASTM, ISO, Environment Canada, BC MOE, and Ontario MOE. Reference methods may incorporate modifications to improve performance (indicated by "mod").

Analytical Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
Total Phosphorus by Colourimetry (Ultra Trace)	E372-U Vancouver - Environmental	Water	APHA 4500-P E (mod).	Total Phosphorus is determined colourimetrically using a discrete analyzer after heated persulfate digestion of the sample.
Dissolved Orthophosphate by Colourimetry (Ultra Trace Level)	E378-U Vancouver - Environmental	Water	APHA 4500-P F (mod)	Dissolved Orthophosphate is determined colourimetrically on a flow analyzer on a sample that has been lab or field filtered through a 0.45 micron membrane filter. Field filtration is recommended to ensure test results represent conditions at time of sampling.
Chlorophyll-a by Fluorometry	E870 Vancouver - Environmental	Water	EPA 445.0 (mod)	Chlorophyll a is determined by solvent extraction followed with analysis by fluorometry using the non-acidification procedure. This method is not subject to interferences from chlorophyll b.

Preparation Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
Digestion for Total Phosphorus in water	EP372 Vancouver - Environmental	Water	APHA 4500-P E (mod).	Samples are heated with a persulfate digestion reagent.
Chlorophyll-a Extraction	EP870 Vancouver - Environmental	Water	EPA 445.0 (mod)	Chlorophyll-a solvent extraction.

QUALITY CONTROL REPORT

Work Order	: **VA21C5663**	Page	: 1 of 3
Client	: The British Columbia Conservation Foundation	Laboratory	: Vancouver - Environmental
Contact	: Thea Rodgers	Account Manager	: Sneha Sansare
Address	: 105 - 1885 Boxwood Rd Nanaimo BC Canada V9S 5X9	Address	: 8081 Lougheed Highway Burnaby, British Columbia Canada V5A 1W9
Telephone	: 250-390-2525	Telephone	: +1 604 253 4188
Project	: 1302015-Enos Lake 2021	Date Samples Received	: 17-Nov-2021 09:10
PO	: ----	Date Analysis Commenced	: 18-Nov-2021
C-O-C number	: ----	Issue Date	: 26-Nov-2021 13:58
Sampler	: P L, T R		
Site	: ----		
Quote number	: Q78255 - Standing offer		
No. of samples received	: 3		
No. of samples analysed	: 3		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits
- Reference Material (RM) Report; Recovery and Acceptance Limits
- Method Blank (MB) Report; Recovery and Acceptance Limits
- Laboratory Control Sample (LCS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is conducted in accordance with US FDA 21 CFR Part 11.

Signatories	*Position*	*Laboratory Department*
Lindsay Gung	Supervisor - Water Chemistry	Inorganics, Burnaby, British Columbia

General Comments

The ALS Quality Control (QC) report is optionally provided to ALS clients upon request. ALS test methods include comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against predetermined Data Quality Objectives (DQOs) to provide confidence in the accuracy of associated test results. This report contains detailed results for all QC results applicable to this sample submission. Please refer to the ALS Quality Control Interpretation report (QCI) for applicable method references and methodology summaries.

Key :

Anonymous = Refers to samples which are not part of this work order, but which formed part of the QC process lot.
CAS Number = Chemical Abstracts Services number is a unique identifier assigned to discrete substances.
DQO = Data Quality Objective.
LOR = Limit of Reporting (detection limit).
RPD = Relative Percentage Difference
# = Indicates a QC result that did not meet the ALS DQO.

Laboratory Duplicate (DUP) Report

A Laboratory Duplicate (DUP) is a randomly selected intralaboratory replicate sample. Laboratory Duplicates provide information regarding method precision and sample heterogeneity. ALS DQOs for Laboratory Duplicates are expressed as test-specific limits for Relative Percent Difference (RPD), or as an absolute difference limit of 2 times the LOR for low concentration duplicates within ~ 4-10 times the LOR (cut-off is test specific).

Sub-Matrix: **Water**

					Laboratory Duplicate (DUP) Report						
Laboratory sample ID	Client sample ID	Analyte	CAS Number	Method	LOR	Unit	Original Result	Duplicate Result	RPD(%) or Difference	Duplicate Limits	Qualifier
Anions and Nutrients (QC Lot: 347431)											
VA21C5606-001	Anonymous	phosphate, ortho-, dissolved (as P)	14265-44-2	E378-U	0.0010	mg/L	<0.0010	<0.0010	0	Diff <2x LOR	----
Anions and Nutrients (QC Lot: 351015)											
VA21C5663-001	SUMP 03 - 1m	phosphorus, total	7723-14-0	E372-U	0.0020	mg/L	0.0120	0.0108	0.0012	Diff <2x LOR	----

Method Blank (MB) Report

A Method Blank is an analyte-free matrix that undergoes sample processing identical to that carried out for test samples. Method Blank results are used to monitor and control for potential contamination from the laboratory environment and reagents. For most tests, the DQO for Method Blanks is for the result to be < LOR.

Sub-Matrix: **Water**

Analyte	CAS Number	Method	LOR	Unit	Result	Qualifier
Anions and Nutrients (QCLot: 347431)						
phosphate, ortho-, dissolved (as P)	14265-44-2	E378-U	0.001	mg/L	<0.0010	----
Anions and Nutrients (QCLot: 351015)						
phosphorus, total	7723-14-0	E372-U	0.002	mg/L	<0.0020	----
Plant Pigments (QCLot: 347339)						
chlorophyll a	479-61-8	E870	0.01	µg/L	<0.010	----

Laboratory Control Sample (LCS) Report

A Laboratory Control Sample (LCS) is an analyte-free matrix that has been fortified (spiked) with test analytes at known concentration and processed in an identical manner to test samples. LCS results are expressed as percent recovery, and are used to monitor and control test method accuracy and precision, independent of test sample matrix.

Sub-Matrix: **Water**

					Laboratory Control Sample (LCS) Report				
					Spike	Recovery (%)	Recovery Limits (%)		
Analyte	CAS Number	Method	LOR	Unit	Concentration	LCS	Low	High	Qualifier
Anions and Nutrients (QCLot: 347431)									
phosphate, ortho-, dissolved (as P)	14265-44-2	E378-U	0.001	mg/L	0.03 mg/L	95.3	80.0	120	----
Anions and Nutrients (QCLot: 351015)									
phosphorus, total	7723-14-0	E372-U	0.002	mg/L	0.05 mg/L	104	80.0	120	----
Plant Pigments (QCLot: 347339)									
chlorophyll a	479-61-8	E870	0.01	µg/L	5 µg/L	102	80.0	120	----

Matrix Spike (MS) Report

A Matrix Spike (MS) is a randomly selected intra-laboratory replicate sample that has been fortified (spiked) with test analytes at known concentration, and processed in an identical manner to test samples. Matrix Spikes provide information regarding analyte recovery and potential matrix effects. MS DQO exceedances due to sample matrix may sometimes be unavoidable; in such cases, test results for the associated sample (or similar samples) may be subject to bias. ND – Recovery not determined, background level >= 1x spike level.

Sub-Matrix: **Water**

					Matrix Spike (MS) Report					
					Spike		Recovery (%)	Recovery Limits (%)		
Laboratory sample ID	Client sample ID	Analyte	CAS Number	Method	Concentration	Target	MS	Low	High	Qualifier
Anions and Nutrients (QCLot: 347431)										
VA21C5606-002	Anonymous	phosphate, ortho-, dissolved (as P)	14265-44-2	E378-U	0.0372 mg/L	0.03 mg/L	124	70.0	130	----
Anions and Nutrients (QCLot: 351015)										
VA21C5663-002	SUMP 03 - 5m	phosphorus, total	7723-14-0	E372-U	0.0504 mg/L	0.05 mg/L	101	70.0	130	----

Chain of Custody (COC) / Analytical Request Form

COC Number: 20 - 978569

Canada Toll Free: 1 800 668 9878

Page 1 of 1

www.alsglobal.com

Report To	Contact and company name below will appear on the final report
Company:	BC Conservation Foundation
Contact:	Thea Rodgers
Phone:	250-390-2525
	Company address below will appear on the final report
Street:	#105 - 1885 Boxwood Rd
City/Province:	Nanaimo, BC
Postal Code:	V9S 5Z9

Invoice To		
	Same as Report To	[X] YES [ ] NO
	Copy of Invoice with Report	[X] YES [ ] NO
Company:		
Contact:		

Reports / Recipients

Select Report Format: [X] PDF [X] EXCEL [ ] EDD (DIGITAL)

Merge QC/QCI Reports with COA [X] YES [ ] NO [ ] N/A

[ ] Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: [X] EMAIL [ ] MAIL [ ] FAX

Email 1 or Fax: trodgers@bccf.com

Email 2:

Email 3:

Invoice Recipients

Select Invoice Distribution: [X] EMAIL [ ] MAIL [ ] FAX

Email 1 or Fax: trodgers@bccf.com

Email 2: llimerick@bccf.com

Turnaround Time (TAT) Requested

[X] Routine [R] if received by 3pm M-F - no surcharges apply

[ ] 4 day [P4] if received by 3pm M-F - 20% rush surcharge minimum

[ ] 3 day [P3] if received by 3pm M-F - 25% rush surcharge minimum

[ ] 2 day [P2] if received by 3pm M-F - 50% rush surcharge minimum

[ ] 1 day [E] if received by 3pm M-F - 100% rush surcharge minimum

[ ] Same day [E2] If received by 10am M-S - 200% rush surcharge. Additional fees may apply to rush requests on weekends, statutory holidays and non-routine tests.

AFFIX ALS BARCODE LABEL HERE (ALS use only)

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm am/pm

For all tests with rush TATs requested, please contact your AM to confirm availability.

Project Information

ALS Account # / Quote #:

Job #: 1302015 - Enos Lake 2021

PO / AFE:

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center: PO#:

Major/Minor Code: Routing Code:

Requisitioner:

Location:

ALS Lab Work Order # (ALS use only):

ALS Contact: Sneha Sansare Sampler: TR/PL

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (ALS use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	NUMBER OF CONTAINERS	Chlorophyll-a (raw)	Total P	Orthophosphate (raw)	SAMPLES ON HOLD	EXTENDED STORAGE REQUIRED	SUSPECTED HAZARD (see notes)
	SWMP03 - 1m	16-11-21	10:30	water	3	✓	✓	✓			
	SWMP03 - 5m	16-11-21	10:45	water	3	✓	✓	✓			
	SWMP03 - 10m	16-11-21	11:00	water	3	✓	✓	✓			

Environmental Division
Vancouver
Work Order Reference
VA21C5663

Telephone : +1 604 253 4188

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System? [ ] YES [X] NO

Are samples for human consumption/ use? [ ] YES [X] NO

Notes / Specify Limits for result evaluation by selecting from drop-down below (Excel COC only)

Chl-a is unfiltered, please filter a.s.a.p. (<48 hrs)
Thanks

SAMPLE RECEIPT DETAILS (ALS use only)

Cooling Method: [ ] NONE [ ] ICE [X] ICE PACKS [ ] FROZEN [ ] COOLING INITIATED

Submission Comments identified on Sample Receipt Notification: [ ] YES [ ] NO

Cooler Custody Seals Intact: [ ] YES [ ] N/A Sample Custody Seals Intact: [ ] YES [ ] N/A

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
				1	

SHIPMENT RELEASE (client use)

Released by: TR Date: 16 Nov. 21 Time: 1400

INITIAL SHIPMENT RECEPTION (ALS use only)

Received by: Date: Time:

FINAL SHIPMENT RECEPTION (ALS use only)

Received by: JC Date: 17 Nov 2021 Time: 910am

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

AUG 2020 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Appendix 2

Limnologist's Report

Enos Lake Protection and Monitoring Program:

Review of 2021 Water Quality Data

From PGL, 2016

For: **BC Conservation Foundation, Lantzville Office**

PO Box 7

Lantzville, B.C.

V0R 2H0

By: John Deniseger

December 2021

Summary

BCCF's Enos Lake annual fundamental water quality monitoring program was once again completed in 2021. The program includes components that are done annually and others that are done on a 5-year cycle. This report examines the results from the annual component collected in 2021, and compares them to water quality targets and trophic status indicators for Enos Lake.

In 2021, the extreme summer drought appeared to exacerbate the annual summer anoxic conditions at depth. As a result, the lack of oxygen extended up into the relatively shallow waters of the thermocline. While it is not known whether this has occurred prior to 2017, it is concerning, as the lake was more susceptible to a summer "fish kill". Climate change will present further challenges as summer water temperatures increase, summer stratification will begin earlier and extend later, with more severe oxygen depletion as was seen in 2021.

In 2021, Enos Lake would be considered a mesotrophic lake based on indicators such as phosphorus and chlorophyll a. Factoring in year-to-year variability and the lack of oxygen at depth during the summer, the data collected over the last 5 years suggests that Enos Lake is mesotrophic, on the edge of being considered eutrophic.

1.0 Background

Enos Lake is a small lake with a surface area of 18 ha and a watershed area of approximately 235 ha. It is in a largely undeveloped area of the Fairwinds Community in Nanoose Bay, B.C. Approximately 12 ha have been developed with predominantly low-density residential housing (PGL, 2016, Nordin 2017).

While some water quality sampling has been carried out since 2006, a standardized sampling program was established in 2017. Sampling history prior to 2017 is further outlined in Nordin (2017). The 2018, 2019 and 2020 data are reviewed in Deniseger (2018, 2019, 2020).

The current water sampling program is intended to build a consistent, long-term database used to both act as a screening tool and to help assess the overall health of Enos Lake with respect to ongoing development, land use, and increasing population within the watershed over the next 10 to 20 years. Fundamental water chemistry and biology are indicators of water quality, potential change, and overall lake and watershed health. The data will be used to assess year-to-year lake health and trends over time.

The purpose of this report is to review the data collected in 2021 and provide a summary report documenting any changes or potential trends observed since 2017.

2.0 Water Quality Results

Table 2.0 below (PGL, 2016) outlines the standardized water quality monitoring which began in 2017. It also lays out the targets used to assist the interpretation of the water quality results for the various parameters.

Table 2.0 Summary of Water Quality Monitoring Program for Enos Lake (PGL, 2016)

Parameter (units)		Water Quality Target	Future Monitoring[a]
Field Parameters (profiles at 1m increments)	Secchi Depth (m)	None – supporting context only	Quarterly sampling[b] at site SWMP-03, starting in 2017 and repeated annually
	Dissolved Oxygen (mg/L and % saturation)	• ≥5 mg/L epilimnion • ≥2 mg/L hypolimnion	Quarterly sampling[b] at site SWMP-03, starting in 2017 and repeated annually
	Conductivity (µS/cm)	None – supporting context only	Quarterly sampling[b] at site SWMP-03, starting in 2017 and repeated annually
	Temperature (°C)	None – supporting context only	Quarterly sampling[b] at site SWMP-03, starting in 2017 and repeated annually
	pH	None – supporting context only	Quarterly sampling[b] at site SWMP-03, starting in 2017 and repeated annually
	Redox (mV)	None – supporting context only	Quarterly sampling[b] at site SWMP-03, starting in 2017 and repeated annually
Laboratory Parameters	*E. coli* (# per mL)	BC Water Quality Guidelines (recreation – secondary contact)[c]	August 2017: 5 times in 30 days. Surface sample from SWMP-03 and any two shoreline locations. Repeat on 5 year increment.
	PAHs (µg/mg)	BC Water Quality Guidelines (freshwater sediments)	August 2017: surface sediment from three locations: SWMP-06, SWMP-04 and SWMP-03.
	Metals (various)	BC Water Quality Guidelines (total metals, freshwater aquatic life). Both average and short-term maximum guidelines apply, where applicable.	February 2017 and August 2017: five samples in a 30 day period. Each sample to occur at three depths from SWMP-03. Sampling to be repeated on five year increments.
	Chlorophyll *a* (µg/L)	Avoid any increase	Quarterly sampling at site SWMP-03, starting in 2017, and repeated annually. Samples to be taken from three depths (surface, mid, deep water)
	Hardness (as $CaCO_3$)	None – required to interpret metals data	February 2017 and August 2017: five samples in a 30 day period. Each sample to occur at three depths from SWMP-03. Sampling to be repeated on five year increments. Data required to interpret metals concentrations.
	Phosphorous (mg/L)	12 µg/L	Quarterly sampling at site SWMP-03, starting in 2017. Samples to be taken from three depths (surface, mid, deep water)

[a]Future monitoring is limited to the scope being taken on by the Developer and will continue until at least one year post build-out within the Enos Lake watershed. It is anticipated that some form of longer term monitoring will be undertaken by RDN in support of long term operation of stormwater infrastructure.
[b]Quarterly sampling is defined as February, May, August, and November.
[c]It is assumed that swimming will not be a recreational use of Enos Lake. If that assumption is incorrect, primary contact guidelines should apply.

2.1 Secchi Depth

Secchi depth is a standard measure of water clarity, providing insight into lake health and productivity from both an aesthetic and ecological perspective. During storm events, it can also be used to qualitatively assess the transport of fine sediment from the watershed into the lake.

The 11 data points collected in 2017 showed substantial variation from 1.4 to 4.8 m with an average of 3 m. Due to the inherent variability in secchi data, Nordin (2017) recommended that the base sampling program include monthly secchi data collection.

In each of 2018 and 2019, only 5 data points were collected, ranging from 2.0 to 3.5 m, and 1.5 to 2.8 m, respectively.

More secchi measurements have been collected in 2020 and in 2021. In 2020, secchi depth ranged from 1.0 to 4.3 m, with an annual average of 2.7 m. In 2021, the 13 data points ranged from a low of 0.8 m in late February to a high of 4.0 m in late August with a mean of 3.0 m. This was very similar to the previous year's readings. In both years, the low February secchi reading is likely indicative of an early spring phytoplankton bloom.

An additional low reading on November 16th reflects the preceding heavy rainfall event and subsequent surface runoff likely carrying fine sediment. The lake was described as being "high and light brown" in colour.

Date	Secchi (m)
Feb 7	1.8
Feb 23	0.8
May 18	3.3
May 30	3.4
June 20	3.8
July 3	2.6
July 28	3
Aug 3	3.3
Aug 10	3.5
Aug 15	4
August 23	3.9
Aug 29	3.7
November 16	1.7

Annual mean 3.0 m

2.2 Temperature

Field data collection in 2021 included temperature, dissolved oxygen, pH, conductivity and redox potential profiles taken quarterly at station 03, the mid-lake sampling station.

Lake temperature has fundamental effects on a lake's seasonal response and susceptibility to watershed activities and disturbance. Thermal stratification is an important factor in understanding fundamental lake ecology and natural processes. Table 2.1 summarizes the lake temperature profiles for 2021. The late February profile shows the lake to be effectively isothermal, unstratified and mixing. The water temperature was 1.5 to 2 degrees C cooler than in February 2020. This is a reflection of more normal precipitation and weather patterns in early 2021 as well as the relatively drier and warmer patterns prevalent in February 2020. By May, the profile indicates well established stratification with a shallow upper warm layer (epilimnion) about 3 meters deep overlying a deeper cool layer(hypolimnion). The transition zone between the two layers is known as the thermocline – it is defined by having a change of greater than 1 C per meter of depth change. The overall difference from top to bottom was 10.6 C. In August, the upper 3 meters of Enos Lake were greater than 21 C, with a very steep, compressed thermocline, particularly between 4.5 and 6 meters but continuing to 8m in depth. The strong thermocline is continuous at least from mid-spring through early fall, effectively isolating the deeper waters of the lake. The surface water was 13.6 C warmer than the deepest waters of the lake. The very compressed nature of the August 2021 thermocline reflects the extremely dry and hot summer of 2021, including the late June "heat dome" event when local air temperatures were between 35 and 40 C for a number of days. While no Enos Lake data was collected during the "heat dome", surface water temperatures would have been increasing relatively quickly.

In contrast to the extreme summer drought, by mid-September, the weather patterns "flipped" completely to initially provide much needed rainfall, followed by a series of storms and rain events culminating in severe flooding in coastal B.C. in mid to late November. The November 23rd sampling

immediately followed the most severe of these coastal rain events. While the data confirmed that the lake was once again isothermal, unstratified and mixing (it had likely been so for quite some time), the lake was also described as "high and light brown in colour, reflecting the heavy rain and the deposition of fine sediment from surface runoff entering the lake. Enos Lake's general thermal stratification patterns appear to be fairly typical of small, east coast Vancouver Island lakes.

Table 2.1 Enos Lake temperature profiles for 2021

Profile - Site SWMP-03				
	2/23/2021	**5/18/2021**	**8/23/2021**	**11/16/2021**
Depth (m)	Temp. (°C)	Temp. (°C)	Temp. (°C)	Temp. (°C)
0.5	3.9	17.9	21.5	8.1
1	3.7	17.9	21.5	8.1
2	3.8	17.7	21.5	8.0
3	3.8	17.1	21.4	8.0
3.5		14.8		8.0
4	3.8	12.3	20.7	8.0
4.5			19.3	8.0
5	3.8	10.6	15.6	8.0
6	3.8	9.3	11.8	8.0
7	3.8	8.3	9.6	8.0
8	3.8	7.8	8.6	8.0
9	3.8	7.5	8.1	8.0
10	3.8	7.4	8.0	8.0
11	3.8	7.3	7.9	7.9
12				8.0

2.3 Dissolved Oxygen

See tables 2.2 and 2.3 for dissolved oxygen concentrations and percent saturation.

The late February sampling was done when the lake was isothermal with temperatures from 3.7. to 3.8 C (see table 2.2). Dissolved oxygen levels were high, consistently greater than 11.6 mg/L, with saturation from 88 to 96.5%. Overall, this reflects isothermal conditions and subsequent mixing throughout the water column. The relatively high saturation levels may be influenced by a phytoplankton bloom occurring in the early spring, as indicated by both the chlorophyll a and secchi data. Significant "blooms" can result in daytime oxygen supersaturation in lake waters.

The May sampling indicates a stratified lake with a thermocline between 3 and 7 meters deep, with significant oxygen depletion below 9 meters and greater than 80% saturation above 5 meters. Saturation levels decrease quickly below 7 meters, with very low oxygen below 8 meters.

The August 2021 profile indicates a warm layer of surface water down to 4 meters, with a deeper, very steep thermocline down to 8 meters. This steep thermocline effectively isolates the deeper, denser colder waters of the lake, so that very little mixing and replenishment occurs. Decomposition of organic

matter in the deeper waters is gradually consuming the oxygen present below the thermocline. As a result, there is severe oxygen depletion in the deeper waters of the lake. In 2020, there was oxygen depletion below 6 meters. In 2021, the deeper waters of the lake below 5 meters were virtually anoxic, with oxygen depletion creeping up into the thermocline. It is highly likely that the summer drought and heat has exacerbated the lack of oxygen at depth.

The November profile reflects isothermal conditions due to the breakdown of the thermocline with dissolved oxygen levels greater than 9 mg/L throughout the water column and dissolved saturation ranging from 78.2 to 84.8%.

In the epilimnion layer (above the thermocline), the water quality target for dissolved oxygen is greater than 5 mg/L. This target was met in each sample set. Below the thermocline in the hypolimnion, the target is 2 mg/L. This target was not met during the late spring and not met through the summer (May through August at least) and likely well into the fall. The August 23rd data was particularly concerning as the lake was virtually anoxic below the mid-point of the thermocline. This is indicative of a productive lake with insufficient mixing/inflow, substantial organic decomposition at depth, as well as internal loading and subsequent release of phosphorus from the sediments.

Table 2.2 Enos Lake Dissolved Oxygen concentration profiles for 2021

Profile - Site SWMP-03				
	2/23/2021	**5/18/2021**	**8/23/2021**	**11/16/2021**
Depth (m)	D.O. (mg/L)	D.O. (mg/L)	D.O. (mg/L)	D.O. (mg/L)
0.5	12.73	8.32	7.41	9.85
1	12.51	8.54	7.44	9.94
2	12.32	7.64	7.29	9.65
3	12.31	8.08	7.24	9.48
3.5		9.52		
4	12.20	10.39	7.05	9.54
4.5			6.55	
5	12.29	9.17	4.56	10.03
6	12.33	8.98	0.21	9.83
7	11.93	7.30	0.11	9.89
8	12.00	5.50	0.07	9.58
9	11.79	2.83	0.05	9.65
10	11.63	1.08	0.05	9.22
11	11.69	0.57	0.05	9.74

Table 2.3 Enos Lake Dissolved Oxygen saturation profiles for 2021 (from Standard Methods for the examination of water and wastewater)

Profile - Site SWMP-03 dissolved oxygen (% saturation)				
	2/23/2021	5/18/2021	8/23/2021	11/16/2021
Depth (m)	D.O. (%saturation)	D.O. (%saturation)	D.O. (%saturation)	D.O. (%saturation)
0.5	96.5	87.8	86.1	84.0
1	94.8	90.0	84.8	83.8
2	93.5	80.2	81.2	81.4
3	93.4	83.7	81.9	80.4
3.5		94.5		
4	92.7	97.2	78.6	80.4
4.5			70.8	
5	93.3	82.1	45.6	84.8
6	93.9	78.2	2.1	83.6
7	90.3	62.2	1.0	83.5
8	91.0	46.3	0.6	81.0
9	89.6	23.6	0.5	80.8
10	88.3	9.0	0.4	78.2
11	88.7	4.8	0.4	82.0

2.4 Conductivity

As a simple measure of dissolved ions in the water, conductivity is a general indicator of lake health and watershed disturbance, in support of other data.

The profile for late February when the lake was not stratified showed minimal variability ranging from 117.8 to 118.3 µS/cm. In May, conductance ranged from 112.5 µS/cm to 121.0 µS/cm. In August, conductance behaved differently, exhibiting 3 fairly distinct layers; the epilimnion above the thermocline was consistently at 137.2 to 137.3 µS/cm, before decreasing through the thermocline ranging from 121.4 µS/cm to 126.0 µS/cm. Below the thermocline, conductance steadily increased from 131.9 µS/cm at 8 m to 151.7 µS/cm at 11 m. In November, the lake was once again effectively isothermal, and conductance showed minimal variability ranging from 122.1 µS/cm to 122.8 µS/cm with the exception of 146.3 µS/cm at 12 m, likely just above the sediment/water interface. While there is some year-to-year variability, the overall trends appear to be similar from year to year. The relative lack of summer rain and inflow to the lake produces a strong thermocline, which limits vertical mixing in the lake. Decomposition in the hypolimnion results in anoxic or near anoxic conditions at depth, which in turn results in internal loading of phosphorus. Evaporation at the lake surface results in an increase in conductance, while an accumulation of dissolved ions and organic matter at depth increases conductance in the hypolimnion.

Overall, conductivity appears to be within the range to be expected for this area, given the precipitation, watershed runoff and previous data (Nordin, 2017).

Table 2.4 Enos Lake conductivity profiles for 2021

Profile - Site SWMP-03				
	2/23/2021	5/18/2021	8/23/2021	11/16/2021
Depth (m)	Conductivity (µS/cm)	Conductivity (µS/cm)	Conductivity (µS/cm)	Conductivity (µS/cm)
0.5	118.1	117.7	137.2	122.5
1	117.9	117.7	137.2	122.6
2	117.8	117.6	137.2	122.5
3	117.9	117.1	137.3	122.7
3.5		114.9		
4	117.9	112.8	134.8	122.7
4.5			126.0	
5	117.9	112.5	121.4	122.7
6	117.8	112.5	122.5	122.7
7	117.9	113.0	124.2	122.8
8	117.9	114.2	131.9	122.8
9	117.9	117.5	144.9	122.4
10	117.9	120.7	149.4	122.1
11	118.3	121.0	151.7	121.7
12				146.3

2.5 pH

Enos Lake pH data is summarized in table 2.5 below

In both 2018 and 2019, pH data was limited due to equipment issues. Since then, the pH data collection and quality has improved considerably. In 2021, pH ranged from 6.25 to 7.92, a similar range to that found in 2020. In February, pH reflected the isothermal conditions present. In May, pH was somewhat higher in the surface waters, decreasing from 7.31 at 4 m to 6.36 at 11 meters, a decrease of 0.95 pH units. As was the case in 2020, a similar but more pronounced decrease was observed in August 2021 with pH values ranging from 7.80 to 7.92 above the thermocline, before rapidly declining through the upper thermocline to 6.33 at 6 m, remaining remarkably consistent to the lake bottom at 11 m

In November, the lake had returned to isothermal conditions, with slight pH fluctuation down to 11 meters in depth. There was a decrease of about 0.5 pH units to 6.47 at 12 meters, likely reflecting conditions just above the sediment/water interface.

The pH trends with depth, which were most pronounced in May and August, may be related to phytoplankton blooms, gradual oxygen depletion and internal loading at depth. In eutrophic lakes, photosynthesizing phytoplankton blooms can raise pH levels in the surface waters. At depth, the bacterial decomposition of organic matter consumes oxygen and releases acidic byproducts, which can cause pH to decrease.

Table 2.5 Enos Lake pH profiles for 2021

Profile - Site SWMP-03				
	2/23/2021	5/18/2021	8/23/2021	11/16/2021
Depth (m)	pH (pH units)	pH (pH units)	pH (pH units)	pH (pH units)
0.5	7.08	7.28	7.86	6.73
1	7.00	7.41	7.92	6.79
2	6.86	7.42	7.91	6.83
3	6.81	7.19	7.91	6.85
3.5		7.32		
4	6.81	7.31	7.80	6.88
4.5			7.51	
5	6.81	7.08	7.12	6.92
6	6.84	6.88	6.33	6.95
7	6.86	6.74	6.33	6.97
8	6.88	6.56	6.30	6.98
9	6.90	6.47	6.26	6.99
10	6.94	6.40	6.25	6.99
11	6.94	6.36	6.29	7.00
12				6.47

2.6 Redox

Enos Lake redox data is summarized in table 2.6 below

Redox potential (sometimes referred to as ORP) measures the lake's ability to be in balance while breaking down organic waste products such as dead and decaying plant matter and plankton. When redox values remain higher, there is lots of oxygen in the water reflecting a balance between lake productivity, watershed health and available oxygen. In general, the higher the redox values, the healthier the lake is, so that bacteria can break down organic matter more efficiently. However, even in healthy lakes, there is generally less oxygen as you approach the bottom sediments, a reflection of the bacterial activity in the sediments.

Over time, there can be an accumulation of slowly decomposing organic matter on the lake bottom, which will further drive the redox and oxygen levels down. This is not a healthy environment for fish or other aquatic organisms. In healthy lakes, redox potential values often range from 300 to 500 mV. In poorly oxygenated water, such as the deeper water of stratified lakes or the sediment of eutrophic lakes, the redox potential will be low (less than 100 mV or even negative values). When redox is low, dissolved oxygen is low, and phosphorus is released from the sediments. This is often referred to as "internal loading" of phosphorus, a process which further exacerbates the eutrophication of lakes, making recovery more difficult. Enos Lake is particularly susceptible to internal loading due to its strong

summer thermocline, which limits vertical mixing, and lack of significant summer inflows due to the generally dry summers typical of the area.

While phosphorus is released from the sediments into the water column during the summer months, it is reabsorbed by the sediments when the thermocline breaks down as the lake cools and mixes during the fall. The process repeats itself annually, as it recycles much of the phosphorus through the lake.

While redox potential can only be measured in the field, it can frequently be a challenge. Redox reactions are slow to equilibrate in the natural environment so that the readings are often considered "semi-quantitative". Probes need frequent maintenance, can have a relatively short shelf life and can become very slow to respond in the field as they age. In 2021, redox data was collected as part of each sampling event.

Table 2.6 Enos Lake redox potential profiles for 2021

Profile - Site SWMP-03				
	2/23/2021	**5/18/2021**	**8/23/2021**	**11/16/2021**
Depth (m)	Redox (mV)	Redox (mV)	Redox (mV)	Redox (mV)
0.5	188.3	187.0	181.8	222.3
1	199.2	186.5	179.6	220.0
2	212.9	186.9	179.4	217.1
3	224.0	190.2	178.0	215.6
3.5		181.4		
4	232.4	198.3	179.9	213.4
4.5			183.9	
5	236.4	191.7	188.3	210.4
6	242.6	200.2	207.5	208.4
7	246.2	205.2	208.1	206.4
8	249.6	208.3	183.0	205.2
9	252.1	210.5	52.6	204.3
10	255.9	212.0	-64.6	203.5
11	257.9	211.5	-138.8	201.8
12				67.0

The redox potential data collected in 2021 is shown above in Table 2.6. The February data is indicative of a well oxygenated water column and the lack of a thermocline. The May data is surprising as it is also indicative of a well oxygenated water column, despite the lack of oxygen at depth. This may indicate a redox probe that is slow to respond due to fouling or aging. The August redox data remained consistently high to 8 meters, despite the anoxic conditions measured below 5 meters. Again, it may indicate a slow to respond redox probe. Regardless, the redox measurements below 8 meters reflected the lack of oxygen at depth, confirming "internal loading" of phosphorus from the sediments. Not surprisingly, the November data once again reflected a well oxygenated water column, other than the 12 meter reading, which likely reflects a measurement taken near the sediment water interface.

2.7 Chlorophyll a

Enos Lake chlorophyll a data is summarized in table 2.7 below

Chlorophyll a is a measure of the algal pigments in lake water and is used to assess overall lake biological productivity.

Interestingly, all of the chlorophyll a data in 2021 was less than 10 ug/L, while in 2020, 8 of 12 samples were higher than 10 ug/L. The more moderate chlorophyll a in 2021 is also reflected in the consistently slightly deeper secchi readings (3 to 4 meters) taken from May through August. As a result, the 2021 annual mean of 6.87 ug/L is the 2nd lowest of the last 5 years.

General trophic status classification using chlorophyll a is based on: <2 ug/L indicates an oligotrophic lake; 2 to 7 ug/L indicates a mesotrophic lake; >7ug/L indicates a eutrophic lake. Enos Lake's 2021 mean concentration of 6.87 ug/L was indicative of a mesotrophic or moderately productive lake, as was the case in 2019.

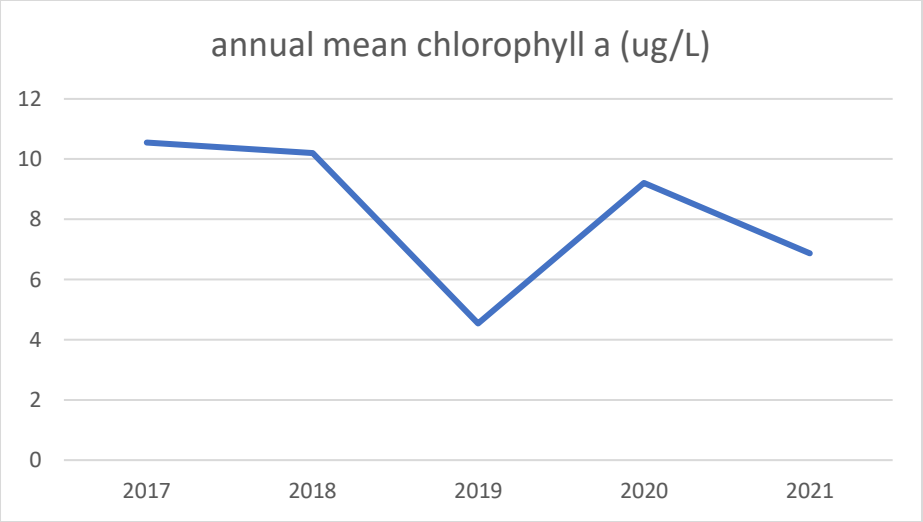
A further target for Enos Lake was to avoid any increase in chlorophyll a over time. Based on the data gathered over the last 5 years, this target has thus far been met.

Table 2.7a Enos Lake chlorophyll a data for 2021

SWMP-03 - chlorophyll a ug/L				
	2/23/2021	**5/18/2021**	**8/23/2021**	**11/16/2021**
Depth (m)				
1	7.38	1.95	3.69	9.66
5	6.92	3.87	7.15	9.45
9.5		6.99	9.72	
10	8.89			6.83
Daily mean	**7.73**	**4.27**	**6.85**	**8.65**
Annual mean	**6.87**			

Table 2.7b Enos Lake Daily and Annual mean chlorophyll a data for 2017 to 2021

SWMP-03 - chlorophyll a ug/L DAILY MEAN AND ANNUAL MEAN					
	FEBRUARY	**MAY**	**AUGUST**	**NOVEMBER**	**ANNUAL MEAN**
2017	11.9	9.82	13.78	6.69	10.55
2018	8.6	8.4	12.4	11.5	10.2
2019		6.61	4.14	2.87	4.54
2020	10.3	2.69	10.9	12.9	9.2
2021	7.73	4.27	6.85	8.65	6.87



2.8 Phosphorus

In lakes, phosphorus is an important nutrient and a key indicator of lake productivity. Excessive phosphorus can result in significant algal blooms and subsequent low dissolved oxygen levels, impacts on drinking water, fish health and recreational use. The water quality target for Enos Lake appears to be an annual average total phosphorus of 12 ug/L. In 2021, the annual average of 10.7 ug/L did meet the target – for the 3rd successive year, well below the 2017 and 2018 averages of 19 and 16.6 ug/L, respectively.

In 2017 and 2018, very high phosphorus values were found through the summer and fall, particularly at depth, likely an indication of a prolonged oxygen deficit in the hypolimnion and subsequent internal loading of phosphorus from the lake sediments. Concentrations between 20 and 40 ug/L were not uncommon. In 2021, the highest concentrations were measured at depth in May (15.7 ug/L) and in August (19.2 ug/L), reflecting internal loading of phosphorus. However, over the last 3 years, there have been no phosphorus measurements higher than 20 ug/L. In both 2019 and 2020, the summer weather included reasonable precipitation which would have provided some inflow and limited surface replenishment. In 2021, on the other hand, there was virtually no rain from mid-June through mid-September. It would appear that phosphorus levels have been lower over the last 3 years, regardless of the summer precipitation patterns.

Another method of evaluating lake trophic status is based on the assessment of total phosphorus. In lakes with longer residence times (>1 year), the assessment is based on concentrations at spring overturn, prior to the establishment of a thermocline. In lakes with shorter residence times (<1 year), it is based on an annual mean. Lakes are considered to be oligotrophic if total phosphorus is less than 10 ug/L; mesotrophic when ranging from 10 to 30 ug/L; and eutrophic when greater than 30 ug/L. Using this assessment method, Enos Lake would be considered mesotrophic in 2021, 2020, and in both 2017 and 2018, but oligotrophic in 2019.

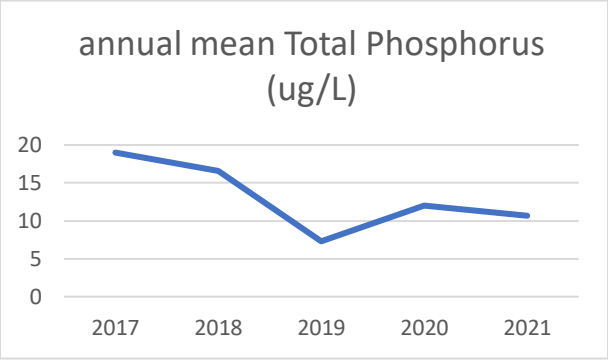
Table 2.8 Enos Lake total phosphorus data for 2021

Site SWMP-03 - total Phosphorus ug/L				
	2/23/2021	5/18/2021	8/23/2021	11/16/2021
Depth (m)				1
1	13.9	6.3	4.2	12
5	11.6	9.4	7.6	6.9
9.5		15.7	19.2	12
10	9.3			
Annual mean	10.7			

Table 2.9 Enos Lake orthophosphate data for 2021

Site SWMP-03 – Orthophosphate ug/L				
	2/23/2021	5/18/2021	8/23/2021	11/16/2021
Depth (m)				
1	1.1	<1	<1	<1
5	<1	<1	<1	<1
9.5		<1	<1	<1
10	<1			

Site SWMP-03 – total phosphorus ug/L				
ANNUAL MEAN				
2017	2018	2019	2020	2021
19	16.6	7.3	12.0	10.7



3.0 Discussion

The primary intent of the annual portion of the Enos Lake monitoring program is to gain insight into the current status and trends in lake productivity. This is important in that watershed disturbance and land use, together with climate change impacts, have the potential to shift the lake's trophic status. As lakes become more eutrophic (more biologically productive), algal blooms (including blue green algal blooms) can become more prevalent leading to lower dissolved oxygen levels, impaired water quality, and impacts on recreational use and drinking water. There are examples of lakes on the east coast of Vancouver Island and the Gulf Islands where this has occurred. Once lakes become eutrophic or

hypereutrophic, it is very difficult to reverse this process. Prevention is a far more effective tool in protecting lake water quality.

The summer of 2021 was characterized by an extreme drought with virtually no rain for 3 months from mid-June to mid-September. There were also periods of substantially warmer weather such as the late June "heat dome" with daytime temperatures approaching 40 C. This resulted in a very steep and compressed thermocline as measured in August. While the epilimnion dissolved oxygen target was met, the hypolimnion target was once again not met. Of concern however, was the lack of oxygen not only below the thermocline, but well up into the thermocline in late August. This has not been seen in previous years. If this continues or worsens, the lack of oxygen through the thermocline may make Enos Lake susceptible to a late summer "fish kill" given the right atmospheric conditions: low atmospheric pressure and windy conditions in late summer may bring relatively shallow anoxic water to the surface. The resulting mixing could result in low oxygen levels throughout the water column. If fish cannot find a layer of sufficient oxygen, a "fish kill" may occur.

Chlorophyll a, total phosphorus and secchi depth are fundamental indicators used to assess lake trophic status. The secchi depth data has consistently suggested that Enos Lake is eutrophic or on the edge of mesotrophic and eutrophic. While total phosphorus continues to accumulate at depth due to internal loading, from spring through early fall, concentrations over the last 3 years are only about 1/3 to 1/2 of what was measured in 2017 and 2018.

Mean annual average chlorophyll a data for 2021 classified Enos Lake as mesotrophic, as was the case in 2019. For the 3rd consecutive year, the total phosphorus target of 12 ug/L was met, while the annual average suggested that Enos Lake was a mesotrophic lake. Not surprisingly, chlorophyll a and total phosphorus appear to be following a similar pattern over the last 5 years. The highest concentrations were in 2017 and 2018, followed by a substantially lower value in 2019 and more moderate levels in 2020 and 2021. It is beyond the scope of the data collected to determine what might explain this. The overarching target of no increase in chlorophyll a over time is currently being met.

Table 3.1 Year to year status of key indicators and targets

*Preliminary assessment as insufficient data collected

	2017	2018	2019	2020	2021
Secchi	mesotrophic/eutrophic	eutrophic*	eutrophic*	eutrophic	mesotrophic/eutrophic
Dissolved oxygen at epilimnion – target of >5 mg/L	Target met	Target met	Target met	Target met	Target met
Dissolved oxygen at hypolimnion – target of >2 mg/L	Target not met	Target not met	Target not met	Target not met	Target not met
Chlorophyll a	eutrophic	eutrophic	mesotrophic	eutrophic	mesotrophic
Chlorophyll a	No increase over time				met
Total phosphorus target of 12 ug/L	Target not met – indicates mesotrophic	Target not met – indicates mesotrophic	Target met – indicates oligotrophic	Target just met- Indicates mesotrophic	Target met – indicates mesotrophic

Weather patterns for the summer of 2021 were extreme, with virtually no rainfall and high temperatures. It is anticipated that summers such as this will become more common due to climate change. In a typical summer, the dissolved oxygen target at depth is not met. During the prolonged summer drought of 2021, the lack of oxygen at depth progressed well upwards into the thermocline, potentially making Enos Lake susceptible to a "fish kill". It is not known if the conditions observed this year have occurred in the past. Regardless, they are likely to re-occur more frequently in upcoming years. In contrast to the summer drought, the "flip" to much cooler, wetter conditions fortunately arrived by mid-September, earlier than is sometimes seen.

While there is year-to-year variability in Enos Lake water quality, there are a number of constants: strong summer stratification; low dissolved oxygen at depth, and internal loading of phosphorus during the summer months. Secchi depth, chlorophyll a and total phosphorus levels appear to indicate that Enos Lake is moderately productive, not far from becoming eutrophic. There may be a slight downward trend in both chlorophyll a and total phosphorus since 2018.

Existing water quality and increasing climactic extremes make Enos Lake very susceptible to watershed disturbance impacts. If Enos Lake gradually becomes more eutrophic to hyper-eutrophic, it will be very difficult to restore the lake. Coupled with summer droughts, fish kills could become more likely. It is far more effective to apply preventative best management practices to protect and maintain Enos Lake water quality.

4.0 Recommendations

The increased Secchi depth data collection should be continued.

Field data is normally collected as the probes are lowered through the water column. As a further check on field data, and to further enhance confidence in the data, it may be useful to repeat the field data collection of pH, dissolved oxygen and redox as the probes are brought back up to the surface. This is a particularly useful check on slow responding probes as they age or foul.

As noted by Nordin (2017), a water budget for Enos Lake is needed, as it would be useful over the longer term in the support of watershed management planning. PGL (2016) reported that 12 ha of the watershed area of 235 ha had been developed. Further updates on the area's development within the watershed are needed, including data on impervious surfaces. It may also be time to begin basic periodic sampling of the main inflows into Enos Lake to assess turbidity and total suspended solids, particularly following prolonged dry periods and during storm events. Simply limiting turbidity and total suspended solids in surface inputs to the lake is an important fundamental step in protecting Enos Lake water quality.

A more thorough data review should be done every 5 years, to examine trends, review the monitoring program, and provide a feedback loop to watershed management. This should be done in 2022, following completion of the more detailed portion of the water quality sampling program, which should also include a QA/QC program including duplicate samples and field blanks.

5.0 Acknowledgements

This document has been prepared as a contract for the BC Conservation Foundation. The conclusions, opinions and any other information in this report represent the author's best professional judgement based on the information available at the time of its completion.

6.0 References

PGL Environmental Consultants. 2016. *Enos Lake Protection and Monitoring Program. Prepared for FW Enterprises Ltd. c/o Seacliff Properties.* PGL file 4675-01.01 30 p + figures and appendix.

Deniseger, J., 2020. *Enos Lake Protection and Monitoring Program: Review of 2018 Water Quality Data.* 14 p.

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Appendix 3

2022 Sampling Plan (PGL 2016)

Table 3-1. Summary of Water Quality Monitoring Program for Enos Lake

Parameter (units)		Water Quality Target	Future Monitoring[a]
Field Parameters (profiles at 1m increments)	Secchi Depth (m)	None – supporting context only	Quarterly sampling[b] at site SWMP-03, starting in 2017 and repeated annually
	Dissolved Oxygen (mg/L and % saturation)	• ≥5 mg/L epilimnion • ≥2 mg/L hypolimnion	Quarterly sampling[b] at site SWMP-03, starting in 2017 and repeated annually
	Conductivity (µS/cm)	None – supporting context only	Quarterly sampling[b] at site SWMP-03, starting in 2017 and repeated annually
	Temperature (°C)	None – supporting context only	Quarterly sampling[b] at site SWMP-03, starting in 2017 and repeated annually
	pH	None – supporting context only	Quarterly sampling[b] at site SWMP-03, starting in 2017 and repeated annually
	Redox (mV)	None – supporting context only	Quarterly sampling[b] at site SWMP-03, starting in 2017 and repeated annually
Laboratory Parameters	*E. coli* (# per mL)	BC Water Quality Guidelines (recreation – secondary contact)[c]	August 2017: 5 times in 30 days. Surface sample from SWMP-03 and any two shoreline locations. Repeat on 5 year increment.
	PAHs (µg/mg)	BC Water Quality Guidelines (freshwater sediments)	August 2017: surface sediment from three locations: SWMP-06, SWMP-04 and SWMP-03.
	Metals (various)	BC Water Quality Guidelines (total metals, freshwater aquatic life). Both average and short-term maximum guidelines apply, where applicable.	February 2017 and August 2017: five samples in a 30 day period. Each sample to occur at three depths from SWMP-03. Sampling to be repeated on five year increments.
	Chlorophyll *a* (µg/L)	Avoid any increase	Quarterly sampling at site SWMP-03, starting in 2017, and repeated annually. Samples to be taken from three depths (surface, mid, deep water)
	Hardness (as $CaCO_3$)	None – required to interpret metals data	February 2017 and August 2017: five samples in a 30 day period. Each sample to occur at three depths from SWMP-03. Sampling to be repeated on five year increments. Data required to interpret metals concentrations.
	Phosphorous (mg/L)	12 µg/L	Quarterly sampling at site SWMP-03, starting in 2017. Samples to be taken from three depths (surface, mid, deep water)

[a]Future monitoring is limited to the scope being taken on by the Developer and will continue until at least one year post build-out within the Enos Lake watershed. It is anticipated that some form of longer term monitoring will be undertaken by RDN in support of long term operation of stormwater infrastructure.
[b]Quarterly sampling is defined as February, May, August, and November.
[c]It is assumed that swimming will not be a recreational use of Enos Lake. If that assumption is incorrect, primary contact guidelines should apply.

2022												
Parameter	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Dissolved Oxygen		F			F			F			F	
Temperature		F			F			F			F	
Redox potential		F			F			F			F	
pH		F			F			F			F	
Secchi Depth		F			F			F			F	
Chlorophyl *a*		L			L			L			L	
Phosphorhus		L			L			L			L	
E Coli								E				
Metals		M						M				
Hardness		M						M				
PAH								P				

Legend

L = Water sample from three depths at SWMP-03

F = 1m in situ profiles from SWMP-03

E = Five samples in 30 days, from SWMP-03 and any two shoreline locations.

M = Five samples in 30 days, from SWMP-03

P = Surface sediment from SWMP-03, SWMP-06 and SWMP-04

From ELPMP (PGL 2016)