xaɬəmət ct tə səlilwət / Water Quality Assessment and Proposed Objectives for səlilwət (Burrard Inlet): Additional Marine Parameters Technical Report

May 2026

Tsleil-Waututh Nation
səlilwətaɬ

BRITISH COLUMBIA

This Technical Report forms part of a series of water quality parameter reports whose purpose is to inform updates to the 1990 Provincial Water Quality Objectives for səlilwət (Burrard Inlet). This report and others in the series assess the current state and impacts of contamination in səlilwət; incorporate new scientific research and monitoring of water quality; and reflect a broader understanding of goals and values, including those of First Nations, to improve the health of the marine waters of səlilwət. Updating the 1990 Provincial Water Quality Objectives is a priority action identified in the Tsleil-Waututh Nation's Burrard Inlet Action Plan which has been an impetus for this work.

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REPORT SUMMARY

This report presents proposed water quality objectives for parameters of known or potential concern in səlilwət (Burrard Inlet) that are not already addressed in other technical reports for the xaɬəmət ct tə səlilwət / Water Quality Objectives for səlilwət (Burrard Inlet). The parameters in this report were not identified as priority parameters at the outset of the WQO update for səlilwət / Burrard Inlet but have been identified as having sufficient available data as well as available screening benchmarks for comparison. Consequently, WQOs are proposed for these parameters. Some of the parameters were included in the water quality objectives (WQOs) for səlilwət / Burrard Inlet in 1990.

More than 700 water quality potential parameters of concern have been recorded in səlilwət / Burrard Inlet. Due to financial and time constraints, it is not possible to produce detailed technical reports for each of these contaminants. There are also limited data for many of these parameters. Nonetheless, many of these parameters are of ongoing concern in the Inlet and affect Tsleil-Waututh Nation's (TWN) goals of being able to sustainably harvest healthy, wild marine resources, and to practice spiritual, cultural, ceremonial, and recreational activities in clean water free of risk from contamination and harmful pathogens.

The WQOs apply to all Burrard Inlet sub-basins, unless specified otherwise, with an overarching objective of decreasing concentrations from current levels in all contaminants in all media (water, sediment and tissue) over time. The proposed objectives were developed using up-to-date research on relevant values and potential effects, benchmark screening, and historic and recent monitoring data for səlilwət / Burrard Inlet. If there was sufficient data available for a parameter, an applicable benchmark and, after comparison to the screening benchmark, exceedances identified, then a WQO was proposed. The proposed WQOs for the additional parameters of concern are as follows:

Proposed Water Quality Objectives for Additional Parameters of Concern for səlilwət */ Burrard Inlet*

Parameter	Medium (water, sediment and/or tissue)	Objective (all sub-basins)	Most Sensitive Value Protected
All anthropogenic (human-made) contaminants	Water, sediment, tissue	Decreasing concentrations from current levels	All
Total ammonia nitrogen (NH_3 as mg/L N; also requires pH, temperature, and salinity data)	Water	See criteria table from the BC Water Quality Guidelines (mean). If toxicity modifying factors (salinity, pH, and temperature) were not measured, the objective is 23 mg/L as N (mean) [1]	Aquatic Life
Chromium	Water	Cr VI: 1.5 µg/L Cr III: 56 µg/L (mean) [1]	Aquatic Life
	Sediment	52.3 µg/g dw (max)[2]	Aquatic Life
	Tissue	Cr VI: 0.08 µg/g ww (max)[3]	Human consumption of fish/shellfish
Manganese	Water	22.6 µg/L (mean) [1]	Human consumption of shellfish
Selenium	Sediment	2 µg/g dw (max) [2]	Aquatic Life
	Tissue	0.21 µg/g ww (max) [3]	Human consumption of fish/shellfish
Silver	Water	0.5 µg/L (mean) [1]	Aquatic Life
	Sediment	1 µg/g dw (max) [2]	Aquatic Life
Thallium	Water	0.27 µg/L (mean) [1]	Human consumption of finfish

[1] Mean is based on at least five weekly samples over a 30-day period. Compare mean to WQO and no more than 20% of samples > WQO.
[2] Based on at least 1 composite sample consisting of at least 3 replicates. Compare maximum to WQO.
[3] Applies to all tissue types. Based on a minimum of one composite sample, comprising no fewer than five fish, five crabs, or twenty-five bivalves. Compare maximum to WQO.

Monitoring in səlilwət / Burrard Inlet of the additional parameters of concern with limited data is recommended. These parameters are as follows:

Parameters to monitor in səlilwət */ Burrard Inlet to determine if a WQO is needed*

Parameter	Medium
1,2,4-trichlorobenzene	Water
1,2-dichlorobenzene	Water, sediment, tissue
17α-ethinylestradiol (EE2) plus other hormones/steroids	Water
Aluminum*	Water, sediment, tissue
Benzene, toluene, ethylbenzene, xylene, styrene (BTEXS)	Water
Biotoxins	Water and tissue
Chlorate and free chlorine	Water
Chlorine-produced oxidants (CPOs)	Water
Chromium (speciated data)	Water and tissue
Cobalt*	Water, sediment, tissue
Cotinine (metabolite of nicotine)	Water
Cyanide (e.g., weak acid dissociable)	Water
Ethylene dichloride	Water, sediment, tissue
Ethylene glycol	Water
Hexachlorobutadiene (HCBD)	Sediment
Iron*	Water, sediment, tissue
Light extractable petroleum hydrocarbon (LEPH)	Water
Methyl tert-butyl ether (MTBE)	Water
Molybdenum**	Water, sediment, tissue
Monochlorobenzene	Water
Selenium	Water
Sulphide (as unionized H_2S)	Water
Tin*	Water, sediment, tissue
Total extractable hydrocarbons (TEH)*, ***	Water
Total Phenols	Water, tissue
Volatile petroleum hydrocarbons (VPHs) and volatile hydrocarbons (nC6 - nC10) (VH6-10)	Water

* There is currently no benchmark for comparison for marine water. Continue to monitor these metals in səlilwət / Burrard Inlet as an applicable benchmark may be developed in the future.
** There is currently no reliable benchmark for comparison for marine water; however, there exists an interim working level of 23 µg/L from the Australia and New Zealand Environment and Conservation Council (ANZECC, 2000; Commonwealth of Australia, 2000), and some exceedances of this interim working level have been observed in səlilwət / Burrard Inlet.
*** Constituents should also be monitored (i.e., polycyclic aromatic hydrocarbons [PAHs] and total PAH).

Work to reduce the concentrations of anthropogenic parameters of concern entering səlilwət / Burrard Inlet is currently underway, including the update to the Metro Vancouver Liquid Waste Management Plan, separation of combined sewer overflows, the ongoing development and implementation of Integrated Stormwater Management Plans (ISMPs), and improvement of wastewater treatment plants.

Additional management priorities should include reviewing industrial and other wastewater discharges authorized by BC and other jurisdictions to identify where updates are needed, implementation and enforcement of best practices related to removal of wood structures with harmful wood preservation treatment in səlilwət / Burrard Inlet, spills and incidental releases of petroleum hydrocarbons from vessels, managing the growth of large commercial vessel traffic in the Inlet, and addressing the numerous other non-point sources of contamination entering səlilwət / Burrard Inlet.

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ACRONYMS

ANZECC	Australia and New Zealand Environment and Conservation Council
BC	British Columbia
CCME	Canadian Council of Ministers of the Environment
df	detection frequency
ECCC	Environment and Climate Change Canada
ECCCB	Environment and Climate Change Canada Benthic program
ECCCDSP	Environment and Climate Change Canada Disposal at Sea Program
ENV	Ministry of Environment and Parks
HLTH	Ministry of Health
ISMP	Integrated Stormwater Management Plans
MV	Metro Vancouver
OW	Ocean Wise
PICES	North Pacific Marine Science Organization
ppt	parts per trillion
SV	Screening value
TWN	Tsleil-Waututh Nation
US EPA	United States Environmental Protection Agency
WLRS	Ministry of Water, Lands and Resource Stewardship
WQG	Water Quality Guideline
WSQG	Working Sediment Quality Guideline
WWQG	Working Water Quality Guideline
WQO	Water Quality Objective

1. INTRODUCTION

This report presents proposed water quality objectives for parameters of known or potential concern in səlilwət (Burrard Inlet) that are not already addressed in other technical reports for the xaɬəmət ct tə səlilwət / Water Quality Objectives for səlilwət (Burrard Inlet). The parameters in this report were not identified as priority parameters at the outset of the WQO update for səlilwət / Burrard Inlet but have been identified as having sufficient available data as well as available benchmarks for comparison. Consequently, WQOs are proposed for these parameters. Some of the parameters were included in the water quality objectives (WQOs) for səlilwət / Burrard Inlet in 1990 (Nijman and Swain, 1990).

Detailed technical reports were prepared for priority contaminants, contaminant groups and other water quality parameters in səlilwət / Burrard Inlet (TWN and ENV, 2024). Those water quality parameters were prioritized for detailed analysis based on factors such as the availability of data, the frequency with which they exceeded screening benchmarks, and their known effects on water values as identified by Rao et al. (2019). Those technical reports contain relevant background information on each parameter including sources, pathways and fate in the marine environment; an overview assessment of current status and trends in water, sediment, and/or biota in səlilwət / Burrard Inlet; comparison to screening benchmarks; proposed objectives and rationale; recommendations for future monitoring; and management options to help attain the objectives.

More than 700 water quality potential parameters of concern have been recorded in səlilwət / Burrard Inlet (Rao, 2022). Due to financial and time constraints, it is not possible to produce detailed technical reports for each of these contaminants. There are also limited data for many of these parameters. Nonetheless, many of these parameters are of ongoing concern in the Inlet and affect Tsleil-Waututh Nation's (TWN) goals of being able to sustainably harvest healthy, wild marine resources, and to practice spiritual, cultural, ceremonial, and recreational activities in clean water free of risk from contamination and harmful pathogens.

This report presents the selection of proposed objectives to ensure that the marine WQOs for səlilwət / Burrard Inlet are as comprehensive as possible, with the intent of restoring the health of the Inlet and protecting the water values guiding this initiative (Rao et al., 2019). The WQOs apply to all Burrard Inlet sub-basins, unless specified otherwise, with an overarching objective of decreasing concentrations from current levels in all contaminants in all media (water, sediment and tissue) over time. The proposed objectives are based on water quality benchmarks such as BC Water Quality Guidelines (WQGs), which have been updated since the first development of WOQs in 1990 (Nijman and Swain, 1990). Any 1990 objectives for these parameters are listed in Appendix B. The proposed objectives may be further updated as more information becomes available.

Parameters were included in this analysis if they were of potential concern in or around səlilwət / Burrard Inlet, for example if they have been detected or if there are known or potential sources including authorized discharges.

2. WATER QUALITY ASSESSMENT

2.1 Screening Benchmarks Used in this Assessment

Screening benchmarks for each parameter from the following jurisdictions were reviewed and the most conservative/sensitive screening benchmark was used to assess data (see Appendix B for details):

- Province of British Columbia (BC):
    - Approved Water Quality Guidelines (WQGs)

    - Working Water Quality Guidelines (WWQGs), including the BC Working Sediment Quality Guidelines (WSQGs)
    - Contaminated Sites Regulation
    - Human-health based screening values for fish and shellfish tissue derived from Health Canada toxicological reference values (Health Canada 2021) or United States Environmental Protection Agency (US EPA) reference doses, and Health Canada risk assessment methodologies (Health Canada, 2010 and 2012; Richardson, 1997; Richardson and Stantec, 2013; US EPA, 2020) – see below for details
- Government of Canada:
    - Cross-referencing with a similar analysis conducted by Environment and Climate Change Canada (ECCC) (unpublished data) to identify which existing benchmarks are the most protective of Southern Resident Killer Whales and their prey, as part of the Contaminants Technical Working Group under the federal Whales Initiative
    - Canadian Council of Ministers of the Environment (CCME) - Environmental Quality Guidelines
    - Federal Environmental Quality Guidelines
    - Canadian Food Inspection Agency standards and methods, and export requirements
    - Canadian Shellfish Sanitation Program manual of operations
- Other governments:
    - Washington State Marine Surface Water Quality Standards
    - US EPA Water Quality Criteria
    - Australia and New Zealand Environment and Conservation Council Guidelines for Fresh and Marine Water Quality

The Province of BC's method for assessing risks to human health from eating fish include deriving screening value benchmarks. Human-health based screening values (SVs) for fish and shellfish tissue were derived from Health Canada toxicological reference values and risk assessment methodologies (Health Canada, 2021). The BC method for derivation of SVs for contaminants in fish tissue is described in guidance from the Ministry of Water, Land, and Resource Stewardship (WLRS, 2023), with səlilwət / Burrard Inlet specific context in ENV and HLTH (2021). Screening values are defined as conservative threshold values against which contaminant concentrations in fish (including finfish and shellfish) tissue can be compared and assessed for potential risks to human health. Fish and shellfish in this report refer to country foods, that is, foods produced in a not for commercial sale setting or harvested through hunting, gathering or fishing activities (Health Canada, 2010).

Three SV receptors (referring to people who eat finfish or shellfish) were used in the data assessment to examine multiple levels of protection and were selected to capture a range of potential fishers. The most conservative SV is for a toddler from a subsistence fisher population while the adult subsistence fisher and adult recreational fisher are less conservative. An allocation factor of 0.2 was used in the calculation to reflect the percentage of each contaminant assumed to come from country foods (in this case, wild seafood). In the case of a carcinogen, the most sensitive receptor is an adult from a subsistence fishing or Indigenous population, as the SV is based on a lifetime of exposure. See WLRS (2023) for specific receptor characteristics, and additional details about the use of tissue screening values to protect the health of human consumers of fish.

Screening benchmarks for this assessment are provided in Appendix B.

2.2 Data Sources

Data for the various water quality parameters in səlilwət / Burrard Inlet were gathered from several studies and monitoring programs and a summary of the priority datasets used for this assessment is presented in Appendix A. Although other datasets containing water quality sampling data exist, the priority datasets were found to contain the best available data for assessing the status of səlilwət / Burrard Inlet within the constraints of the project. Maps outlining the sample sites for the various water quality parameters in səlilwət / Burrard Inlet are provided in Figure 1 through Figure 6.

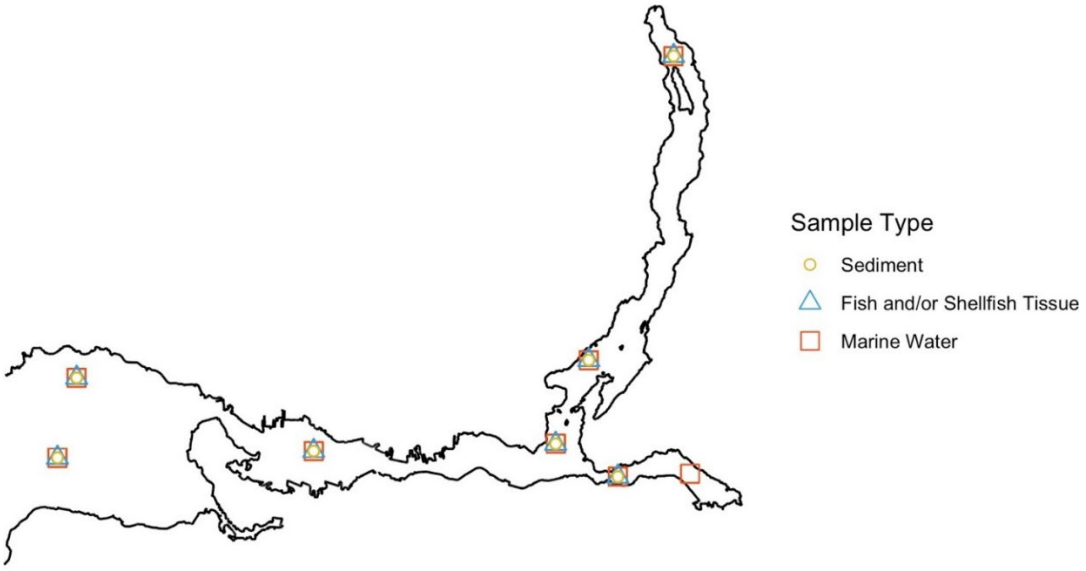

Figure 1. Metro Vancouver Burrard Inlet Ambient Monitoring Program sampling stations in səlilwət / Burrard Inlet (2007 to 2016)

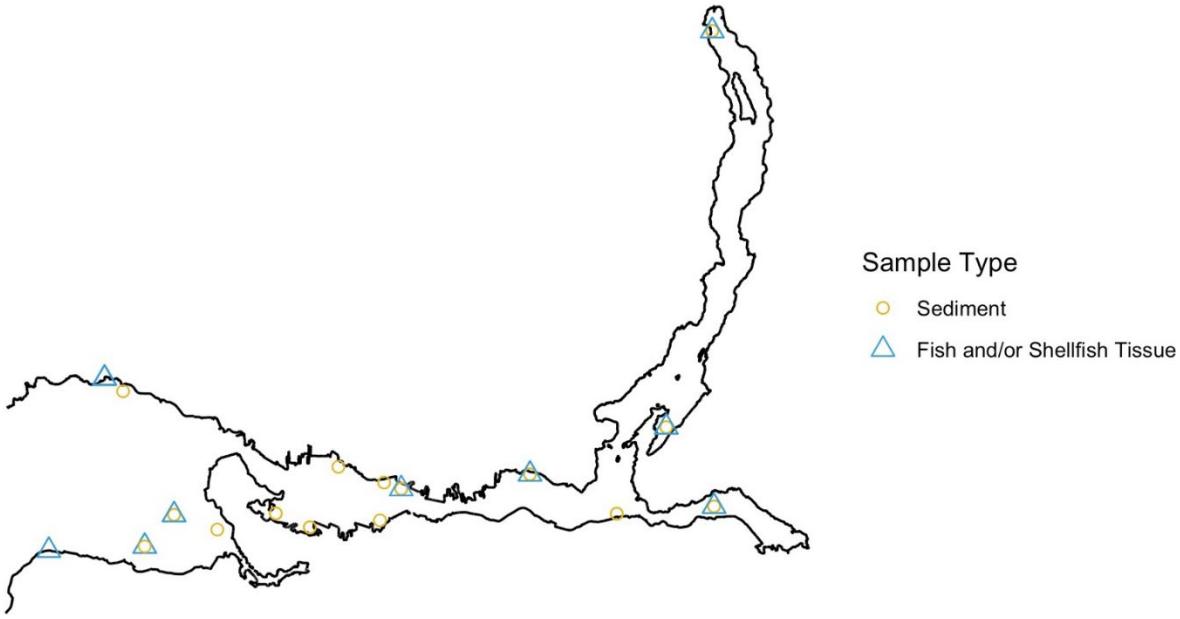

Figure 2. Ocean Wise (Pollution Tracker) sampling stations in səlilwət / Burrard Inlet (2015 to 2019)

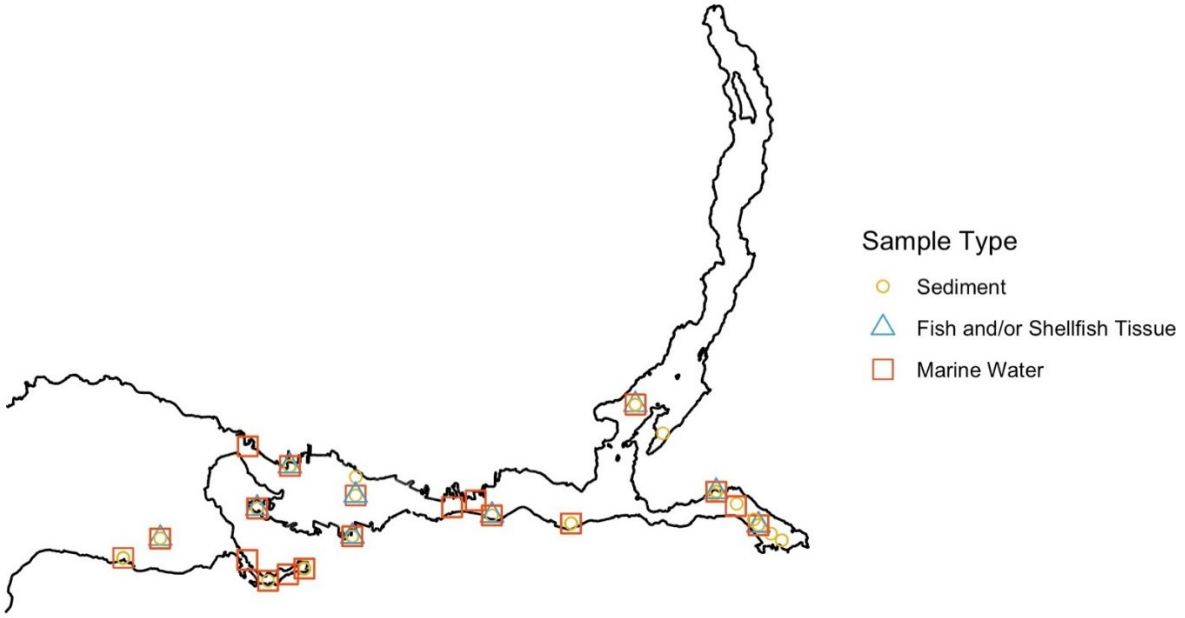

Figure 3. ENV Provincial Water Quality Objectives Attainment Monitoring sampling stations in səlilwət / Burrard Inlet (1992 to 2020)

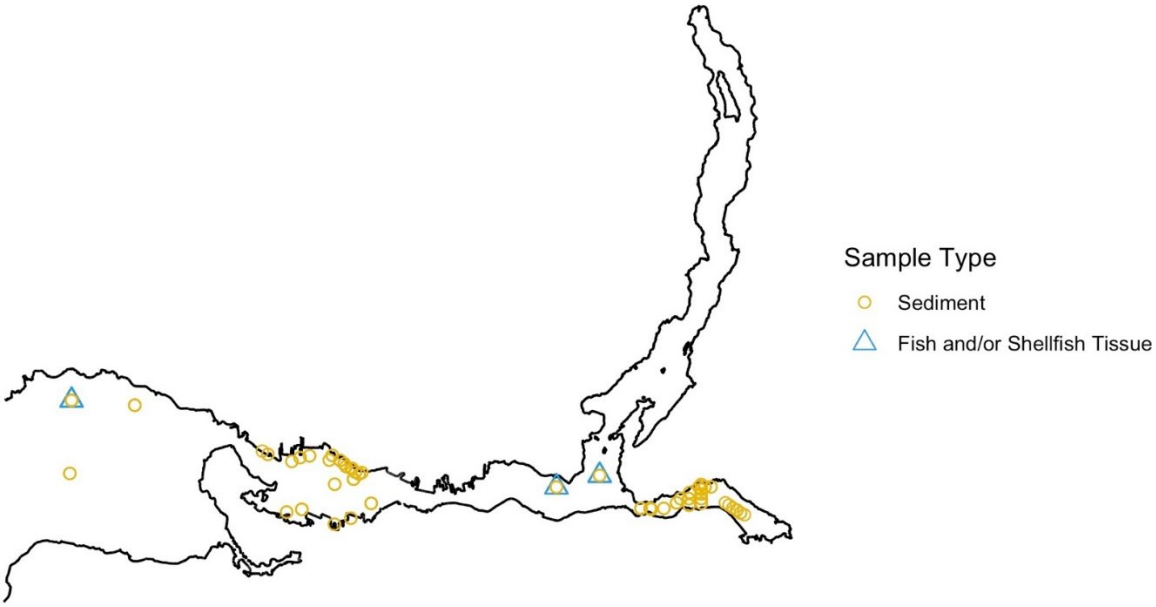

Figure 4. ECCC benthic sampling stations in səlilwət / Burrard Inlet (1985 to1986)

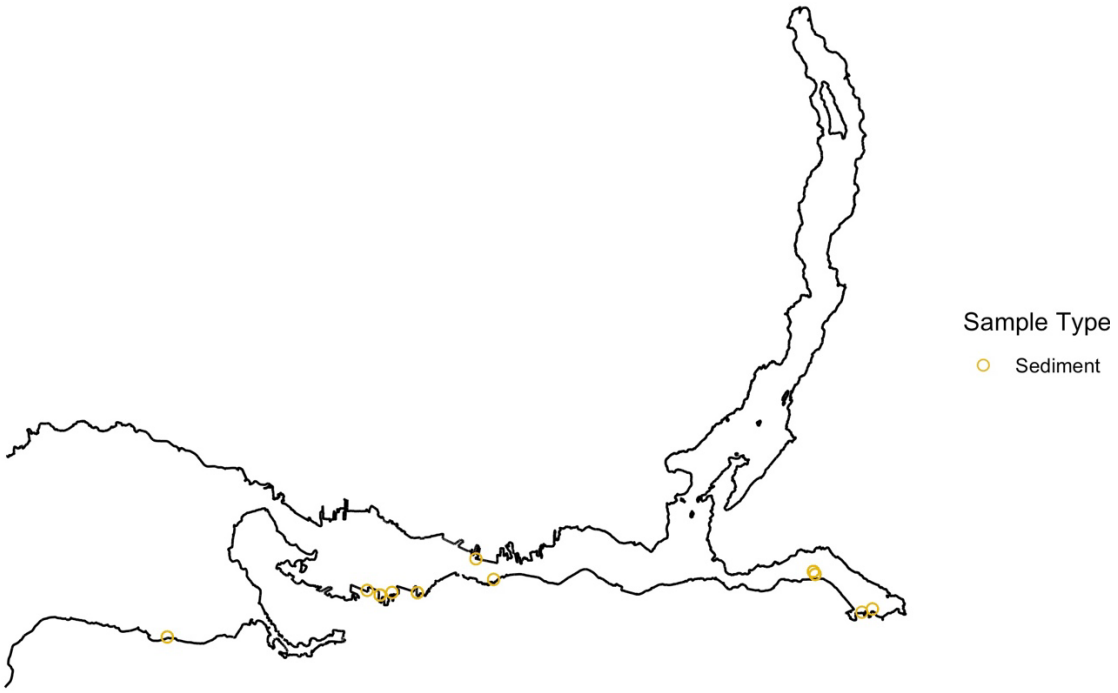

Figure 5. ECCC disposal at sea sampling stations in səlilwət / Burrard Inlet (2009 to 2017)

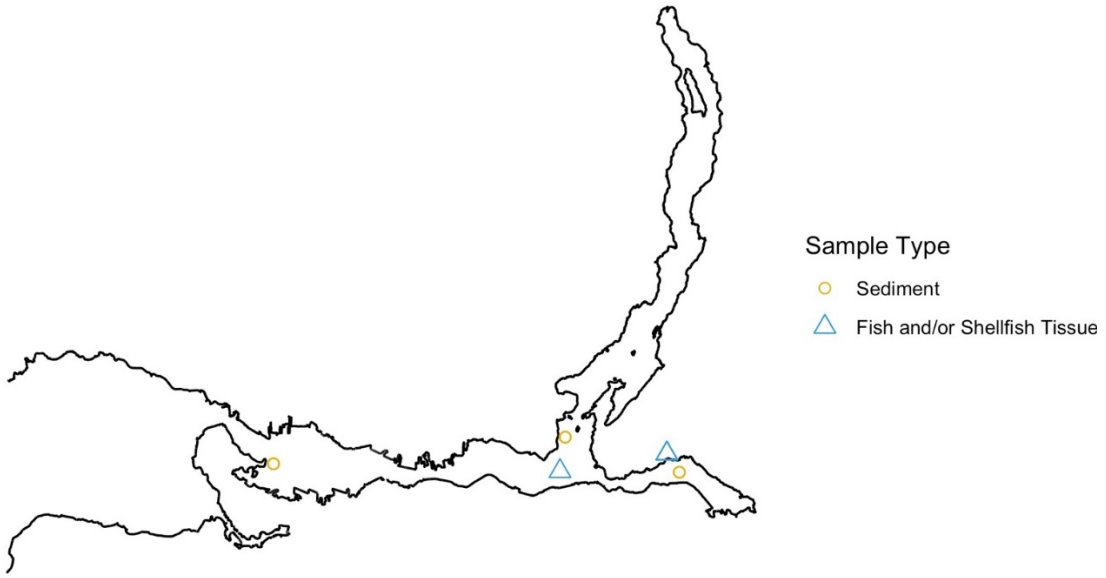

Figure 6. North Pacific Marine Science Organization (PICES) PAH and Pesticide Study sampling stations in səlilwət / Burrard Inlet (1999)

2.3 Assessment Results

Available monitoring data were compared to screening benchmarks, with summaries in the following section, and more numerical details and summaries of these results are provided in Appendix C. Because of the large number of reviewed compounds, observations are presented for səlilwət / Burrard Inlet as a

whole, and not for each sub-basin. Because of variations in the sampling and analytical methods and distribution of sites, results from each monitoring program are presented separately.

Detection limits were variable and frequently above the screening benchmarks, which created challenges for providing comparisons. Where the highest detection limit within a dataset for a parameter was greater than a benchmark, this was noted as a limitation. Non-detects were not included in the calculation of summary statistics or count of benchmark exceedances as the detection limits were frequently an order of magnitude or higher than the benchmarks and this was consistently across all parameters assessed.

As a conservative approach, analytical data were not blank corrected[1] (i.e., the measured values for the blank samples were not subtracted from the measurements for the collected samples). Field replicates were averaged prior to the assessment. Key observations for detection frequency, exceedances, and maximum observed concentrations are described by monitoring program.

Analyses are limited to those parameters for which data were available and exceeded screening benchmarks. Overall summaries of status and observations for total ammonia nitrogen, chromium, manganese, selenium, silver, and thallium in marine water, sediment and/or tissue are provided below alongside the rationale for the proposed WQOs.

Total Ammonia Nitrogen

Total ammonia nitrogen has been measured in marine water samples collected by Metro Vancouver (MV) and ENV. The screening benchmark concentration for total ammonia nitrogen in water is from the BC WQG and ranges between 0.67 to 312 mg/L as N and the toxicity is dependent on modifying factors - salinity, temperature, and pH (WLRS, 2026). The screening benchmark is for the protection of aquatic life. In many cases, toxicity modifying factors have not been measured alongside total ammonia nitrogen, leading to difficulty determining whether conditions that may be harmful to marine aquatic life were present.

- ***Marine Water***

  A total of 1,065 samples across 27 sites were available for total ammonia nitrogen in marine water samples collected by the MV and ENV monitoring programs. Total ammonia nitrogen was detected in 731 samples (69%) with concentrations ranging from 5 to 300 mg/L as N. 94% of the total ammonia nitrogen samples were not accompanied by measurements of the toxicity modifying factors required to calculate condition specific benchmarks.

  - ENV: Toxicity modifying factors were not measured alongside total ammonia nitrogen. Therefore, it was not possible to determine condition specific exceedances.
  - MV: Total ammonia nitrogen was detected in 61 samples that were accompanied by measurements of toxicity modifying factors. The calculated condition specific benchmarks ranged from 23 to 200 mg/L as N. 6 (10%) samples exceeded the benchmark.

Chromium

Chromium has been measured in marine water, sediment, and fish and shellfish tissue. Total chromium in marine water was measured by MV and ENV. Chromium in sediment data was measured by all six monitoring programs. Chromium in fish and/or shellfish tissue was measured by ENV, MV, Ocean Wise (OW), ECCC, and the North Pacific Marine Science Organization (PICES). The screening benchmarks for

[1] Blank correction refers to a typical laboratory procedure of measuring the chemical contents of solvents and other materials used to analyze a sample, and subtracting those measurements from the sample being analyzed.

chromium forms are from the BC WQGs and BC WWQGs and are 1.5 µg/L (for chromium (Cr)[VI]), 52.3 µg/g dry weight (dw) (for Cr[III]), and 0.08 µg/g wet weight (ww) (for Cr[VI]) in water (WLRS 2026), sediment (WLRS, 2025a), and fish/shellfish tissue (WLRS 2023), respectively.

It is noted that only total chromium water quality results were available and were compared conservatively to the screening benchmark for Cr(VI) or Cr(III), as available. Measurement of speciated chromium is recommended for future data collection and analysis (see Section 4.0).

- ***Marine Water***

A total of 1,114 marine water samples across 28 sites were analyzed for total chromium in ENV's and MV's monitoring programs. Total chromium was detected in 407 samples (37%) with concentrations ranging from 0.5 to 43.0 µg/L, of which 313 samples (28% of total) exceeded the benchmark value of 1.5 µg/L for Cr (VI).

  - ENV: 404 samples were collected from 20 sites sporadically from 1972 to 2009. Total chromium was detected in 146 samples (36% detection frequency [df]) with concentrations ranging from 2.0 to 43.0 µg/L. All concentrations (100%) exceeded the benchmark of 1.5 µg/L for Cr(VI).
  - MV: A total of 710 samples were collected annually from 2007 to 2016 from 8 sites. Chromium was detected in 261 samples (37% df, 64% exceedance) with concentrations varying from 0.5 to 5.6 µg/L.

- ***Sediment***

A total of 928 sediment samples from 148 sites were analyzed by all monitoring programs. Chromium was detected in 924 samples (> 99%), with concentrations between 1.3 and 310 µg/g dw. Chromium concentrations were above the benchmark value of 52.3 µg/g dw for Cr(III) in 184 samples (20% of total).

  - ENV: 137 samples were collected from 34 sites in 12 years over the last five decades, all above the detection limit (100% df, 11% exceedance), with concentrations ranging from 4.0 to 145 µg/g.
  - MV: Sediment samples were collected every two years from 2008 to 2015 across 7 sites. In all 105 samples, chromium was detected; 4 samples exceeded the benchmark (100% df, 4% exceedance). The concentrations ranged from 15.9 to 72.0 µg/g.
  - OW: Sediment samples were collected biannually between 2015 and 2019 from 18 sites. 32 samples were collected, and chromium was detected in 28 samples (88% df, 0% exceedance).
  - ECCC Benthic program (ECCCB): 262 samples were collected across 71 sites. All samples were above detection limits and ranged between 11.8 and 310 µg/g. 152 samples had higher than benchmark chromium concentrations (100% df, 58% exceedance). In 18 samples, concentrations were more than twice the benchmark and the highest detected concentration (310 µg/g) was almost six times higher than the benchmark.
  - ECCC Disposal at Sea Program (ECCCDSP): 350 samples were collected across 11 sites in 2009 and between 2012 and 2017. Chromium was detected in all samples with concentrations ranging from 2.5 to 62.0 µg/g (100% df, < 1% exceedance).
  - PICES: Sediment samples were collected once in 1999 from 7 sites. Chromium was detected in all 42 samples and 10 samples showed chromium concentrations over the benchmark

value of 52.3 µg/g (100% df, 24% exceedance). Chromium concentrations ranged between 1.3 and 75.0 µg/g.

- ***Fish/Shellfish Tissue***

In total, 898 samples were collected by all monitoring programs excluding ECCC Disposal at Sea. Chromium was detected in 734 samples (82%). Concentrations of chromium in fish or shellfish tissue ranged from 0.037 to 27.7 µg/g ww. Most (70%) samples had concentrations less than 1.3 µg/g ww. The lowest benchmark, protective of a toddler from a subsistence fishing population, for hexavalent chromium (Cr[VI], the most toxic form) is 0.08 µg/g ww (WLRS, 2023). Chromium concentrations were above this benchmark in 94% of samples.

- ENV: 20 samples were collected from 11 sites between 1990 and 2003. Concentrations ranged from 1.0 to 6.0 µg/g (15% df, 100% exceedance). The detection limit was 0.2 µg/g.
- MV: 73 samples were collected in 2007 or 2012 across seven sites. The detected concentrations ranged from 0.04 to 0.1 µg/g (19% df, 50% exceedance).
- OW: 22 tissue samples were collected from 10 sites biannually between 2015 and 2019 except 2017. Chromium was detected in all samples and 18 samples exceeded the benchmark (100% df, 82% exceedance). Concentrations were between 0.04 and 3.0 µg/g.
- ECCCB: 772 samples were collected across 12 sites. Concentrations ranged between 0.4 and 27.7 µg/g (89% df, 100% exceedance).
- PICES: In 1999, 11 samples were collected across nine sites, with concentrations ranging from 0.1 to 0.4 µg/g (73% df, 100% exceedance).

Manganese

Total manganese has been measured in marine water samples collected by MV and ENV. The screening benchmark concentration for manganese in water, developed by the US EPA and adopted by BC as a WWQG, is 100 µg/L (WLRS, 2025a; US EPA, 1986), which is for protection of humans eating shellfish. Manganese was detected in 1,055 samples (99%) with concentrations ranging from 0.76 to 707 µg/L. Most concentrations were less than 8.5 µg/L (72%), and in 99.9% of the samples, concentrations were less than 60 µg/L. Manganese concentrations were above the benchmark in one sample[2] (< 1% of total).

Although most of the dataset met the available screening benchmark, to see no further degradation from current conditions, an interim numerical objective was calculated using the 95th percentile of individual sample values based on 10 years of existing monitoring data from Metro Vancouver's Burrard Inlet Ambient Monitoring Program. The Metro Vancouver monitoring data was applied for derivation of the objective due to more consistent sampling frequency and more recent sampling date (latest sample in 2016 compared to 2009 for ENV).

Summary statistics are provided in Table 1. All measurements were above detection limits (representing 100% of 570 data points) and all measurements were given equal weight. ENV's practice when deriving a WQO is to calculate the objective as 20% higher than the 95th percentile to account for the dynamic nature of water chemistry and the accuracy and precision of laboratory results (ENV, 2021); hence the proposed objective for water is 22.6 µg/L. Additional rationale for the derivation of this proposed WQO is in Section 3.2.

[2] The one datapoint (707 µg/L) that exceeded the available screening benchmark of 100 µg/L is uncertain given that the next highest measured concentration in the dataset is 60 µg/L.

Table 1: Summary Statistics for total manganese levels recorded in Metro Vancouver's Burrard Inlet Ambient Monitoring Program Samples between 2007 and 2016

Summary Statistic	Count	Minimum	25th percentile	Median (50th percentile)	Mean	75th percentile	95th percentile	Maximum
Value in µg/L	N = 570 N > DL* = 570	0.8	3.6	4.6	6.4	6.2	18.8	55.0

* DL ranges from 0.05 to 0.5 µg/L.

- ***Marine Water***

A total of 1,067 samples across 27 sites were available for manganese in marine water samples collected by ENV's and MV's monitoring programs. Manganese was detected in 1,055 samples (99%) with concentrations ranging from 0.76 to 707 µg/L to compare to the proposed WQO of 22.6 µg/L.

- ENV: 497 samples were collected from 19 sites in 13 years over the last six decades and manganese was detected in 485 samples (98% df, 1% exceedance). Concentrations ranged from 1 to 707 µg/L.
- MV: 570 samples with manganese detected in all samples and concentrations ranging from 0.8 to 55.0 µg/L (100% df, 4.2% exceedance).

Selenium

Selenium has been measured in marine water, sediment, and fish and shellfish tissue. Screening benchmark concentrations for selenium are from the BC WQG and BC WWQG and are 2 µg/L, 2 µg/g dw, and 0.21 µg/g ww in water (WLRS 2026), sediment (WLRS 2025a), and fish/shellfish tissue (WLRS 2023), respectively.

- ***Marine Water***

A total of 647 samples across 21 sites were available for selenium in marine water samples collected by ENV and MV. Selenium was detected in 81 samples (13%) with concentrations ranging from 0.5 to 1.5 µg/L. There were no exceedances identified in water when compared to the marine water screening benchmark; therefore, no WQO was defined for water (see Section 3.2 for rationale).

- ***Sediment***

465 samples from 63 sites were available from all monitoring programs excluding ECCC Benthic and North Pacific Marine Organization PAH and Pesticide Study. Selenium was detected in 169 samples (36%) with concentrations ranging from 0.1 µg/g to 5.2 µg/g dw. Selenium concentrations were above the benchmark value of 2 µg/g dw in 44 samples (9% of total).

- ENV: 89 samples were collected from 30 sites over the past four decades. Selenium was detected in 23 samples (26% df, 0% exceedance). Concentrations ranged from 0.2 to 1.4 µg/g.
- MV: Sediment samples were collected in 2008, 2011, 2013, and 2016. Out of 105 samples, selenium was detected in 86 samples and 41 benchmark exceedances occurred (82% df, 48% exceedance). The concentrations ranged from 0.35 to 5.2 µg/g.
- OW: Sediment samples were collected from 18 sites annually between 2015 and 2019 except in 2017. 32 samples were collected, and selenium was detected in 21 samples (66% df, 0% exceedance). Concentrations ranged from 0.21 to 1.2 µg/g.

- ECCCDSP: 239 samples across 8 sites were collected in 2009, and in all years between 2013 and 2016. Selenium was detected in 39 samples. 3 samples had concentrations higher than the benchmark (16% df, 8% exceedance). Measured concentrations were between 0.1 and 2.2 µg/g.

- ***Fish/Shellfish Tissue***

A total of 114 samples across 28 sites were available for selenium in fish or shellfish tissue collected by ENV's, MV's, and OW's monitoring programs. Selenium was detected in 103 samples (90%) with concentrations ranging from 0.2 to 4.6 µg/g ww. The benchmark value of 0.21 µg/g ww was exceeded in 102 samples (99% of detects).

- ENV: 19 samples were collected from 11 sites and selenium was detected in 8 samples (42% df, 100% exceedance). Concentrations ranged from 0.5 to 0.9 µg/g.
- MV: Selenium was detected in all 73 samples with concentrations ranging from 0.3 to 4.1 µg/g (100% df, 100% exceedance).
- OW: 22 tissue samples were collected from 10 sites biannually between 2015 and 2019 except 2017. Selenium was detected in all samples (100% df, 95% exceedance). Concentrations were between 0.2 and 4.6 µg/g.

Silver

Silver has been measured in marine water and sediment samples. Data for marine water were available from ENV and MV sources while sediment data were available from ENV, MV, OW, and ECCCDSP. Screening benchmark concentrations for silver are from the BC WQGs and the BC WSQGs and are 0.5 µg/L in marine water (WLRS, 2026 and WLRS, 2025b) and 1 µg/g dw in sediment (WLRS, 2025a).

- ***Marine Water***

A total of 788 marine water samples across 21 sites were collected by ENV and MV. Silver was detected in 40 samples (5%) with concentrations ranging from 0.05 to 20.0 µg/L. Three samples (< 1% of total) had concentrations higher than the benchmark value of 0.5 µg/L.

- ENV: 78 samples were collected in 2000, 2001, and 2009 from 13 sites. Silver was detected in 3 samples with concentrations between 10.0 and 20.0 µg/L which all exceeded benchmark value (4% df, 100% exceedance).
- MV: 710 marine water samples were collected annually from 8 sites. Silver was detected in 37 samples (5% df, 0% exceedance), with concentrations ranging from 0.05 to 0.12 µg/L.

- ***Sediment***

415 sediment samples were collected by all programs excluding ECCC Benthic and North Pacific Marine Organization PAH and Pesticide Study. Silver was detected in 344 samples (83%). Concentrations of silver ranged from 0.051 µg/g to 6.0 µg/g dw. Concentrations were higher than the benchmark value of 1 µg/g dw in 15 samples (4% of total).

- ENV: Silver was detected in 33 samples from a total of 39 samples with 8 exceeding the benchmark (85% df, 24% exceedance). Concentrations ranged between 0.077 µg/g and 4.0 µg/g.
- MV: Sediment samples were collected across 7 sites. In all 105 samples, silver was detected (100% df, 0% exceedance). Concentrations ranged from 0.2 to 0.9 µg/g.

- OW: 32 sediment samples were collected from 18 sites. Silver was detected in 19 samples (59% df, 0% exceedance). Concentrations were between 0.1 µg/g and 0.6 µg/g.
- ECCCDSP: 239 samples across 8 sites were collected. Silver was detected in 187 samples, and 7 samples exceeded the benchmark value (78% df, 4% exceedance). Sample concentrations were between 0.051 and 6.0 µg/g.

Thallium

Thallium has been measured in marine water samples from ENV and MV sources. The screening benchmark concentration for thallium in marine water is 0.27 µg/L (Washington State, 2024) for the protection of human consumption of finfish. It was not clear from the reference whether this is for a calculated mean (chronic) or maximum (acute) benchmark comparison but was interpreted as a chronic benchmark.

- ***Marine Water***

A total of 631 samples across 19 sites were available for thallium in marine water samples collected by ENV and MV. Thallium was detected in 2 samples (< 1%). One sample (< 1% of total) exceeded the benchmark value of 0.27 µg/L.

- ENV: Thallium was not detected in any of the 61 samples collected (0% df).
- MV: 570 marine water samples were collected from 8 sites. Thallium was detected in 2 samples (< 1% df, 50% exceedance) at 0.13 and 0.3 µg/L.

2.4 Knowledge Gaps and Research Needs

There is not yet enough information about marine biotoxin sources and levels in səlilwət / Burrard Inlet. Biotoxins are toxic agents that are derived from living organisms. They are of high importance to TWN due to their effect on shellfish harvest potential, so an improved understanding is necessary of the factors contributing to biotoxin levels. Biotoxins of particular interest (and their associated illnesses) include, but are not limited to, domoic acid (amnesic shellfish poisoning), okadaic acid (diarrhetic shellfish poisoning), brevetoxins (neurotoxin shellfish poisoning) and saxitoxins (paralytic shellfish poisoning). Although the sources may, at times, be out of our control, improved understanding of water quality conditions that influence biotoxins, and methods for managing biotoxins, is required to help achieve the vision and values for səlilwət / Burrard Inlet. Management of physical water quality (see Björklund et al., 2024) is one approach for managing biotoxin levels. Further recommendations for monitoring are provided in Section 4.0.

3. PROPOSED OBJECTIVES FOR ADDITIONAL PARAMETERS IN səlilwət / BURRARD INLET

The general decision-making process applied in this technical report to determine whether a WQO should/can be proposed for a particular water quality parameter is presented in Figure 7. If there was sufficient data available for a parameter, an applicable screening benchmark and, after comparison to the screening benchmark, exceedances identified, then a WQO was considered and/or proposed.

In some cases, parameters are indicator parameters or needed for calculating a benchmark (e.g., biological oxygen demand [BOD], carbonaceous biological oxygen demand [CBOD], total organic carbon [TOC]). These parameters should continue to be monitored appropriately as part of a monitoring program.

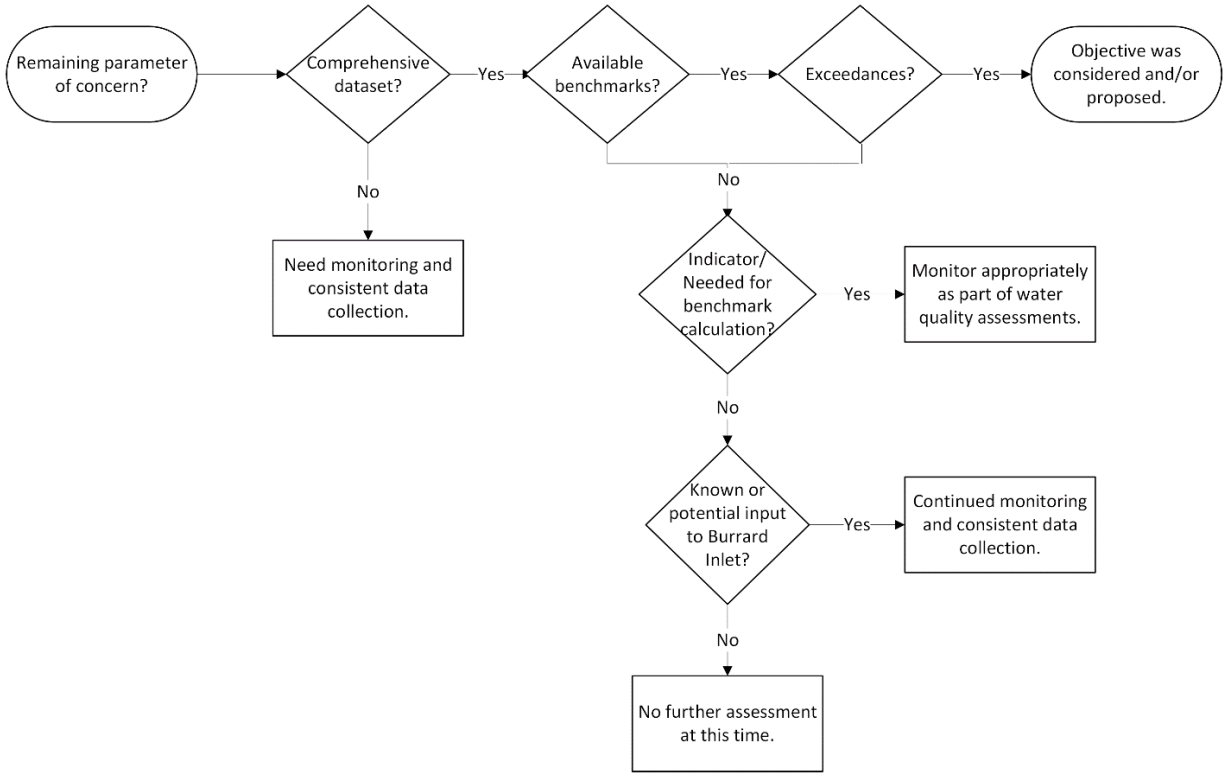

Figure 7: Decision-making process for determining whether to propose a WQO for additional marine parameters.

3.1 Proposed Objectives

Based on the assessment results summarized above, proposed objectives are presented in Table 2, with additional information for each parameter presented in Appendix B. These objectives are proposed to apply to all sub-basins.

The most sensitive value protected by each proposed objective is from the list of values identified and described in Rao et al. 2019, specifically: shellfish and finfish consumption by humans, marine aquatic life and wildlife, cultural practices and recreational uses, and institutional water uses.

Table 2: Proposed Water Quality Objectives for additional parameters of concern for səlilwət */ Burrard Inlet (see Appendix B for details and references)*

Parameter	Medium (water, sediment and/or tissue)	Objective (all sub-basins)	Most Sensitive Value Protected
All anthropogenic (human-made) contaminants	Water, sediment, tissue	Decreasing concentrations from current levels	All
Total ammonia nitrogen (NH_3 as mg/L N; also requires pH, temperature, and salinity data)	Water	See criteria table from the BC WQGs (mean). If toxicity modifying factors (salinity, pH, and temperature) were not measured, the objective is 23 mg/L as N (mean) [1]	Aquatic Life
Chromium	Water	Cr VI: 1.5 µg/L Cr III: 56 µg/L (mean)[1]	Aquatic life
	Sediment	Cr III: 52.3 µg/g dw (max)[2]	Aquatic life
	Tissue	Cr VI: 0.08 µg/g ww (max)[3]	Human consumption of fish/shellfish
Manganese	Water	22.6 µg/L (mean) [1]	Human consumption of shellfish
Selenium	Sediment	2 µg/g dw (max) [2]	Aquatic life
	Tissue	0.21 µg/g ww (max) [3]	Human consumption of fish/shellfish
Silver	Water	0.5 µg/L (mean) [1]	Aquatic life
	Sediment	1 µg/g dw (max) [2]	Aquatic life
Thallium	Water	0.27 µg/L (mean) [1]	Human consumption of finfish

[1] Mean is based on at least five weekly samples over a 30-day period. Compare mean to WQO and no more than 20% of samples > WQO.
[2] Based on at least 1 composite sample consisting of at least 3 replicates. Compare maximum to WQO.
[3] Applies to all tissue types. Based on a minimum of one composite sample, comprising no fewer than five fish, five crabs, or twenty-five bivalves. Compare maximum to WQO.

3.2 Rationale and Limitations

In the case of parameters for which levels in səlilwət / Burrard Inlet have exceeded screening benchmarks, the most conservative benchmark for each medium (water, sediment, tissue) is proposed as a water quality objective for səlilwət / Burrard Inlet, in relation to the values to protect as outlined in Rao et al. 2019. Objectives may be updated as understanding of effects and monitoring efforts increase, and detection limits improve.

Objectives have not been proposed for water quality parameters of potential concern for which data are currently insufficient (e.g., data is >10 years old, limited dataset, not consistently monitored). Instead, monitoring is recommended to determine if levels of those parameters exceed screening benchmarks, as presented in Table 3.

For total ammonia nitrogen, the proposed WQO is based on a criteria table from the BC WQGs that requires measurement of toxicity modifying factors (salinity, pH, and temperature) to calculate a condition specific benchmark (Appendix D). The salinity of deeper water is usually 29-30 parts per trillion (ppt), while the surface salinity can vary from 20-25 ppt during the winter local runoff period and to less

than 10 ppt during the summer when Fraser River runoff is the major dilution factor to səlilwət / Burrard Inlet. The most saline surface waters in səlilwət / Burrard Inlet occur between the First and Second Narrows due to turbulent mixing associated with estuarine and tidal flows through the shallow areas (Nijman and Swain, 1990). If data was not collected for toxicity modifying factors, the proposed objective is the lowest calculated screening benchmark among the dataset (23 mg/L as N).

An assessment by ECCC and Health Canada concluded that after considering all available lines of evidence presented, there is risk of harm to the environment from manganese and its compounds (ECCC and Health Canada, 2025). Manganese and its compounds meet the criteria under paragraph 64(c) of Canadian Environmental Protection Act as they are entering or may enter the environment in a quantity or concentration or under conditions that constitute or may constitute a danger in Canada to human life or health (ECCC and Health Canada 2025). While most of the water quality data reviewed was below the available screening benchmark of 100 µg/L, a WQO for manganese in marine water of 22.6 µg/L was derived due to the conclusions of the ECCC and Health Canada assessment. This process differs from the decision-making process presented in Figure 7.

Objectives for selenium in sediment and tissue are proposed, as there were screening benchmark exceedances in these two media. An objective for selenium in water (in which there were no screening benchmark exceedances) was not proposed, however, unlike similar circumstances with other metals (e.g., arsenic, nickel). Objectives for arsenic and nickel in water had been calculated from the 95th percentile of the data. This method was not applied to selenium because selenium particulates are highly bioavailable in the water column and are rapidly incorporated into sediments or taken up by organisms (ENV, 2014); therefore, water concentrations are expected to be relatively low. It is still recommended to monitor selenium in water and compare to relevant screening benchmarks.

Assessments have not yet been done to determine if these WQOs are protective of the most sensitive values affected by each parameter. They may also not be protective enough to account for bioaccumulation of contaminants into human consumers of fish or shellfish, or apex predators such as killer whales. With the understanding that the overall goal is to restore the health of səlilwət / Burrard Inlet to protect the values articulated at the outset of this initiative, namely shellfish and finfish consumption by humans, aquatic life, wildlife, cultural practices and recreational uses, and institutional water uses (Rao et al. 2019), a general objective is to see a reduction in all contaminants in all media (water, sediment and tissue) over time, with the aspiration that no anthropogenic contaminants be present in the Inlet.

4. MONITORING RECOMMENDATIONS

Due to insufficient data for səlilwət / Burrard Inlet, monitoring is recommended for the water quality parameters listed in Table 3. Marine screening benchmarks (e.g., BC WQGs, Federal Environmental Quality Guidelines) are available for many of these parameters, for comparison of monitoring results. A coordinated approach is recommended, to determine the most efficient monitoring regime (e.g., frequency, sampling locations, sampling effort, resources, funding) (see TWN 2025).

Table 3: Parameters to monitor in səlilwət */ Burrard Inlet to determine if a WQO is needed*

Parameter	Medium
1,2,4-trichlorobenzene	Water
1,2-dichlorobenzene	Water, sediment, tissue
17α-ethinylestradiol (EE2) plus other hormones/steroids	Water

Parameter	Medium
Aluminum*	Water, sediment, tissue
Benzene, toluene, ethylbenzene, xylene, styrene (BTEXS)	Water
Biotoxins	Water and tissue
Chlorate and free chlorine	Water
Chlorine-produced oxidants (CPOs)	Water
Chromium (speciated data)	Water and tissue
Cobalt*	Water, sediment, tissue
Cotinine (metabolite of nicotine)	Water
Cyanide (e.g., weak acid dissociable)	Water
Ethylene dichloride	Water, sediment, tissue
Ethylene glycol	Water
Hexachlorobutadiene (HCBD)	Sediment
Iron*	Water, sediment, tissue
Light extractable petroleum hydrocarbon (LEPH)	Water
Methyl tert-butyl ether (MTBE)	Water
Molybdenum**	Water, sediment, tissue
Monochlorobenzene	Water
Selenium	Water
Sulphide (as unionized H_2S)	Water
Tin*	Water, sediment, tissue
Total extractable hydrocarbons (TEH)*,***	Water
Total phenols	Water, tissue
Volatile petroleum hydrocarbons (VPHs) and volatile hydrocarbons (nC6 - nC10) (VH6-10)	Water

* There is currently no benchmark for comparison for marine water. Continue to monitor these metals in səlilwət / Burrard Inlet as an applicable benchmark may be developed in the future.
** There is currently no reliable benchmark for comparison for marine water; however, there exists an interim working level of 23 µg/L from the Australia and New Zealand Environment and Conservation Council (ANZECC, 2000; Commonwealth of Australia, 2000), and some exceedances of this interim working level have been observed in səlilwət / Burrard Inlet.
*** Constituents should also be monitored (i.e., polycyclic aromatic hydrocarbons [PAHs] and total PAH; see Braig et al. 2021).

5. MANAGEMENT OPTIONS

The following initiatives are planned or underway and will help reduce impacts of these additional parameters in səlilwət / Burrard Inlet:

- Tsleil-Waututh Nation's ongoing work to restore the health of the Inlet through implementation of the Burrard Inlet Action Plan.
- Continued advancement of strategies to reduce combined sewer overflows.
- Ongoing development and implementation of ISMPs for all developed watersheds that flow into səlilwət / Burrard Inlet to address erosion, drainage, flooding, stream health, and remediation of any potential water quality issues within watersheds.
- Improving sanitary and industrial wastewater treatment, e.g., via the planned new North Shore Wastewater Treatment Plan, to further reduce levels of hormones/steroids, organic material, and nutrients entering səlilwət / Burrard Inlet.

The following management options have the potential to further reduce anthropogenic sources of these additional parameters (including the parameters listed above with recommendations for ongoing

monitoring) to səlilwət / Burrard Inlet and are recommended for consideration, although this is not an exhaustive list of tools and actions:

- Review industrial and other wastewater discharges authorized by BC and other jurisdictions to identify where updates are needed to reduce entry of contaminants into səlilwət / Burrard Inlet.
- Removal of wood structures with harmful wood preservation treatment in səlilwət / Burrard Inlet.
- Limiting oil tanker traffic to reduce the potential for an accident/malfunction and potential contribution of petroleum hydrocarbons into səlilwət / Burrard Inlet.
- Regular monitoring to determine if there are unreported oil, fuel, and other spills in and around səlilwət / Burrard Inlet along with subsequent compliance and enforcement activities and/or mitigative measures, where necessary.
- Improved emergency response coordination and notification to communities on spill events.
- Engagement with TWN and other Indigenous Nations on actions tied to regulations for spill mitigative measures including TWN's Oil Spill Response Plan and Preparedness Assessment (Nuka and TWN, 2021).
- Evaluate the access and availability of land-based spill response caches around səlilwət/Burrard Inlet for addressing spills on areas that are regulated by existing spill requirements.
- Prioritise compliance verification of authorisations and enforcement of regulations on waste dumped from private and commercial properties and marine vessels into səlilwət / Burrard Inlet to reduce contamination concentrations.
- A coordinated effort between agencies, industry, and local governments to address the numerous other non-point sources of contamination entering səlilwət / Burrard Inlet.

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APPENDIX A: DATA SOURCES

Table A1: Data Sources for Additional Parameters of Concern in səlilwət */ Burrard Inlet*

Source	Program	Parameter	Media	No. of Obs.	No. of Sites	Sampling Frequency	Years with Data
BC ENV	Provincial Water Quality Objectives Attainment Monitoring	Total ammonia nitrogen	Marine water	435	19	Sporadic	1973-1980, 1982, 2002, 2009
		Chromium	Marine Water	404	20	Sporadic	1972-1980, 1989, 1994, 2002, 2001, 2009
		Chromium	Sediment	137	34	Sporadic	1981, 1988-1994, 2000, 2002, 2009, 2020
		Chromium	Fish or Shellfish Tissue	20	11	Sporadic	1990, 1992, 2002-2003
		Manganese	Marine Water	497	19	Sporadic	1972-1980, 2000-2002, 2009
		Selenium	Marine Water	77	13	Sporadic	2000-2001, 2009
		Selenium	Sediment	89	30	Sporadic	1988-1994, 2000, 2002, 2009, 2020
		Selenium	Fish or Shellfish Tissue	19	11	Sporadic	1990, 1992, 2002-2003
		Silver	Marine Water	78	13	Sporadic	2000-2001, 2009
		Silver	Sediment	39	21	Sporadic	2000, 2002, 2009, 2020
		Thallium	Marine Water	61	11	Single event	2009
Metro Vancouver	Burrard Inlet Ambient Monitoring Program	Total ammonia nitrogen	Marine water	630	8	Annual	2007, 2009-2016
		Chromium	Marine Water	710	8	Annual	2007-2016
		Chromium	Sediment	105	7	Biannual	2008, 2011, 2013, 2015
		Chromium	Fish or Shellfish Tissue	73	7	Every 5 years	2007, 2012
		Manganese	Marine Water	570	8	Annual	2007-2011, 2014-2016
		Selenium	Marine Water	570	8	Annual	2007-2011, 2014-2016
		Selenium	Sediment	105	7	Biannual	2008, 2011, 2013, 2015

Source	Program	Parameter	Media	No. of Obs.	No. of Sites	Sampling Frequency	Years with Data
		Selenium	Fish or Shellfish Tissue	73	7	Every 5 years	2007, 2012
		Silver	Marine Water	710	8	Annual	2007-2016
		Silver	Sediment	105	7	Biannual	2008, 2011, 2013, 2015
		Thallium	Marine Water	570	8	Annual	2007-2011, 2014-2016
Ocean Wise	**Pollution Tracker**	Chromium	Marine Water	NA	NA	NA	NA
		Chromium	Sediment	32	18	Biannual	2015-2016, 2018-2019
		Chromium	Fish or Shellfish Tissue	22	10	Biannual	2015-2016, 2018-2019
		Manganese	Marine Water	NA	NA	NA	NA
		Selenium	Marine Water	NA	NA	NA	NA
		Selenium	Sediment	32	18	Biannual	2015-2016, 2018-2019
		Selenium	Fish or Shellfish Tissue	22	10	Biannual	2015-2016, 2018-2019
		Silver	Marine Water	NA	NA	NA	NA
		Silver	Sediment	32	18	Biannual	2015-2016, 2018-2019
		Thallium	Marine Water	NA	NA	NA	NA
ECCC	**Benthic**	Chromium	Marine Water	NA	NA	NA	NA
		Chromium	Sediment	262	71	Single Event	1985-1987
		Chromium	Fish or Shellfish Tissue	772	12	Single Event	1985-1986
		Manganese	Marine Water	NA	NA	NA	NA
		Selenium	Marine Water	NA	NA	NA	NA
		Selenium	Sediment	NA	NA	NA	NA
		Selenium	Fish or Shellfish Tissue	NA	NA	NA	NA
		Silver	Marine Water	NA	NA	NA	NA
		Silver	Sediment	NA	NA	NA	NA
		Thallium	Marine Water	NA	NA	NA	NA
ECCC		Chromium	Marine Water	NA	NA	NA	NA

Source	Program	Parameter	Media	No. of Obs.	No. of Sites	Sampling Frequency	Years with Data
	Disposal at Sea	Chromium	Sediment	350	11	Annual	2009, 2012-2017
		Chromium	Fish or Shellfish Tissue	NA	NA	NA	NA
		Manganese	Marine Water	NA	NA	NA	NA
		Selenium	Marine Water	NA	NA	NA	NA
		Selenium	Sediment	239	8	Sporadic	2009, 2013-2016
		Selenium	Fish or Shellfish Tissue	NA	NA	NA	NA
		Silver	Marine Water	NA	NA	NA	NA
		Silver	Sediment	239	8	Sporadic	2009, 2013-2016
		Thallium	Marine Water	NA	NA	NA	NA
PICES	PAH and Pesticide Study	Chromium	Marine Water	NA	NA	NA	NA
		Chromium	Sediment	42	7	Single Event	1999
		Chromium	Fish or Shellfish Tissue	11	9	Single Event	1999
		Manganese	Marine Water	NA	NA	NA	NA
		Selenium	Marine Water	NA	NA	NA	NA
		Selenium	Sediment	NA	NA	NA	NA
		Selenium	Fish or Shellfish Tissue	NA	NA	NA	NA
		Silver	Marine Water	NA	NA	NA	NA
		Silver	Sediment	NA	NA	NA	NA
		Thallium	Marine Water	NA	NA	NA	NA

Notes: NA = Not analysed

APPENDIX B: SCREENING BENCHMARKS AND EXCEEDANCES

Table B1. Proposed Water Quality Objectives for Additional Parameters of Concern for səlilwət */ Burrard Inlet*

Parameter Class/ Group	Parameter	Medium	Potential sources[1]	Available Benchmark	Value protected	Benchmark Reference	1990 WQO	Burrard Inlet data?	Above detection limits in Burrard Inlet?	Benchmark exceedances recorded?	Proposed WQO
Nitrogen	Total Ammonia Nitrogen	Water	Particle board, wood manufacturing, wood treatment.	Criteria Table (mean)	Aquatic life	ENV, 2001	Yes	ENV, MV	Yes	Yes	Appendix D - Criteria Table (mean)
Metals	Chromium	Water	Wood treatment, construction (concrete pouring).	Cr(VI): 1.5 µg/L Cr(III)): 56 µg/L (mean)	Aquatic life	WLRS, 2026 (CCME, 1999a)	Yes, 50 ug/L (total only)	ENV, MV	Not speciated	Total chromium exceeded benchmarks for Cr(VI) and/or Cr(III)	Cr(VI): 1.5 µg/L Cr(III): 56 µg/L (mean)
Metals	Chromium	Sediment		52.3 µg/g dw	Aquatic life	WLRS, 2025a (CCME, 1999b)	Yes (60 ug/g dw)	ECCC, ENV, MV, OW, PICES	Yes	Yes	52.3 µg/g dw
Metals	Chromium	Tissue		Cr(VI): 0.08 µg/g ww	Human consumption of shellfish	WLRS, 2023	No	ECCC, ENV, MV, OW, PICES	Yes	Yes	0.08 µg/g ww
Metals	Manganese	Water	Recycling or bulk storage, galvanizing, welding or machine shops, petroleum or natural gas	100 µg/L (mean)	Human consumption of shellfish	WLRS, 2026 (US EPA, 1986)	No	ENV, MV	Yes	Yes	22.6 µg/L (mean)
Metals	Selenium	Sediment		2 µg/g dw (mean)	Aquatic life	WLRS, 2025a (Beatty and Russo, 2014)	No	ECCCC, ENV, MV, OW	Yes	Yes	2 µg/g dw (mean)

Parameter Class/ Group	Parameter	Medium	Potential sources[1]	Available Benchmark	Value protected	Benchmark Reference	1990 WQO	Burrard Inlet data?	Above detection limits in Burrard Inlet?	Benchmark exceedances recorded?	Proposed WQO
Metals	Selenium	Tissue	production facilities, automotive, truck, bus, subway or other, motor vehicle maintenance, repair, salvage or wrecking, dry docks, marinas, shipbuilding or boat repair and maintenance, including paint removal from hulls, railyards, waste oil reprocessing, recycling or bulk storage.	0.21 µg/g ww	Human consumption of shellfish	WLRS, 2023	No	ENV, MV, OW	Yes	Yes	0.21 µg/g ww
Metals	Silver	Water		0.5 µg/L (mean)	Aquatic life	WLRS, 2026 (WLRS, 2025b)	No	ENV, MV	Yes	Yes	0.5 µg/L (mean)
Metals	Silver	Sediment		1 µg/g dw	Aquatic life	WLRS, 2025a (Long and Morgan, 1990)	No	ECCC, ENV, MV, OW	Yes	Yes	1 µg/g dw
Metals	Thallium	Water		0.27 µg/L	Human consumption of finfish	Washington State, 2024	No	ENV, MV	Yes	Yes	0.27 µg/L

Notes:

dw = dry weight; ww = wet weight

ECCC = Environment and Climate Change Canada; ENV = Ministry of Environment and Parks; MV = Metro Vancouver; OW = Ocean Wise; PICES = North Pacific Marine Science Organization

[1] From CSAP PCOC guidance for potential contaminants of concern - https://csapsociety.bc.ca/wp-content/uploads/Legacy_Thurber-PCOCGuidanceFinal-Jan2023.pdf

APPENDIX C: DATA SCREENING RESULTS

Notes:

- Observations are presented for Burrard Inlet as a whole, and not for each sub-basin.
- Results from different monitoring programs are not directly comparable as variations exist in the sampling and analytical methods as well as the distribution of sites.
- Applied screening benchmarks are presented in Appendix B.
- Samples below detection limits were excluded from the summary of mean, minimum, and maximum concentrations.
- NA = Not Analysed; OW = Ocean Wise Pollution Tracker; PICES =North Pacific Marine Organization; MV = Metro Vancouver; ENV = BC Ministry of Environment and Parks; ECCCB = Environment and Climate Change Canada Benthic; ECCCDSP = Environment and Climate Change Canada Disposal at Sea Program

Table C1: Summary of Observations of Additional Parameters of Concern in səlilwət */ Burrard Inlet Media*

Parameter	Media	Source	Sample Count	% Detection	Range of Detection Limits	Benchmark	% Benchmark Exceedance	Minimum	Maximum	Mean
					µg/L or µg/g	µg/L or µg/g		µg/L or µg/g	µg/L or µg/g	µg/L or µg/g
Total Ammonia Nitrogen	Marine Water	ENV	435	46%	Not listed	Insufficient data to calculate	NA	5	300	32
Total Ammonia Nitrogen	Marine Water	MV	630	84%	5 to 50	23 to 200	10%	5	270	34
Chromium	Marine Water	ENV	404	36%	0.005 to 6	1.5	100%	2.0	43.0	9.7
Chromium	Marine Water	MV	710	37%	0.5 to 1	1.5	64%	0.5	5.6	2.1
Chromium	Marine Water	OW	NA	NA	NA	1.5	NA	NA	NA	NA
Chromium	Marine Water	ECCCB	NA	NA	NA	1.5	NA	NA	NA	NA
Chromium	Marine Water	ECCCDSP	NA	NA	NA	1.5	NA	NA	NA	NA
Chromium	Marine Water	PICES	NA	NA	NA	1.5	NA	NA	NA	NA
Chromium	Sediment	ENV	137	100%	Unknown	52.3	11%	4.0	145	33.2
Chromium	Sediment	MV	105	100%	0.1 to 1	52.3	4%	15.9	72.0	34.9

Parameter	Media	Source	Sample Count	% Detection	Range of Detection Limits	Benchmark µg/L or µg/g	% Benchmark Exceedance	Minimum	Maximum	Mean
					µg/L or µg/g			µg/L or µg/g	µg/L or µg/g	µg/L or µg/g
Chromium	Sediment	OW	32	88%	0.5 to 0.5	52.3	0%	4.4	47.7	27.0
Chromium	Sediment	ECCCB	262	100%	Unknown	52.3	58%	11.8	310	62.2
Chromium	Sediment	ECCCDSP	350	100%	Unknown	52.3	1%	2.5	62.0	26.6
Chromium	Sediment	PICES	42	100%	Unknown	52.3	24%	1.3	75.0	26.5
Chromium	Fish / Shellfish	ENV	20	15%	0.2	0.08	100%	1.0	6.0	3.0
Chromium	Fish / Shellfish	MV	73	19%	0.04 to 0.5	0.08	50%	0.04	0.17	0.09
Chromium	Fish / Shellfish	OW	22	100%	0.01 to 0.05	0.08	82%	0.04	2.98	0.53
Chromium	Fish / Shellfish	ECCCB	772	89%	0.2 to 4	0.08	100%	0.04	27.7	1.31
Chromium	Fish / Shellfish	ECCCDSP	NA	NA	NA	0.08	NA	NA	NA	NA
Chromium	Fish / Shellfish	PICES	11	73%	0.2	0.08	100%	0.10	0.40	0.23
Manganese	Marine Water	ENV	497	98%	0.05 to 20	22.6	1%	1	707 (possible outlier with 60 µg/L being the next highest measured concentration)	11.5
Manganese	Marine Water	MV	570	100%	0.05 to 0.5	22.6	4.2%	0.8	55	6.4
Manganese	Marine Water	OW	NA	NA	NA	22.6	NA	NA	NA	NA
Manganese	Marine Water	ECCCB	NA	NA	NA	22.6	NA	NA	NA	NA
Manganese	Marine Water	ECCCDSP	NA	NA	NA	22.6	NA	NA	NA	NA
Manganese	Marine Water	PICES	NA	NA	NA	22.6	NA	NA	NA	NA
Selenium	Marine Water	ENV	77	10%	0.04 to 60	2	0%	1	1.5	1.2
Selenium	Marine Water	MV	570	13%	0.5 to 0.71	2	0%	0.5	1.5	0.8

Parameter	Media	Source	Sample Count	% Detection	Range of Detection Limits	Benchmark µg/L or µg/g	% Benchmark Exceedance	Minimum	Maximum	Mean
					µg/L or µg/g			µg/L or µg/g	µg/L or µg/g	µg/L or µg/g
Selenium	Marine Water	OW	NA	NA	NA	2	NA	NA	NA	NA
Selenium	Marine Water	ECCCB	NA	NA	NA	2	NA	NA	NA	NA
Selenium	Marine Water	ECCCDSP	NA	NA	NA	2	NA	NA	NA	NA
Selenium	Marine Water	PICES	NA	NA	NA	2	NA	NA	NA	NA
Selenium	Sediment	ENV	89	26%	0.5 to 10	2	0%	0.2	1.4	0.6
Selenium	Sediment	MV	105	82%	0.1 to 50	2	48%	0.35	5.2	2.1
Selenium	Sediment	OW	32	66%	0.2	2	0%	0.21	1.2	0.5
Selenium	Sediment	ECCCB	NA	NA	NA	2	NA	NA	NA	NA
Selenium	Sediment	ECCCDSP	239	16%	0.1 to 3	2	8%	0.1	2.2	1.0
Selenium	Sediment	PICES	NA	NA	NA	2	NA	NA	NA	NA
Selenium	Fish / Shellfish	ENV	19	42%	0.5 to 10	0.21	100%	0.5	0.9	0.7
Selenium	Fish / Shellfish	MV	73	100%	0.01	0.21	100%	0.3	4.1	1.2
Selenium	Fish / Shellfish	OW	22	100%	0.01 to 0.05	0.21	95%	0.2	4.6	1.2
Selenium	Fish / Shellfish	ECCCB	NA	NA	NA	0.21	NA	NA	NA	NA
Selenium	Fish / Shellfish	ECCCDSP	NA	NA	NA	0.21	NA	NA	NA	NA
Selenium	Fish / Shellfish	PICES	NA	NA	NA	0.21	NA	NA	NA	NA
Silver	Marine Water	ENV	78	4%	0.005 to 10	0.5	100%	10	20.0	13.3
Silver	Marine Water	MV	710	5%	0.05 to 0.1	0.5	0%	0.05	0.12	0.07
Silver	Marine Water	OW	NA	NA	NA	0.5	NA	NA	NA	NA
Silver	Marine Water	ECCCB	NA	NA	NA	0.5	NA	NA	NA	NA

Parameter	Media	Source	Sample Count	% Detection	Range of Detection Limits	Benchmark µg/L or µg/g	% Benchmark Exceedance	Minimum	Maximum	Mean
					µg/L or µg/g			µg/L or µg/g	µg/L or µg/g	µg/L or µg/g
Silver	Marine Water	ECCCDSP	NA	NA	NA	0.5	NA	NA	NA	NA
Silver	Marine Water	PICES	NA	NA	NA	0.5	NA	NA	NA	NA
Silver	Sediment	ENV	39	85%	2	1	24%	0.077	4.0	0.84
Silver	Sediment	MV	105	100%	0.05 to 0.1	1	0%	0.2	0.9	0.5
Silver	Sediment	OW	32	59%	0.1	1	0%	0.1	0.6	0.4
Silver	Sediment	ECCCB	NA	NA	NA	1	NA	NA	NA	NA
Silver	Sediment	ECCCDSP	239	78%	0.05 to 2	1	4%	0.05	6.0	0.30
Silver	Sediment	PICES	NA	NA	NA	1	NA	NA	NA	NA
Thallium	Marine Water	ENV	61	0%	0.002 to 0.1	0.27	0%	NA	NA	NA
Thallium	Marine Water	MV	570	0.4%	0.05 to 0.13	0.27	50%	0.13	0.30	0.22
Thallium	Marine Water	OW	NA	NA	NA	0.27	NA	NA	NA	NA
Thallium	Marine Water	ECCCB	NA	NA	NA	0.27	NA	NA	NA	NA
Thallium	Marine Water	ECCCDSP	NA	NA	NA	0.27	NA	NA	NA	NA
Thallium	Marine Water	PICES	NA	NA	NA	0.27	NA	NA	NA	NA

APPENDIX D: CRITERIA TABLES FOR TOTAL AMMONIA NITROGEN

Table D1. Mean (average) Concentration of Total Ammonia Nitrogen for Protection of Aquatic Life (mg/L of Nitrogen).

Salinity equals 10 g/kg; Temperature (T) in degrees Celsius

pH	T = 0	T = 5	T = 10	T = 15	T = 20	T = 25
7.0	41	29	20	14	9.4	6.6
7.2	26	18	12	8.7	5.9	4.1
7.4	17	12	7.8	5.3	3.7	2.6
7.6	10	7.2	5	3.4	2.4	1.7
7.8	6.6	4.7	3.1	2.2	1.5	1.1
8.0	4.1	2.9	2.0	1.4	0.97	0.69
8.2	2.7	1.8	1.3	0.87	0.62	0.44
8.4	1.7	1.2	0.81	0.56	0.41	0.29
8.6	1.1	0.75	0.53	0.37	0.27	0.20
8.8	0.69	0.50	0.34	0.25	0.18	0.14
9.0	0.44	0.31	0.23	0.17	0.13	0.10

Salinity equals 20 g/kg; Temperature (T) in degrees Celsius

pH	T = 0	T = 5	T = 10	T = 15	T = 20	T = 25
7.0	44	30	21	14	9.7	6.6
7.2	27	19	13	9.0	6.2	4.4
7.4	18	12	8.1	5.6	4.1	2.7
7.6	11	7.5	5.3	3.4	2.5	1.7
7.8	6.9	4.7	3.4	2.3	1.6	1.1
8.0	4.4	3.0	2.1	1.5	1.0	0.72
8.2	2.8	1.9	1.3	0.94	0.66	0.47
8.4	1.8	1.2	0.84	0.59	0.44	0.30
8.6	1.1	0.78	0.56	0.41	0.28	0.20
8.8	0.72	0.50	0.37	0.26	0.19	0.14
9.0	0.47	0.34	0.24	0.18	0.13	0.10

Salinity equals 30 g/kg; Temperature (T) in degrees Celsius

pH	T = 0	T = 5	T = 10	T = 15	T = 20	T = 25
7.0	47	31	22	15	11	7.2
7.2	29	20	14	9.7	6.6	4.7
7.4	19	13	8.7	5.9	4.1	2.9
7.6	12	8.1	5.6	3.7	3.1	1.8
7.8	7.5	5.0	3.4	2.4	1.7	1.2
8.0	4.7	3.1	2.2	1.6	1.1	0.75
8.2	3.0	2.1	1.4	1.0	0.69	0.50
8.4	1.9	1.3	0.90	0.62	0.44	0.31
8.6	1.2	0.84	0.59	0.41	0.30	0.22
8.8	0.78	0.53	0.37	0.27	0.20	0.15
9.0	0.50	0.34	0.26	0.19	0.14	0.11