

## Rico Lake – Sediment and Water Surface assessment

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Measured sediment samples from Rico Lake exceeded values for arsenic, cadmium, copper, nickel, and zinc when compared to the guidelines for freshwater sediment (Table 1). The concentrations of arsenic, cadmium, copper, nickel, and zinc were either close to or exceeding the toxicological standards (TEC and PEL) for freshwater biota (Table 1). The heavy metals values were compared to Canadian and United States regulations.

The data generated on sediment and water samples from Rico Lake show a snapshot of the environmental quality conditions. On their own, they do not provide a basis for determining if the present concentration of the chemical elements represents significant hazards to aquatic organisms. Based on the TEC (threshold effect level) and PEL (probable effect level) standards, the metals previously mentioned could have the potential to cause harm to the biota. However, to determine if the measured values are having a negative influence on aquatic life, further testing will be needed.

Following the Trophic State Index (TSI), the nutrients (total phosphorus, nitrate, and nitrite) concentrations from Rico Lake seem to indicate an oligotrophic body of water (TSI index 0-40 indicates an oligotrophic system, having the least amount of biological productivity, "good" water quality). A designation of 'good water quality' indicates low productivity due to limited organic resources and does not reflect the degree of inorganic pollutants. In the case of the Rico Lake, the source of contamination seems to come from an inorganic origin.

The low productivity of a lake (oligotrophic) may be attributed to the presence of contaminants, which can affect the biological activity of the microbial loop and the food web by affecting both plankton and nekton (bacterioplankton, phytoplankton, zooplankton and fish, etcetera) in the system. It is possible this is the reason for low productivity at this location. Further study is necessary.

Rico Lake drains into McIvor Lake in the wet months, and McIvor Lake flows through a BC hydro dam (Ledore Dam) into John Hart Lake. Campbell River draws their drinking water from John Hart Lake. Based on this information, it seems to me that there are not enough monitoring points to accurately map the surface water status to the system as a whole.

I suggest the deployment of more sampling points over several months within the water column (e.g., samples from the surface, middle (if applicable) and bottom). Also, sediment samples should be taken at McIvor and John Hart lakes as well as at Campbell

River (Figure 1). Water column monitoring should also be done for Rico Lake. Such an approach should help quantify the effects of inorganic chemical input from the Upland Excavating Ltd. Activities on the quality of the water.

All explanations and suggestions are based on the results that I have at the moment. For a more precise analysis and conclusion, I would need more time and access to more information. Variables such as total nitrogen, total phosphate, inorganic phosphate, total carbon, total inorganic carbon, total organic carbon, chlorophyll (*a*, *b*, and *c*), ferrous ion, ferric ion, dissolved manganese, and dissolved zinc would help me give a more complete analysis.

In addition, it would be helpful to perform some toxicological tests using pre-determined organisms.

A complete set of nutrients (phosphate and total nitrogen) and phytoplankton biomass (chlorophyll *a*) would help confirm the oligotrophic status for Rico Lake. Chlorophyll *a* measurements would be the most helpful.

I would like to check the geological data carefully (Hydrogeology and Hydrology Characterization Report / Proposed Upland Landfill / Campbell River, British Columbia - Upland Excavating Ltd.) of the region as well. Depending on the type of geological composition present, some elevated chemical concentrations from natural sources could be expected.

The OSHA guideline does not have regulated limits for cadmium, copper, iron, and zinc regarding PEL. Cadmium, copper and iron concentrations apply to respiratory issues. The zinc limits are for zinc oxide only, not total zinc (measured). The OSHA limits apply to inhalation and not from water ingestion, I am not sure that we can use OSHA limits to compare values from freshwater ecosystems. I need to check again to be sure. Sorry!

**Table 1:** Results of the Rico Lake sediment and water surface samples and Guidelines values.

	MATRIX	TYPE	UNITS	Arsenic	Cadmium	Copper	Iron	Manganese	Nickel	Zinc
	SEDIMENT	RICO LAKE	(mg/kg)	6.48	0.98	138	40800	670	24.5	158
<b>GUIDELINES</b>										
Canadian Sedim Quali Guide Aqua Life/ CCME EPC-98E / ISQG	sediment		(mg/kg)	5.9	0.6	35.7	1.0	0.29-0.38**	16	123
CCME EPC-98E		PEL (Probable Effect Level)		0.017	3.5	197	x	x	x	315
Florida Department of Environmental Protection 2003		PEC (Probable Effect Level)		33	5	150	x	x	49	460
		TEC (threshold effect level)		9.8	1	32	x	x	23	120
EPA-905 (2000, 2002)		PEL (Probable Effect Level)		17	3.53	197	x	x	36	315
		TEC (threshold effect level)		5.9	0.596	35.7	x	x	18	123
CSR 375/96		soil			(mg/kg)	11	2.2	120	x	x
ISQG (industrial use)			12	22		91	x	x	89	410
	WATER	RICO LAKE	(mg/L)	0.0001	0.00001	0.0013	0.153	0.0046	X	0.005
Drinking Water Quality Guide 2017	water		(mg/L)	0.01	0.005	≤ 1.0	≤ 0.3	≤ 0.05	x	≤ 5.0
British Columbia Working Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture (2017/2018)		drinking water sources		0.025	x	x	x	≤ 1.091 mg/L	x	x
		freshwater aquatic life		0.005	<0.01 - 0.06 ug/L	≤ 0.002	0.3	0.0044	0.025	0.008
		marine aquatic life		0.0125	0.12	<0.002	x	x	0.0083	0.01
		irrigation		0.1	5.1	x	5	x	0.2	1
		livestock		0.025	8	x	x	x	1	2
		wildlife		0.025	x	x	x	x	x	x
		recreation/aesthetics		x	x	x	x	x	x	x
OSHA		PEL (Probable Effect Level)	mg/L	0.0005	x	x	x	0.005	0.001	x

X = no data or not applicable.

\*\* Information based on the draft – Scientific criteria document for the development of the Canadian Water Quality Guidelines for the protection of Aquatic Life (Manganese). August 2018.

**Figure 1: Sampling point suggestions (red circles).**

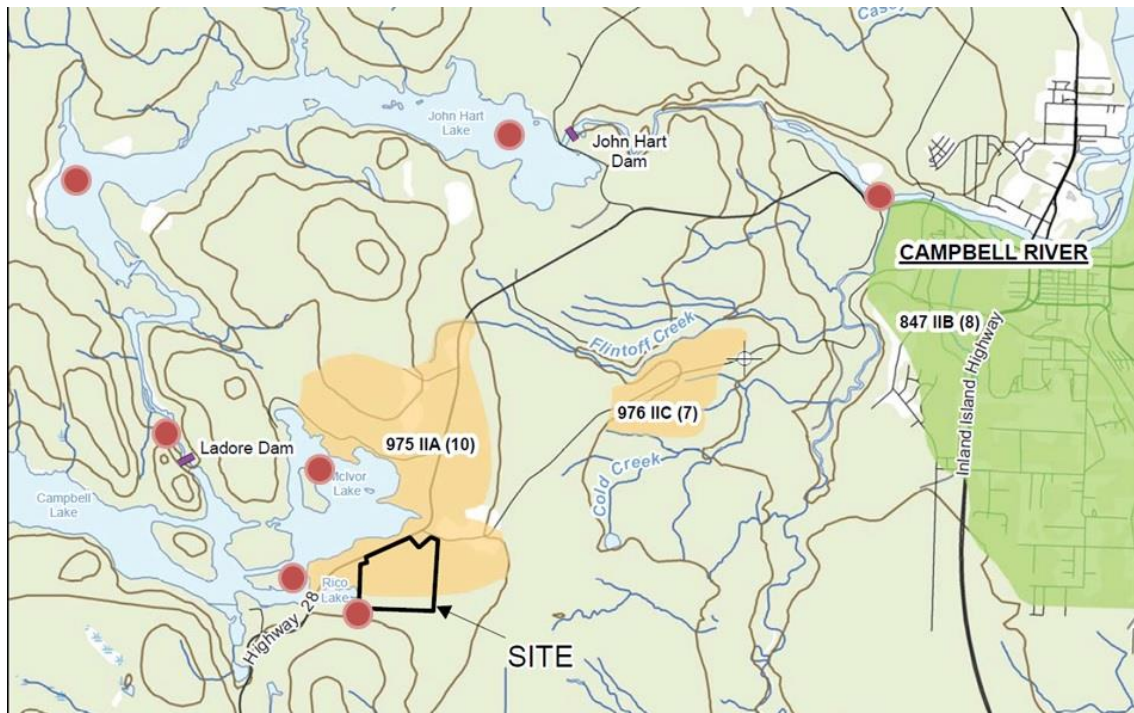


Figure 1 Sampling point suggestions (red circles). Rico Lake, Rico Lake outlet for Mclvor Lake, into Mclvor Lake, after the Ladore Dam inlet, into the John Hart Lake at two spots, one sample point after the Ladore Dam, one sample point before John Hart Dam, and one last sample point into the Campbell River.

\*Note: All samples points should cover the surface, middle, and bottom of the water column, and be performed during several months.

## REFERENCES

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- ✓ Occupational Safety and Health Administration (OSHA): Permissible Exposure Limits – Annotated Tables (Table Z-1). Access: <https://www.osha.gov/dsg/annotated-pels/>